ASSESSING POST MORTEM INTERVAL OF *SUS DOMESTICUS* IN A NORTHERN CALIFORNIA ENVIRONMENT.

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In
Anthropology

By
Devan C. Glensor
San Francisco, California
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CERTIFICATION OF APPROVAL

I certify that I have read *Assessing Post Mortem Interval of Sus Domesticus in a Northern California Environment* by Devan Christine Glensor, and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requests for the degree: Master of Arts in Anthropology at San Francisco State University.

Dr. Mark Griffin, Associate Professor of Anthropology

Dr. Cynthia Wilczak, Associate Professor of Anthropology

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Devan Christine Glensor
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The complex relationship between the environment and decomposition rate results in a need for taphonomic studies in multiple environments to be performed. While taphonomic studies on human remains are prolific in the Midwest, a lack of knowledge upon the rates of decomposition in the west, specifically California, remains. This thesis investigates the rate of decomposition to produce a skeleton in Northern California and attempts to address how temperature and clothing impact decomposition rates utilizing clothed and nude domestic pig subjects. This experiment found that overall temperature, or microclimate, had a more significant impact upon decomposition rates than that of clothing. Although clothing did appear to provide a protective environment for necrophagous species. Subjects placed in full sunlight decomposed at an accelerated rate in early stages of decomposition when compared to their shaded counterparts, however those in full shade reached skeletonization prior to those in full sun due to mummification which retarded the rate of decomposition for the pair in direct sunlight. This study advises that estimations of Post Mortem Interval on subjects found in direct sunlight be made with caution, due to the lack of changes noted in later stages of decomposition.

I certify that the Abstract is a correct representation of the content of this thesis.

Chair, Thesis Committee	Date

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CHAPTER 1- INTRODUCTION

The role of forensic anthropologists and taphonomic studies has grown in recent years, specifically in assisting investigations through assessing the Post Mortem Interval (PMI) or time since death. PMI has become an important tool in forensic investigations as it provides vital information on identification; corroborating or refuting the story of suspects, linking the cadaver into a timeline of events prior to the death of an individual through identifying natural and human caused effects on the remains (Megyesi et al. 2005). Taphonomic studies that look at the surrounding local environmental effects upon the remains are of high interest due to the potential it offers to forensic investigations. However it is important to note that little is understood of the variables involved.

The purpose of this study is to analyze the effects of the decomposition process, focusing on the time to produce a skeleton in an arid environment with clothed and unclothed domestic pig subjects. This research will be addressing the role in which clothing and sunlight play in the rate of decomposition in Northern California environments. This particular project is relevant as no research around the rate of decomposition in Northern Californian environments has been conducted. Numerous studies have noted the complex relationship between environment and decomposition, specifically how the rate of decomposition responds to several environmental variables such as temperature, humidity percentage and entomological activity (Bornemisszа 1957; Reed 1958; Payne 1965; Galloway 1989; Prieto et. al 2004; Megyesi 2005; Simmons

2007; Parks 2011). Due to the fact that the rate of decomposition varies greatly by region, season and environment, there is a need for controlled experiments that help forensic anthropologists better understand how specific variables affect that rate. Experimental taphonomic studies have become prolific since 1980 in specific regions. In 1980 Dr. William Bass established the Anthropological Research Facility at Tennessee Knoxville which has become one of the main contributors to human taphonomic studies (Rottenstein 2006). However because environment plays a major role upon the rate of decomposition it is crucial that taphonomic studies are performed in other regions to create accurate time frames of PMI in these areas.

Understanding local environments is key to any Taphonomic study, thus the lack of research done in Northern California presents a problem. Due to the lack of data, little is known of the variables that may influence the rate of decomposition for this area. This research will provide a tool for law enforcement, medical examiners, as well as archaeologists that can be used for clandestine burials in Northern California. The primary goal of this research is to better understand the rate of decomposition for Northern California, the role clothing and sunlight play upon that rate, and to test the reliability of Megyesi's ADD regression equation to accurately estimate the PMI. This study will measure the rate of decomposition through visual observation, monitoring 4 pig pairs (one clothed/ one nude) in sunlight, and shade.

Previous studies have shown that there is a correlation between ADD and Post Mortem Interval (Megyesi 2005, Myburgh 2013). This study examines the estimation of

PMI by testing and documenting decomposition rates until skeletonization in a Northern California environment. Four *Sus scrofa domesticus* cadavers were placed outdoors on the ground in two separate microenvironments; extreme sunlight and extreme shade. Further it is unclear the role in which clothing plays upon the rate of decomposition, thus two of the four pigs (one in each microenvironment) were clothed. As part of understanding outdoor aboveground decomposition and taphonomy this study includes observations of changes to soft tissue and skeletal material and the effect of clothing upon rates of decomposition. Observations such as these are an important component the reconstruction of body placement at the time of death, the movement of remains postmortem, as well as estimating postmortem interval.

CHAPTER 2 – LITERATURE REVIEW

In this chapter I will discuss the history of forensic anthropology with particular regards to forensic taphonomy. I hope to shed light on how forensic taphonomic experiments have changed the course of forensic anthropology through quantitative methodology. This chapter will look at the history of such experiments and take a closer look at the biological process of decomposition and all of variables that may accelerate or retard the rate of decomposition.

Forensic Taphonomy

Taphonomy was born as a branch of paleontology, initially defined by Russian paleontologist I.A. Efremov in 1940 as the study of the transition of animal remains from the biosphere (life) to lithosphere (death). He coined the term 'taphonomy' from the words "*taphos*" meaning burial and "*nomos*" meaning law, this taphonomy being the laws of burial. The term taphonomy, though initially reserved for the study of animal remains, later included all biological organisms including plants (Bristow 2011). The study of taphonomy has taken on several different definitions depending largely upon the sub-discipline defining it, however the underlying study has remained the same (Rottenstein 2006). The 1970s saw some of the first anthropological taphonomic studies published outside of paleontology (Dirkmaat 2008). Empirical based forensic studies flourished in the 1980's and 1990s, primarily focusing on vertebrate taphonomy and developing a better understanding of material transport and bone weathering (Bristow

2011). Forensic anthropologists adapted the term taphonomy to encompass all processes that act upon remains between death and the discovery of said remains; it was no longer strictly confined to the biological remains or the biosphere in practice but was synonymous with all aspects of the burial or post mortem process (Bristow 2011). This had a significant impact upon the discipline of forensic anthropology and archaeology as forensic investigations were no longer solely lab based.

Until 1988, issues beyond laboratory-derived observations of the bones themselves fell outside of the job description of what a forensic anthropologist did. Iscan, in his 1988 article "Rise of Forensic Anthropology" highlights a need for research aimed specifically at forensic anthropology applications, which was hindered at the time by inappropriate sample materials and strategies, poor analytical standards and methodologies as well as the lack of specific training of forensic practitioners (Dirkmaat 2008). Forensic Taphonomy largely helped to provide a new conceptual framework for forensic anthropology, one that is deeply entrenched in the natural sciences (Dirkmaat 2008). The primary goal of forensic anthropology was aiding in the identification of human remains in forensic contexts; what was unique about the introduction of forensic taphonomy to forensic anthropology was how similar the goals of each discipline were. Forensic anthropology involved the application of principles utilized in other anthropological subfields while simultaneously enhancing methodology in other anthropological subfields; providing a solid scientific underpinning via the introduction of new taphonomic methods and principles for data collection taken from its paleontological and zooarchaeological roots (Dirkmaat 2008; Bristow 2011). From both a methodological and theoretical aspect, taphonomy was the link to integrate other sub-disciplines within forensic anthropology and begin to change the role of what a forensic anthropologist does.

This revolutionary shift was important as it moved forensic anthropology away from the positive ID paradigm, placing importance on context rather than sole focus upon the remains. This moved the discipline closer to its archaeological roots (Dirkmaat 2008). Dirkmaat and colleagues (2008) state that the adoption of taphonomy by forensic anthropologists was the most influential development altering the discipline of forensic anthropology as it has been the leading force in pushing forensic anthropology from a lab-based subject to a scientific discipline with a strong field component. Past forensic anthropologists saw the field only as a way of gathering evidence or creating a biological profile, rather than understanding the field as an opportunity to apply taphonomic techniques to a forensic scene in order to collect information relevant to reconstructing the events surrounding death, body disposal, and placement at the scene (Dirkmaat 2008). Methods relied on skeletal collections composed largely of unclaimed bodies, collections that have been shown to be inadequate as the basis for analyzing modern forensic cases due to secular changes as well as other factors (Dirkmaat 2008). This was particularly problematic after the cases of *Daubert v. Merrel Dow Pharmaceuticals, Inc.* (1993) and *Kumho Tire Company v. Carmichael* (1999).

The Daubert Standard, created in the wake of *Daubert v. Merrel Dow Pharmaceuticals, Inc.* (1993), moved the focus from the experts experience to the experts methods, demanding that methodology was more quantitative in nature rather than qualitative and thus, replicable. Specifically the Daubert Standardss required that methodology adhere to the following restrictions: be testable and have been tested through the scientific method, have been subject to peer review; have established standards; have a known potential error rate and a widespread acceptance by the relevant scientific community (Sharplin 2012). Replicable methods are essential as they specify direct results, rather than analogies. The testability and reliability of replicable methods ensures that conclusions are objectively arrived at rather than subjectively formulated (Dirkmaat 2008). The Daubert standards have increased the urgency of improving analytical methods in forensic anthropology, answering the problem originally proposed by Iscan in 1988. Iscan (1988) stated that there was an urgent need to improve biological profile techniques and to overcome such limitations it was critical that new comparative samples that were more representative of the modern population were assembled. Secular changes in collections created biases in overall body size, health and nutritional status, thus placing serious limitations upon quantitative studies affecting forensic anthropology research. Through carefully controlled experimental taphonomic studies, forensic anthropologists can aim to reconstruct complex events surrounding death, disposal of the body and recovery.

The establishment of the Forensic Anthropology Center at the University of Tennessee, which includes the Anthropology Research Facility (ARF) commonly referred to as “the body farm”, the William Bass Skeletal Collection (BSC), and the Forensic Data Bank (FDB) were created to study human decomposition (Dirkmaat 2008). These collections served to alleviate the bias that forensic anthropologists were up against and to improve quantitative methodology. They were drawn from contemporary populations, reducing bias derived from secular changes and the FDB is largely founded from and updated with forensic cases (Dirkmaat 2008).

Taphonomic studies led to new outcomes that helped to expand the role of forensic anthropologists. It pushed for scientifically grounded estimates of postmortem interval (time-since-death) based on decompositional factors (primarily soft tissue, but in later stages may include bone modification factors), entomological evidence, chemical methods, and associated physical evidence modification. Forensic anthropologists were no longer the lab techs of law enforcement, their skills are vital. Quantitative methodologies helped forensic anthropologists better reconstruction the original position and orientation of the body as well as understand the characterizations of the role played by human intervention (as a taphonomic agent) on the remains, through the process of ‘‘stripping away’’ all other ‘‘natural’’ agents affecting the remains (Dirkmaat 2008).

Forensic Anthropology has evolved from its paleontology past in which studies were concerned with the study of transport, fossilization and the transition of animal remains from the biosphere to the lithosphere to include all of the processes between death and recovery of remains (Bristow 2011). Namely this includes the study of decomposition in order to understand Post Mortem Interval. Post Mortem Interval or time since death has proved critical in answering the five "W"s (who, what, when, where and why) at a crime scene (Vass 2001). Taphonomic studies help to answer: who is the victim, how did the victim die, where and when did death occur, as well as aiding in the identification of the decedent (Vass 2001). Thus the relationship between taphonomy and forensic anthropology is an intimate one (Dirkmaat 2008).

Decomposition and Post Mortem Interval

Decomposition can be broken down into two categories: autolysis and putrefaction. The onset of decomposition is due to a process called autolysis, where cells are deprived of oxygen creating a domino effect in which carbon dioxide in the blood increases, pH decreases and wastes accumulate which poison the cells (Vass 2001). This process can also be referred to as "self-digestion" and begins within minutes after death. Cellular enzymes begin to dissolve the cells from inside out causing them to rupture and release nutrient-rich fluids. Autolysis does not generally become visually apparent for a few days and is first observed by the appearance of fluid filled blisters and skin slippage (Vass 2001). As the body acclimates to ambient temperature (algor mortis), blood settles in the body causing discoloration of the skin (livor mortis and the cellular cytoplasm has gelled due to increased acidity (rigor mortis) (Vass 2001). Putrefaction can begin once enough cells have ruptured and enough nutrient-rich fluids become available (Vass 2001). Putrefaction is the destruction of the soft tissues of a body by the actions of micro-organisms, resulting in the catabolism of tissue into gases, liquids and simple molecules (Vass 2001). Active decay can begin once gases have been purged from the body due to putrefaction. Separate from soft tissue decomposition, bone undergoes another complex process called diagenesis. Diagenesis serves to alter the proportions of organic (collagen) and inorganic components (hydroxyapatite, calcium, magnesium) of bone exposed to environmental conditions, particularly moisture (Vass 2001). The process of autolysis, putrefaction and diagenesis work together to return the complex structures composed of proteins, carbohydrates, sugars, collagen and lipids returning to their simplest building blocks (Vass 2001).

Decomposition is a continuous process, beginning at the time of death and continuing until a skeleton has been produced, therefore it is impossible to create concrete stages of decay. However several researchers have attempted a quantitative approach to systematically place a time estimate around the successive stages of decay (Bornemissza 1957; Reed 1958; Payne 1965; Galloway 1989; Prieto et. al 2004; Megyesi 2005; Simmons 2007; Parks 2011; Card 2015). All devise a similar system that describes the appearance of decay in four to six stages: fresh, bloated, active decay, dry, and remains.

During the Fresh stage livor mortis, rigor mortis and algor mortis can be observed. Due to the effects of gravity and the lack of circulation, blood settles causing a discoloration of the lower parts of the body (Vass 2001). This discoloration is called livor mortis and can be observed 1-4hrs from the time of death. As ATP is converted to ADP, lactic acid is produced causing a stiffening of the muscles, this is called rigor mortis and can first be observed between 2-6hrs of death and continues to develop up to 12 hours since death. Rigor mortis generally lasts from 24 hours to 84 hours after death, afterwards the muscles begin to relax again (Goff 2009). Rigor mortis is sensitive to temperature, warmer temperatures tend to delay the onset of rigor mortis and shorten the duration. Algor mortis sets in. The cooling of the body to ambient temperature most often occurs 18-20h from the time of death (Rottenstein 2006). The Fresh stage is generally observed from the time of death until bloating begins to occur.

The first insects begin to arrive within approximately 10 minutes from the time of death, these first insects are usually Calliphoridae (blow flies) and Sarcophagidae (flesh flies). Female flies will begin exploring for potential areas for oviposition or larviposition (Goff 2009). Initially orifices of the face pose attractive sites for flies and later the openings of the anus and rectum, though this may be dependent on access to these areas. Similarly, wounds that occurred anti-mortem when blood was still flowing appear more attractive to flies that those wounds inflicted post-mortem when blood flow is lacking (Goff 2009). During the fresh stage the most common necrophagous species noted on the body appear to be from the order Diptera, of the families Calliphoridae, Sarcophagidae and Muscidae.

The bloated stage begins with the bloating of the carcass, generally occurring 2-7 days after death (Goff 2009). Generally this stage is marked by the beginning of a greenish discoloration caused by the breakdown of hemoglobin in the liver. Forty-eight hours from the time of death, skin slippage begins to occur; hair and nails also begin to loosen (Rottenstein 2006). As red blood cells begin to die, marbling begins to occur. The overgrowth of bacteria and fungi in the gut resulting in a bloated appearance also causes the smell of decomposition to become apparent. Finally fluids are expelled from the body through natural openings and a strong smell of ammonia can be noted; the normal soil fauna will leave from under the body as the pH begins to become more alkaline (Goff 2009:33) This stage generally begins with bloating of the body and ends with the deflation of the abdomen. During this stage the adult Calliphoridae are strongly attracted to the body and masses of maggots can be observed associates with orifices of the body. Though they are largely observed externally, larger populations are internal feeding on bacterial putrefaction (Goff 2009: 33).

After the purging of fluids due to putrefaction, active decay begins. Active Decay is further characterized by desiccation and discoloration (associated with desiccation), partial skeletonization and mummification. Muscles composed of proteins, thus composed of amino acids yield to the formation of additional volatile fatty acids through bacterial action (Vass 2001:190). Protein and fat decomposition yields phenolic compounds and glycerols and at this point in the decay cycle elecrolytes are rapidly leaching out of the body (Vass 2001). Most tissue loss occurs within this stage and plant material within Cadaver Island dies (Taylor 2011). This stage is observed from deflation of the abdomen until 50% of the bone is exposed. Mummification is the result of tissue, generally skin, that has survived the active decay cycle. The skin appears parchment-like or leathery due to dehydration and desiccation of the tissue (Vass 2001). Fly Larvae is responsible for the majority of tissue loss. Masses of maggots can be observed internally, externally and often spilling out onto the ground around the body. The active stage ends when maggots of Calliphoridae and Sarcophagidae move away from the cadaver to pupariate in the surrounding soil. Diptera larvae will have removed most of the flesh from the remains, leaving only skin and cartilage (Goff 2009).

The Dry Stage occurs when more than 50% of the carcass is skeletonized, dried or mummified skin and tissue may still remain. Exposure of large portions of the skeleton usually does not occur until 6 months after death. In hot, dry climates exposed bone will begin to bleach out and any remaining tissue will dehydrate. Diptera will cease to be the prominent species, gradually being replaced by Coleoptera; their feeding removes the remaining dried flesh and cartilage leaving bones with a polished appearance (Goff 2009).

The remains stage is noted when only hair and bone remain. Exfoliation of the bones begin to occur. This can be observed at about 9 months after death dependent on climate and microenvironment. Soil dwelling taxa, such as Acari and Collembola, can be used in the estimation of time since death. Gradually the pH balance of the soil will return to normal, however differences in soil fauna can be noted, indicating that there once was a body in that location (Goff 2009).

Taphonomic Factors

Taphonomic studies of decomposition have allowed forensic anthropologists to better understand how much time has passed between the time of death and the recovery of remains. However many factors may influence the rate of decay creating challenges in estimating an exact post mortem interval or concrete stages of decomposition. Factors influencing decomposition include intrinsic factors (contributed by the body) such as weight, size of the cadaver, inflicted trauma, presence of clothing, disarticulation, and embalming; extrinsic factors (contributed by the environment) such as burial type, temperature, humidity, aridity, sunlight exposure, rainfall, soil PH, insect and faunal activity. These factors have been discussed in the literature: ambient temperature (Micozzi 1986; Galloway et al. 1989; Komar 1998; Rhine and Dawson 1998; Megyesi et al. 2005; Myburgh et al 2014); temperature of soil, water, or surface cadaver is on or in (Rhine and Dawson 1998); humidity (Ross and Cunningham 2011); outdoor or indoor locations (Galloway 1997; Ritchie 2005; Anderson 2011); containment of a body in coffins or sealed containers (Bass, 1984; Forbes et al. 2005a; 2005b; Hyder 2007); sun exposure and weathering (Behrensmeyer 1978; Shean et al. 1993; Lyman and Fox 1997; Srnka 2003; Rottenstein 2006; Sharplin 2012; Myburgh 2014); rainfall (Archer 2004); partial or complete submersion in water (Sorg et al. 1997; Haglund and Sorg 2002b;

Heaton et al. 2010; Christensen and Myers 2011); adipocere formation (Forbes et al. 2005; O'Brien and Kuehner 2007; Ubelaker and Zarenko 2011); physical disturbance (Adlam and Simmons 2007);depth of burial in soil (Rodriguez and Bass 1985; Turner and Wiltshire 1999; Jaggers and Rogers 2009); insect access to the corpse (Reed 1958; Payne 1965; Anderson 2001; Seet 2003; Goff 2009; Sharplin 2012); access of larger fauna to a cadaver (Haglund 1997; Haglund 1997a; Morton and Lord 2006; Klippel and Synstelien 2007; Reeves 2009; Bright 2011); transportation and dispersal (Morton and Lord 2006); fire or cremation (Warren 2002; Gruenthal et al. 2011); trauma (Micozzi 1986; Kelly 2006; Calce and Rogers 2007;Cross and Simmons 2010); dismemberment (Janjua and Rogers 2008); manner of death such as drug overdose (Amendt et al. 2004); body mass (Hewadikaram 1991; Morton and Lord 2006; Simmons et al. 2010; Spicka et al. 2011; Matuszewski et al. 2016); and body covering such as clothing or wrappings (Galloway 1989;Cahoon 1992; Rowe 1997; Miller 2002; Kelly 2006; ; Dautartas 2009; Card 2015) among others. Of the various factors that affect the transition from the biosphere to the lithosphere, this experiment will be particularly concerned with the effects of temperature, body coverings and insect succession.

Animal Contributions to the Decay Process

The primary organisms involved in the majority of decomposition of the body are insects and arthropods (Goff; 2009). Insects and arthropods will arrive at exposed carrion quickly after death, sometimes as quickly as 10 minutes, beginning their activities immediately upon arrival (Goff; 2009). In regards to decomposition, four basic relationships between a decomposing body and arthropods are identified by Goff (2009; 1993): necrophagous species, predators and parasites of necrophagous species, omnivorous species and adventive species.

Necrophagous species refers to the taxa that are directly feeding upon the carrion, much of this group is comprised of true flies (Diptera), particularly those of Calliphoridae and Sarcophigidae (Goff; 2009). This group of early invaders also includes beetles (Coleoptera) specifically the families of Silphidae and Dermestidae. The Acari sometimes make themselves known early one, but are not known to be prevalent during the early stages of decomposition (Goff; 2009). The most significant group of taxa affecting the decomposition of carrion are those that fall within the group of predators and parasites of necrophagous species'; most of this group comprises of beetles (Coleoptera), flies (Diptera) and wasps (Hymenoptera) (Goff; 2009). Certain species of fly larva (maggots) that may have been necrophages in the early stages of their development, may become predators on other larva during later stages (Goff; 2009). Other predators noted during later stages of decomposition were species of the Macrochelidae, Parasitidae, and Uropodidae, preying on various organisms in and around the soil directly associated with the decomposing remains (Goff; 2009).

Those species belonging to the omnivorous group included taxa such as wasps and ants (Hymenoptera) and beetles (Coleoptera); these groups feed on both the corpse as well as associated arthropods (Goff; 2009). Large populations of omnivorious species may in fact slow down the rate of decomposition as they are depleting necrophagous species (Goff; 2009; 1986). The forth group of arthropods to affect decomposition is that of the adventive species, this category includes taxa that use the cadaver as an extension of their own habitat (Goff; 2009). Goff mentions this often includes springtails (Collembola), Spiders and Millipedes.

Aside from insects and arthropods, vertebrate scavengers will also be attracted to carrion as a potential food source. An exposed cadaver is particularly attractive. Significant damage, even by small vertebrate scavengers, can be done by the direct feeding of carnivores (Goff; 2009). If scavengers get access to the carcass they can completely skeletonize the body in less than a week (Goff; 2009). In this experiment the carrion will be protected from potential vertebrate scavengers to allow us a better understanding of both the temperature and entomological effects upon decomposition.

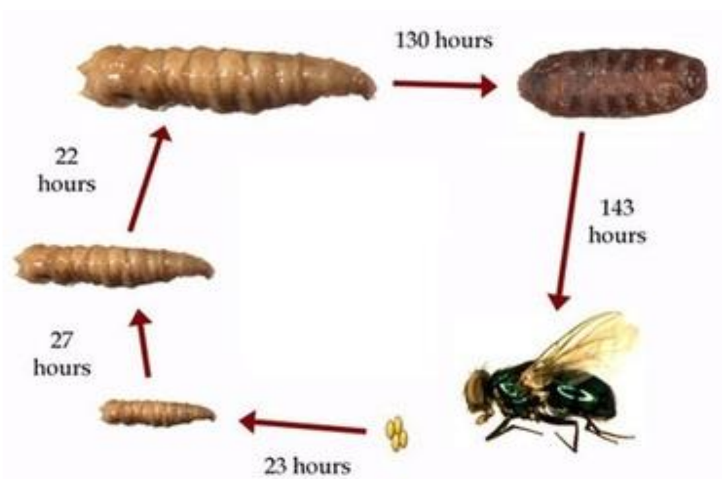

Figure 2.1 Dipteran Lifecycle (http://crimesceneinsects.weebly.com/life-cycle.html)

Establishing post mortem interval is the primary reason why entomological evidence is analyzed at a death scene (Haskell; 1997). The most precise method used in establishing PMI is to use a known insect species life cycle, the precision of this depends upon known temperature at the scene as well as accurate species identification (Haskell; 1997). Because Dipteran species are the most prevalent and predictable at a death scene, understanding their life cycle can help narrow down PMI potentially within 12 hours of death in the first 15-20 days (Haskell; 1997). Adult female flies generally lay eggs on or around their food source, in this case the carrion. Within a few hours, depending on the specific species and temperature, eggs will hatch and begin the 1^{st} of three instar stages. Often the first instar is hard to see when gathering entomological evidence as it is generally less than 2mm and a darker hue, often being mistaken for dirt inside carrion orifices (Haskell; 1997). The second instar are derived from the molting (shedding) of the first instars, this stage is the shortest at approximately 8-12 hours (Haskell; 1997). However this stage is important to note as the larvae begin to feed more heavily in preparation for the third instar level. The second instars are larger than the first instars (4-6mm) and their soft tissues are chemically changing from acid to alkaline in nature, facilitating increased digestion of connective tissues and muscle (Hobson; 1932).The third instar stage emerges as the second instar stage molts. This stage will continue to feed but increase their voraciousness; the larval "maggot mass" will consume large quantities of soft tissue, so much that it is possible to observe soft tissues disappearing from the cadaver (Haskell; 1997). Once the larvae have consumed enough fat, the larval mass will cease feeding and migrate from the carrion (Haskell; 1997).

Flora, Fungi and Microflora involvement in the Decay Process

Bacteria are associated both in internal and external aspects of the human body. In death these bacteria, once contained to the digestive system, begin to move past their former barrier finding new areas of tissue to grow within. Soon, these bacteria begin to digest the body from the inside, which is particularly evident in head and abdomen regions (Goff 2009). Isolated bacteria within the body as well as bacteria being introduced by the environment and animal scavengers all play a role in the decomposition process. Vass (2001) notes that in the cases where microflora are sterilized through human effects (i.e. chemicals, lead coffins, etc.) the decomposition rate was grossly retarded.

Fungi and molds also play a role in the decomposition process. In life the body continues to shed the outer stratum corneum as new tissues are produced underneath (Goff 2009). This shedding of dander also releases any attached spores of mold or fungi. However in death with the bodies' inability to shed the outer layer, these same spores will begin to colonize the external surface of the remains (Goff 2009).

Temperature and Humidity effects on the Decay Process

Geographic region plays an important role in the decomposition process, especially in regards to temperature and humidity. High temperatures enhance insect activity which is one of the main contributors of decomposition (Bass 1997). In regards to thermodynamics, Van't Hoff states that an increase in temperature of 10'C will increase the speed of chemical reactions two or more times (Rottenstein 2006). This helps to explain the exponential increase in decomposition during early stages as maggot masses increase the temperature over ambient temperature, accelerating the decomposition of remains. Air humidity only helps to accelerate the rate of decomposition as it provides a better feeding environment for insects as opposed to arid climates where mummification due to dehydration incurs less insect activity. Galloways' (1989) study showed that tissue loss in an arid region, such as the Sonoran Desert in Arizona, could take as long as 4-6 months.

Decay rates in the summer versus the winter vary drastically as high temperatures provide an ideal situation for quick decomp, where loss of tissue can occur as quickly as two weeks. In winter, the decomposition process can continue until the following summer. Bass (1997) cited an extreme case in which Mississippi woman who reached skeletonization within 10 days. Ambient temperature is highly influential over decay rates, however this can be altered by human involvement such as placing the cadaver in direct sun or shade. Winter months significantly slow decomposition and in some cases can halt the decomposition process altogether (Bass 1997; Mann et al 1990). In cold temperatures there is a lack of insect activity as certain fly species will only continue to lay eggs in temperatures over 4 or 5°C (Mann et al 1990). Below freezing, larva will die off. In extreme cold maggots will often burrow underground to wait out the winter months, resurfacing in warmer temperatures to begin feeding upon remains once more

(Mann et al. 1990). Bass as well as Mann and colleagues discuss the instance where maggots do continue to feed, despite cold temperatures, due to self-produced heat maintained within the body.

Anderson (2001) notes that shade can provide greater protection for maggot masses, however they also note that bodies in direct sunlight lose biomass more rapidly than bodies in shade and progress through decomposition stages at a faster rate. Certain insect species, such as Calliphoridae, show preferences in feeding environments in regards to carrion which can alter the rate of decomposition. Shean and Coauthors (1992), in their experimental study comparing pig carrion in sun and shade in Washington state, showed that the cadavers in direct sunlight lost mass more rapidly and progressed through decomposition stages faster than that of the cadavers in full shade. Rapid soft tissue loss continued until only skin remained and the authors hypothesize that the rapid weight loss may be due to a combination of dehydration and differences in maximum daily temperatures in the sun and the shade (Sharplin 2012). Similar findings were seen at the Forensic Anthropology Research Facility at the University of Knoxville. However Srnka (2003) noted that after bloating ceased, the deflated skin quickly dehydrated in the sun and no other change occurred during the experimental period. Srnka (2003) notes that PMI of a body in the sun longer than a few weeks could be misinterpreted when comparing to shaded remains due to this halt in decomposition progression. Rottenstein (2006) observed that while carcasses in direct sun decomposed much faster than their shaded counterparts, they were also the last to skeletonize.

Fabric Contributions to the Decay process

Looking at the literature in regards to the effects of clothing upon the rate of decomposition, we can see that anthropologists are at odds with each other when it comes to the results. Some anthropologists (Galloway 1989; Kelly 2006; Card 2015) have hypothesized that clothing may retard the rate of decomposition, while others (Mann 1990; Cahoon 1992; Rhine and Dawson 1998; Anderson 2001; Duartaras 2009; Sharplin 2012) suggest that clothing or other body wrappings may accelerate the decomposition process. A few have not seen a statistical difference between clothed and nude decedents (Miller 2002; Megyesi 2005).

In Galloway and colleagues' (1989) medicolegal investigation of remains in the Arizona desert, they believed that clothing and other body wrappings may have slowed down the rate of soft tissue loss especially in advanced decomposition (Galloway; 1989). Similarly, Card (2015) results indicated that there was a significant difference between clothed and unclothed cadavers. Nude cadavers decomposed at a significantly faster rate than those that were clothed or wrapped in fabric. However Card (2015) explains that the results from each carcass group are still too similar to separate when applying a 95% confidence interval. This meant that also results indicated statistical significance, when applied practically in a forensic setting, these results did not warrant a different formulae to estimate PMI (Card 2015). Dautartas (2009) research focused on temperature with the hypothesis that clothing or fabric wrapping would increase temperature and thus, decomposition. Dautartas (2009) observed greater bone exposure on those cadavers that remained nude. Mummification was noted to have increased on those cadavers that were wrapped in a cloth blanket, prolonging decomposition. Kelly (2006) saw a delay in drying in those wrapped in fabric, however she also found that less flesh remained on those wrapped in fabric. In her results section Kelly (2006) did not see a statistical difference between clothed cadavers and those that were nude. Like Kelly, Miller explains in her 2002 study of six pig cadavers that there was no statistical difference between clothed and nude subjects. Megyesi and coworkers (2005) study of 68 cases with a known date of death noted that differences between 42 cases that were clothed or wrapped and those that were nude were insufficient. Megyesi and colleagues recommended that more research was needed to understand the rate of decomposition of clothed and nude decedents.

However in 1990 Mann and coworkers experimental study in Knoxville, Tennessee reported observations that stated the contrary, that clothing and other body wrappings may actually accelerate decomposition. They believed that clothing protected the body from direct sunlight, which maggots tend to avoid, creating a more inviting atmosphere for maggot masses thus speeding up the decay process (Mann et al. 1990). In Cahoon's (1992) experimental winter study, she observed that arthropods were more attracted to the clothed cadaver than they were to the nude cadaver. Due to this, the clothed cadaver exhibited continuous higher frequencies of arthropod attention accelerating the cadaver to bloat within two weeks. Cahoon (1992) believed that in the colder months clothes may create a protected, insulated, habitat for insect activity. Rhine and Dawson (1998) reviewed medicolegal cases from New Mexico and noted that clothing, warmer temperatures and cadaver body mass all act as accelerants in the loss of soft tissue (Rhine and Dawnson 1998).Similarly, Anderson (2001) also found that clothing may accelerate soft tissue loss. Anderson (2001) states that the majority of human cases are either clothed, partially clothed or wrapped bodies and therefore clothing and other wrappings may be having an effect on decomposition and insect colonization (Anderson; 2001). Anderson (2001) believes that the acceleration of decomposition rate is due to the idea that clothing absorbs body fluids providing new habitats and shelter for insect oviposition (Anderson; 2001). Sharplin's 2012 study showed that the main difference between clothed and nude subjects was that clothed subjects exposed bone more readily when compared to nude subjects; this was thought to be the result of increased soft tissue consumption under clothing.

Decomposition Stage Models- History of Methodology

Several researchers have broken down the continuous process of decomposition into stages. These stage models aid in the estimation of post mortem interval and serve to break down the complicated continuous process of decomposition into understandable stages for a jury (Goff 2009). Stages range in number and cut-off point based on the researcher's focus, frequency of observation, environment and subject type. Generally stages are based on tissue breakdown and have employed an entomological approach

(Bass 1983). These are a few examples of the decompositional studies and the stage models those researchers utilized for ease of explanation.

One of the earliest known studies of decomposition was done by Mégnin in 1894 who divided the decomposition of human bodies exposed to air into eight stages (Reed 1958). While Bornemissza's 1957 study looked at insect activity upon carrion, it was Reed's (1958) study that is one of the best known. Reed observed 45 domesticated dog (Canis familiaris) carcasses in Tennessee, noting the relationship between insect activity and decay rates. Reed broke decomposition into four stages beginning with "fresh stage" beginning at death and continuing until bloating of the carcass is observed; "bloated stage" began during early stages of bloating and ended when bloating ceased to be evident; "decay stage" began when bloating ceased and ended when most of the remains were observed to be relatively dry; "dry stage" were more difficult to define as later stages of decomp were more variable and without clearly defined beginning and end stages (Reed 1958). The "dry stage" was observed when only small amounts of decaying tissue remained (Reed 1958). Reed noted that arthropod populations were greater in the summer and were larger in wooded areas than in non-wooded areas (Bass 1983). Further Reed observed that decomposition progressed more rapidly in open areas potentially due to higher temperature exposure (Bass 1983).

Payne's (1965) study in Tipton, SC observed the entomological activity and its relation to decay rates upon young domestic pigs (Sus scrofa domesticus). He broke down the decomposition process into 6 stages, modifying Reed's decomposition stage model by breaking the decay stage into "active decay" and "advanced decay" as well as adding a "remains" stage (Payne 1965). Differences in decay stages were characterized by the different arthropod groups inhabiting the carcass. He observed that a cadaver free of insects decomposed and dried at a much slower rate (Bass 1983). A later study concerned with seasonal variation and insect activity was conducted by Johnson in 1965, observing 39 small mammal carcasses in a forested area of Des-Plaines, Illinois and placed at different times over the span of 18 months. Johnson utilized a modified version of Reed's decomposition stage model, stating that the "decay stage" begins with the onset of aerobic protein decomposition which he saw was the direct result of insect activity (Johnson 1975). Johnson believed that the burrowing of maggots allowed air to enter the carcass and promote decay. Further Johnson observed that the "dry stage" is defined by the absence of maggots and lasts until carrion fauna are no longer found associated with the remains (Johnson 1975). Bass's 1983 study began to fill in the gap of knowledge around human decay rates. Bass observed four human cadavers that were donated to the University of Tennessee's department of anthropology's decay research facility in Knoxville for the purpose of scientific research (Bass 1983). Bass utilized Reed's decompositional stage model with few modifications for his experiment.

Overall researchers utilized modified versions of Reed's decomposition model (Payne 1965; Johnson 1975; Rodriguez and Bass 1983) until 1989. In 1989 Galloway retrospective study in the southwest, observed 468 cases that were selected from the office of the Medical Examiner in Pima County, Arizona and five stages of decay were assigned to cadavers based on their last known time alive and any visual evidence extracted from death scene photographs (Galloway et al. 1989). Galloway notes that the "fresh stage" is observed when there is no discoloration, other than lividity, about the body and no insect activity present. The second stage, "early decomposition", was characterized by the beginning stages of discoloration, bloating and the arrival of maggots (Galloway et al. 1989). "Advanced decomposition" included the sagging of tissues and extensive maggot activity as well as the acceleration of autolysis and the rapid occurrence of skeletonization or adipocere formation (Galloway et al.1989). In this study "mummification" was added to the "advanced decomposition" stage and characterized by the dehydration and hardening of the outer surface of remains in arid climates; mummification marked a departure from the usual patterns of decomposition previously outlined in more humid climates (Galloway et al. 1989). After the majority of bones are exposed the remains enter the "skeletonization" stage. Bleaching, exfoliation, and cortical breakdown mark the final "decomposition of skeletal remains" stage (Galloway et al. 1989). Similarly, after 22 years examining the decomposition of human cadavers at the University of Tennessee Anthropological Research Facility, Bass added a fifth stage labeled "bone breakdown". Bass (1997) observed that high humidity aided in the advance of this final stage and that direct sun exposure caused bones to crack. Additionally Bass added that roots, leaf litter and scavenger activity may have caused extensive taphonomic changes to bone by this stage.

Prieto and colleagues (2004) study reviewed case reports obtained through the Laboratorio de Antropología y Odontología Forense (LAF) of the Instituto Anatómico Forense de Madrid, Spain. 29 cases were utilized to understand the post mortem interval in coastal, inland and mountainous regions of Spain. Prieto and Coworkers (2004) found that cases could be grouped into 4 phases of decomposition: “putrefaction”, “early skeletonization”, “advanced skeletonization” and “complete skeletonization”. However the addition of two more phases, “mummification” and “supponification” represented processes of cadaver conservation (Prieto et al. 2004). The phase of supponification was added for cadavers that were long interred in a well; phases were limited by the cases reviewed in this study.

Recent studies have attempted to quantify the approach to scoring decomposition, the following studies have utilized a form of body region scoring to provide a better picture of the decomposition process. Megyesi (2005) reviewed photographs of the remains from 68 cases where time of death was known. Only cases in which all parts of the body were clearly visible were used to assign a numeric score to regions of the body based on a modification of Galloway et al.’s (1989) method. Decomposition was divided into four categories: fresh, early decomposition, advanced decomposition, and skeletonization (Megyesi et al. 2005). Megyesi and colleagues noted that decomposition does not apply equally to all body regions and in order to account for this the remains were scored independently in three separate regions of the body: Head and neck, including the cervical vertebrae; the trunk, including the thorax, pectoral girdle, abdomen, and pelvis; and the limbs, including the hands and feet (megyesi et al. 2005). These scored were summed to produce a Total Body Score (TBS).

Adlam and Simmons (2007) utilized 24 rabbit carcasses, dividing the rabbit body into regions and numerically scoring them based on the overall picture of decomposition. Higher numbers were assigned to more advanced characteristics of decomposition. Stages of decomposition reflect a modified version of Megyesi et al. (2005), including “fresh”, “early decomposition”, advanced decomposition” and “skeletonization”. Adlam and Simmons (2007) note that a scoring system of regional decomposition yields a more accurate picture of the decomposition process versus a reductionist approach (Adlam and Simmons 2007).

Decomposition studies have inspired a number of Masters Theses in recent years (Rottenstein 2003, Adlam and Simmons 2007, Parks 2011, and Sharplin 2012) which have added to the discussion of post mortem interval. Parks (2011) observed a single human cadaver in central Texas over a 10 week period (Parks 2011). This study utilized the stage model set by Galloway and the Accumulated Degree Day (ADD) method established by Megyesi and colleagues. Parks noted that in this study prior refrigeration of the subject may have prolonged the “fresh” stage (Parks 2011). The human remains were exposed to direct sunlight for eleven hours a day which resulted in mummification and was compared to Galloway’s 1989 study of decomposing human remains in Arizona (Sharplin 2012). Sharplin (2012) observed six pig cadavers, which had not been refrigerated prior to placement. Similarly this study also utilized a modified version of Galloway's 1989 decomposition stage model and Megyesi and coworkers ADD methodology. Sharplin (2012) exposed cadavers to direct and partial sunlight while keeping the remaining two cadavers in full shade to understand the impact of temperature on decomposition. In addition to this Sharplin (2012) clothed half of the cadavers (1 cadaver per microenvironment) to understand if clothing played an effect upon the rate of decomposition.

Myburgh and colleagues (2013) observed 46 domestic pig cadavers at the Miertjie le Roux Experimental Farm owned by the faculty of Natural and Agricultural Sciences of the University (Myburgh et al. 2013) of Pretoria. Cadavers were placed at different times throughout the 232 period. A modified stage model developed by Megyesi et al. (2005) which was based on Galloway et al. was utilized in this study, further TBS and ADD methodology developed by Megyesi and coworkers (2005) was both used and tested in this experiment. Myburgh and colleagues (2013) noted that decomposition increased in a linear fashion during early stages, however once TBS was greater than 17 decomposition was highly variable and thus less predictable (Myburgh et al. 2013).

Environment, particularly humidity and temperature, play a critical role in the rate of decomposition, the applicability of current post mortem interval (PMI) models must be tested in different settings (Myburgh 2014). It is important that post mortem interval estimates be created for specific geographic regions (Myburgh 2014). The accumulated degree day (ADD) model is an appropriate comparison as it looks at heat units that represent the accumulation of thermal decomposition, thus ADD represents chronological time and temperature combined (Megyesi 2005). The amount of heat required for an insect to develop from the time of oviposition to the time of hatching is calculated in units called degree days or degree hours (Amendt et. al 2004). ADD is tied to the rate in which Dipteran larva develop, assuming that temperature is linear in the mid-range sigmoidal curve, with an upper and lower threshold beyond which development halts (Greenberg and Kunich 2002). Degree days (or hours) are the accumulated product of time and temperature between the developmental thresholds for each day (Sharplin 2012). Each development stage, by species, requires a specific number of degree-days to reach the next instar, because of this, researchers can accurately predict the time it takes for a certain species to reach a certain development stage (Amendt 2004). These growth cycles are only applicable when reliable temperature data is taken (Amendt 2004). Greenberg and Kunich (2002) recommend taking temperature data at the scene, at the body as well as in the maggot mass as maggot mass feeding temperatures can vary dramatically above ambient temperature (Greenberg and Kunich 2002; Goff 2009). These temperatures must then be compared with the nearest weather station to extrapolate temperatures at the scene, however if the nearest weather station data differs statistically a linear regression must be utilized.

Megyesi’s 2005 study noted the particular importance that temperature played on the rate of decomposition, stating that temperature accounts for 80% of the variation in rate. Megyesi and colleagues devised a quantifiable method similar to those used in forensic entomology and forensic botany to be applicable within the discipline of forensic anthropology. The goal was to create a more precise method to measure accumulated temperature as they believed that accumulated temperature has significant effect on decomposition (Sharplin 2012). This study showed that as maggot growth cycles show a direct correlation with accumulated temperature, so could soft tissue decomposition propelled by arthropod and bacterial activities (Sharplin 2012). Megyesi and coworkers (2005) define accumulated degree days (ADD) as heat energy units that propel biological processes such as bacterial or arthropod growth, therefore calculating ADD requires that a base temperature be established in which all biological processes cease. Vass and coauthors (1992) suggest that this base temperature is 0◦C when human decomposition essentially stops. Megyesi and colleagues (2005) study uses a Total Body Score (TBS) system, in which the degree of decomposition is scored for three regions of the body: the head and neck, trunk, and limbs. The lowest score being a 3 for a "fresh" cadaver, where each body region was scored with a numeric value of 1. Numeric values assigned increase with the level of decomposition observed, the highest value assigned for a severely decomposed corpse would be a 35 (Megyesi 2005). This TBS score is then compared with the average high and low temperatures of the known PMI period so that it could be estimated how many ADD it would take for that corpse to reach that level of decomposition. Megyesi and Colleagues created a regression equation to calculate the ADD from the TBS:

$$\mathbf{ADD = 10(0.002*TBS*TBS+1.81) \pm 388.16}$$

where 388.16 is the standard margin of error of the regression in untransformed (non-logged) ADDs (Sharplin 2012; Megyesi 2005). Megyesi and colleagues (2005) study only used cases with known PMI. Their study looked at cases from Midwestern states during the months of May through September (Megyesi 2005).

The literature illustrates a progression towards more quantitative methodologies where predictable stages of decomposition were observed, and finally scored in order to conduct repetition studies. These repetition studies helped researchers better understand the variables that have a direct impact upon the rates of decomposition, as well as to highlight the research that still must be done to better understand the complex relationship between the environment and decomposition.

CHAPTER 3 – MATERIALS AND METHODS

The methodology for this study was based upon Megyesi's 2005 research utilizing an ADD regression equation to estimate post mortem interval and Sharplin's 2012 methodology which created a controlled experiment in Southern California from which to use the ADD equation. Megyesi's original study looked at 69 open cases pulled from the coroner's or medical examiner's office. Rating stages of decomposition was done either in the morgue or from photos provided from the scene. Despite Megyesi's large sample size, cases were coming from multiple environments predominately from the Midwest. Because of this an extreme amount of variability entered the sample. Sharplin used Megyesi's research and created a controlled experiment, using six pig subjects, to test several variables impacting the rate of decomposition. By reducing the variability within the sample, we could better understand the statistical differences between the subjects and certain factors affecting their decomposition. This study replicates Sharplin's experiment as it represents a recent study in a similar environment, the replication of methodology will also allow us to compare northern California decomposition rates to southern California decomposition rates for future research.

Decomposition Subjects (*Sus scrofa domesticas*)

Pigs have been chosen for a number of forensic experiments as analogues for human cadavers due to their availability as well as certain physical characteristics they share with humans (Payne 1965; Shean et. al 1993; Turner and Wiltshire 1999; Seets

2003; Archer 2004; Rottenstein 2006; O'Brien et. al 2007; Schoenly et. al 2007; Cross and Simmons 2010; Sharplin 2012; Caballero et. al 2014; Zanetti et. al 2014; Card et.al 2015). Pigs, like humans, are relatively hairless. As this experiment analyses the effects of clothing on the rate of decomposition, a mammal with less fur was preferred. Pigs also share a similar digestive tract and omnivore diet, thus the contents within their gastrointestinal system will be closer to that of a human's digestive tract during decomposition (Rottenstein 2006; Sharplin 2012; Myburgh 2013).

Four pigs (*Sus scrofa domesticas*) were purchased from Millar Swine Farms in Glenn, California, for this experiment. All four pigs are approximately 100 pounds (45.36 Kilograms), analogous with the size of young human. In order to eliminate any additional bias into the experiment, all four pigs were the same sex. The pigs were transported from Glenn, CA to Sheridan, CA (64miles). Because of the distance the pigs were transported alive to avoid skewing the data by minimizing the amount of time between death and placement of the pigs in their microenvironments. In an effort to replicate the 2012 experiment and eliminate additional variables entering this study, only cotton clothing was used. Two of the pigs were clothed in 100% cotton t-shirts and blue jeans, all purchased from a clothing store to understand how clothing may impact the rate of decomposition (Sharplin 2012). Clothing was applied once we arrive at the experimental site location and after death. Two pigs were left in their natural (or nude) state to understand the rate of decomposition without clothing as not all decedents are found clothed (Sharplin 2012). Each pair of pigs (one clothed; one nude) were placed at one of the two experimental micro-climate locations, sunlight or shade, to better understand how temperature affects the rate of decomposition for both clothed and nude decedents (Sharplin 2012).

Experimental Site Location

The experimental site location is in Sheridan, California on private land owned by Jim Bradley. The experimental decomposition site location is on the back acre of Mr. Bradley's 10 acre property at approximately 38°59'47.41"N 121°22'15.69"W. This site is approximately 34 meters above sea level. The region is typically classified as a Mediterranean climate characterized by hot summers and mild, low temperatures in the winter with rainfall (Weather Underground 2016). Annual average temperatures for this region ranges between 39°F (4°C) and 97°F (36°C) with humidity levels ranging from very dry to dry (average 12-17%) in summer months and humid to very humid 62%-99 in winter months; annual rainfall is 42.28 inches with an average 0.39 inches in the summer (June- September). Weather averages were taken over a 30-year period (Weather Underground 2016).

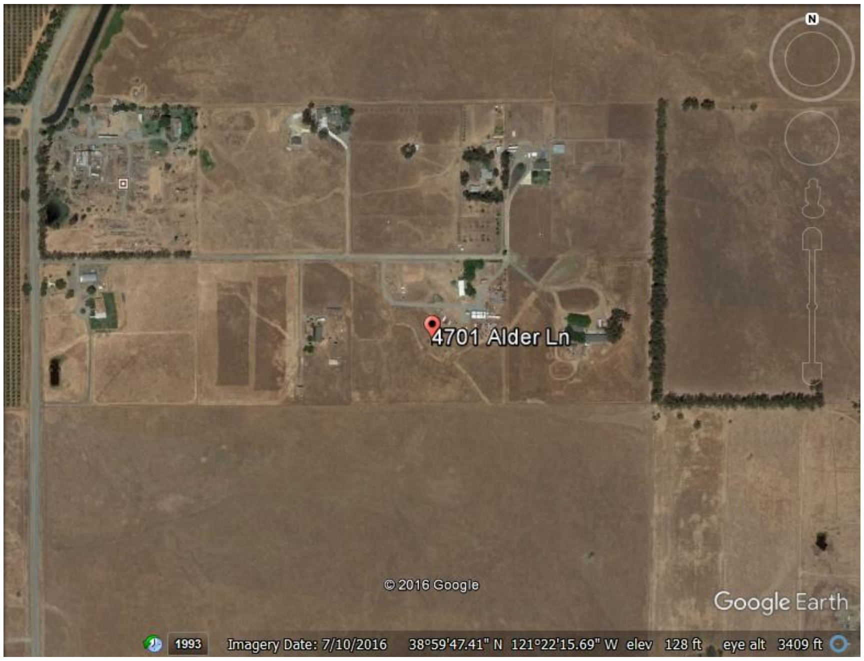

Figure 3.1: Satellite image of the experiment site at 4701 Alder Ln. Sheridan, CA

Observations:

Millar Swine Farms in Glenn, CA is located approximately one hour and twenty minutes from the experimental site in Sheridan, CA; a distance of 64 miles. Upon arrival four pigs will be euthanized via a shotgun to the head by the Yuba County Agriculture Commissioner, Stephen Scheer. The subjects will then be placed on the soil in two microclimate locations (full sunlight and full shade) (Sharplin 2012). All leaf litter and small plants will be removed from the surface beforehand to ensure close contact with the soil due to the fact that soil temperature plays a role in the rate of decomposition. The subjects will be protected from scavengers using large dog crates reinforced with 1 inch chicken wire on all sides, including the base as scavengers can dig beneath the soil to access carrion (Myburgh 2013). Crates will be anchored to the soil using a ShelterLogic solid steal EasyHook Anchor Kit. Chicken wire will be re-enforced using zip ties (Sharplin 2012).

In an attempt to replicate the methodology of the 2012 southern California study the exact time frame was utilized to aid in future comparison studies. After placing the pig carcasses in the experimental microenvironment locations, observations will be taken every three hours from 9 a.m. to 6 p.m. daily (9:00 a.m., 12:00 p.m., 3:00 p.m., 6:00 p.m. Because this study does not have a full team or camera equipment to observe events for a 24 hour period, this study will utilize weather station data (Myburgh 2013; Sharplin 2012). Once the carcasses stopped showing changes, observations will be taken every third day, then weekly for twelve weeks. For this particular study, a modified version of Galloway's decomposition stages were used (Myburgh 2013). Galloway proposed four stages of decomposition: fresh, early decomposition, advanced decomposition, skeletonization (Megyesi 2005; Myburgh 2013). As the first three stages of decomposition are exponential in rate it is important for the observer to take frequent notes of changes upon the subjects until maggot mass leaves the carcass and decomposition slows (Sharplin 2012; Myburgh 2013). A final period of observations and sample collection will be made six months after the start date (Sharplin 2012).

Decomposition Events

Observations will be recorded as the pig carcasses progress through decomposition. this study will be recording changes in skin color and location on the body; bloat circumference measured below the second nipple; presence or absence of lividity (blood pooling under the skin); and skin slippage (gloving as well as formation of postmortem bullae, or fluid filled pockets between skin layers); odor; kill wound, oral, nasal and anal discharge; skeletal disarticulation, tooth loss; and insects and arachnids present (Megyesi 2005; Sharplin 2012; Myburgh 2013). Further, we will be taking note of the identification and growth stage of the insects and arachnids involved with the carrion in addition to their location and proximity to the pig carcasses (Goff 1993).

Table 3.0: Decomposition Events by Visual Inspection

Observation	**Measurement**
Skin Color and Location	Visual Observation
Bloat Circumference	Measured in Inches
Lividity (Blood pooling under the body)	Present/Absent
Skin Slippage	Present/Absent
Odor	Present/Absent
Kill Wound Discharge	Present/Absent
Nasal Discharge	Present/Absent
Anal Discharge	Present/Absent
Skeletal Disarticulation	Present/Absent
Toothloss	Present/Absent
Insect/Arachnid	Few/Some/Many

Microenvironment Observations:

Temperature and humidity play a critical role in affecting the rate of decomposition, due to this fact several measurements to understand the climate in Sheridan, CA are taken to document air and soil temperature as well as humidity (Sharplin 2012). Microenvironment observations around the pig will include ambient temperature readings taken 10 inches above the soil, measured in degrees Celcius with a ActiveAir™ Indoor-Outdoor Digital Thermometer with Hygrometer (Hydrofarm, Santa Fe Springs, CA); relative humidity measured at 10inches above the soil as a percentage using a ActiveAir™ Indoor-Outdoor Digital Thermometer with Hygrometer (Hydrofarm, Santa Fe Springs, CA); soil temperature will be taken in the same place at one end of each pig's enclosure using a Taylor Stainless Steel Instant-Read Dial Thermometer (Taylor Precision Products, Oak Brook, IL); sky appearance will be recorded by visual inspection and recorded as either Clear, Few Clouds, Some Clouds, Partly Cloudy, or Cloud Cover; and rainfall will be measured in inches using a Taylor Precision 2700N ClearVu 5 inch 90 Capacity Rain Gauge (Taylor Precision Products, Oak Brook, IL) (Sharplin 2012).

All temperature and humidity measurements from microenvironment experimental sites will be compared with the measurements from the nearest National Weather Service (NWS) and National Oceanic and Atmospheric Administration (NOAA) weather station at Lincoln Regional Karl Harder Field (KLHM) Lat: 38.9092°N Lon:

121.3513°W Elev: 121ft. These Measurements will be compared with our site temperature and humidity measurements for statistical significance (Myburgh 2013; Sharplin 2012).

Table 3.1: Measurements of microenvironment ambient conditions, units and instruments.

Measurement	Units	Instrument
Ambient temperature taken 10 inches above the soil	Measured in degrees Celcius	ActiveAir™ Digital Thermometer Hygrometer
Relative humidity	Measured as a percentage	ActiveAir™ Digital Thermometer Hygrometer
Soil Temperature taken at one end of the pig enclosure	Measured in degrees Fahrenheit	Taylor Stainless Steel Analog Instant Read Dial Thermometer
Sky appearance	Recorded as either no clouds (clear sky), few clouds (more sky visible), some clouds (half sky/half clouds), Partially cloudy (some sky visible), or cloud cover (no sky visible)	Visual Inspection
Rainfall	Measured in Inches	Taylor Precision 2700N ClearVu 5 Inch Capacity Rain Gauge

Accumulated Degree Days (ADD)

Estimated ADD is a regression equation developed by Megyesi and coauthors (2005). Users assign a Body Region Score (BRS) to each of three regions: head and neck, torso, and limbs. The three Body Region Scores are summed for a Total Body Score (TBS) that is plugged into the regression equation: $ADD = 10(0.002*TBS*TBS+1.81) \pm 388.16$ (Megyesi 2005). Working backwards from the day that the remains were scored, the daily average temperatures are summed until the calculated ADD is reached, the number of days required to reach the ADD represents the interval since death in days (Megyesi 2005).

ADD is a calculation based on nearby weather station data. For this experiment I utilized Lincoln Regional Karl Harder Field (KLHM) Lat: 38.9092°N Lon: 121.3513°W, which represented to closest local weather station. KLHM was located approximately 12 miles South East of the experiment site. Elevation of KLHM was measured at 121 ft above sea level whereas the experiment site came in at approximately 112 ft above sea level. Further utilizing weather station data allows for us to test the accuracy of ADD calculations as 24 hour on-site weather data was not collected. Daily minimum and maximum temperatures were gathered from our weather station at 3:00pm daily to ensure consistency across the experiment. Weather station data from (KLHM) was downloaded from http://forecast.weather.gov and compared with our microclimate (sun or shade) on-site observations using a paired t-test to test for unequal variance. Significance was noted between the weather station data and ambient temperature gathered on sight, indicating that it was not of the same environment.

Total body score was calculated by combining scores from three anatomical regions: head and neck, trunk, and limbs. Estimated scores for each region were done on sight during the field observation time period to ensure accuracy. These scores were used in a regression equation to calculate Accumulated Degree Days (ADD) and predict Post Mortem Interval (PMI).

$ADD = 10^{(0.002 \text{ x } TBS \text{ x } TBS + 1.81)}$

For example, if the cadaver has a TBS score of 20, the ADD would be 407.38, and at an average temp of 68 degrees Fahrenheit gives us a PMI of approximately 6 days.

$ADD = 10^{(0.002 \text{ x } 20 \text{ x } 20 \text{ x } 1.81)} = 407.38$

Table 3.2: Categories and stages of decomposition for the head and neck (Megyesi et. al 2005).

A. Fresh	
(1 pt)	1. Fresh, no discoloration
B. Early Decomposition	
(2 pts)	1. Pink-white appearance with skin slippage and some hair loss
(3 pts)	2. Gray to green discoloration: some flesh still relatively fresh
(4 pts)	3. Discoloration and/or brownish shades particularly at edges, drying of nose, ears and lips
(5 pts)	4. Purging of decomposition fluids out of eyes, ears, nose, mouth,
	some bloating of neck and face may be present
(6 pts)	5. Brown to Black Discoloration
C. Advanced Decomposition	
(7 pts)	1. Caving in of the flesh and tissues of eyes and throat
(8 pts)	2. Moist decomposition with bone exposure less than one half that of the area being scored
(9 pts)	3. Mummification with bone exposure less than one half that of the area being scored
D. Skeletonization	
(10 pts)	1. Bone exposure of more than half the area being scored with greasy
	substances and decomposed tissue.
(11 pts)	2. Bone exposure of more than half the area being scored with desiccated or mummified tissue.
(12 pts)	3. Bones largely dry, but retaining some grease
(13 pts)	4. Dry bone

Table 3.3: Categories and stage of decomposition for the trunk (Megyesi et. al 2005).

A. Fresh	
(1 pt)	1. Fresh, no discoloration
B. Early Decomposition	
(2 pts)	1. Pink-white appearance with skin slippage and marbling present.
(3 pts)	2. Gray to green discoloration: some flesh still relatively fresh.
(4 pts)	3. Bloating with green discoloration and purging of decompositional fluids.
(5 pts)	4. Post bloating following release of the abdominal gases, with
	discoloration changing from green to black.
C. Advanced Decomposition	
(6 pts)	1. Decomposition of tissue producing sagging of flesh; caving in of the abdominal cavity.
(7 pts)	2. Moist decomposition with bone exposure less than one half that of the area being scored.
(8 pts)	3. Mummification with bone exposure less than one half that of the area being scored
D. Skeletonization	
(9 pts)	1. Bones with decomoposed tissue, sometimes with body fluids and grease still present.
(10 pts)	2. Bones with desicated or mummified tissue covering less than one half of the area being scored.
(11 pts)	3. Bones largely dry, but retaining some grease.
(12 pts)	4. Dry bone.

Table 3.4: Categories and stage of decomposition for the limbs (Megyesi et. al 2005).

A. Fresh	
(1 pt)	1. Fresh, no discoloration
B. Early Decomposition	
(2 pts)	1. Pink-white appearance with skin slippage of hands and feet.
(3 pts)	2. Gray to green discoloration: some flesh still relatively fresh.
(4 pts)	3. Discoloration and/or brownish shades particularly at edges, drying of
	fingers, toes, and other projecting extremities.
(5 pts)	4. Brown to black discoloration, skin having a leathery appearance
C. Advanced Decomposition	
(6 pts)	2. Moist decomposition with bone exposure less than one half that of the area being scored.
(7 pts)	3. Mummification with bone exposure less than one half that of the area being scored
D. Skeletonization	
(8 pts)	1. Bone exposure over one half the area being scored, some
	decomposed tissue and body fluids remaining.
(9 pts)	2. Bones largely dry, but retaining some grease.
(10 pts)	3. Dry bone.

Statistical Methods

In this experiment the independent variables will be the microenvironments of full sunlight and full shade, the weather station data as well as entomology. My dependent variables in this experiment will be the decomposition events as well as entomology. In this case entomology is both an independent as well as a dependent as arthropods are both a cause and effect in the rate of decomposition study; entomological activity is caused by the local environment and it can affect the rate of decomposition of the remains. All temperature and humidity measurements from the microenvironment experimental sites were compared with the measurements from the nearest National Weather Service (NWS) and National Oceanic and Atmospheric Administration (NOAA) weather station at Lincoln Regional Karl Harder Field (KLHM) Lat: 38.9092°N Lon: 121.3513°W Elev: 121ft. These weather station measurements were compared with our site temperature and humidity measurements for statistical significance.

Due to the small sample size, running statistical tests will not yield correct information regarding rates of decomposition. Rather daily observations were charted via scatterplot charts and line charts to better understand the progression of decomposition. These charts help us better understand the rate in which the cadavers pass from one stage to the next. Further we were able to analyze if there are differences in the rate of decomposition between those that are clothed versus those that are nude as well as analyze differences by microenvironment. This allowed us to test our first hypothesis and see if there is a difference in decomposition rates by condition and environment. However statistical tests were used to compare weather station and experiment site weather data. A paired t-test and Pearson's correlation were ran in SPSS to see if there was a statistical difference between the weather station data and the weather data collected at the experiment site for both microenvironments.

CHAPTER 4 – RESULTS

In this chapter I will discuss the results of this experimental study, illustrating the variables and their effects upon the rate of decomposition.

Weather Data

The range of temperatures and humidity percentages over the course of the experimental time period is illustrated by Figure 4.1, whereas figure 4.2 shows minimum and maximum temperature ranges over the same time frame. A paired T-test as well as a Pearson's correlation was run in SPSS to see if there was a difference between the temperature data collected from the local weather station and the temperature data gathered on site, figure 4.3 shows that there was a statistical difference between temperature data collected on site for both microclimates when compared to the local weather station data. All raw weather data collected is included in appendices I and II.

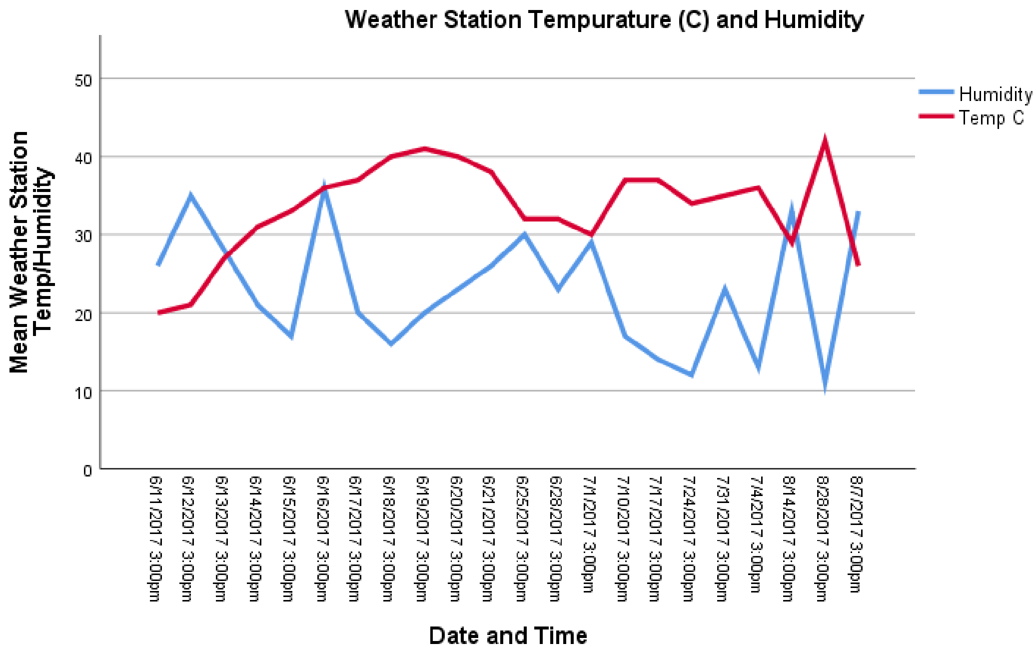

Figure 4.1: Weather and Humidity throughout the course of the observational time period.

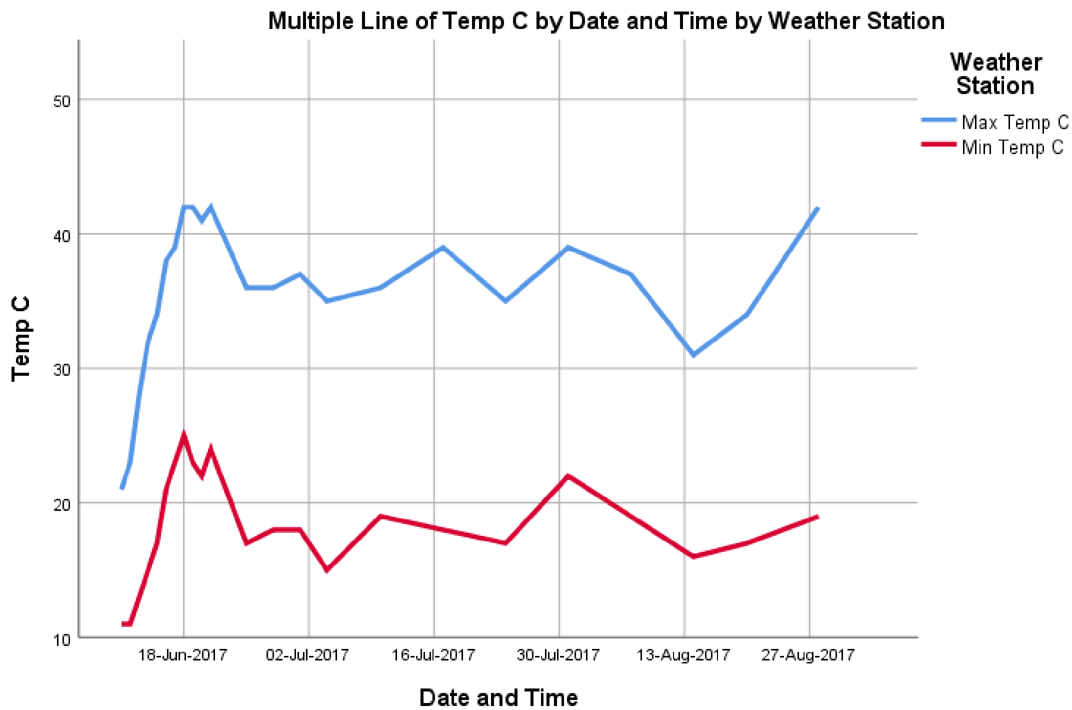

Figure 4.2: Minimum and Maximum Temperatures throughout the course of the observational time period.

Paired T-Test	Sig
Temp C Weather Station and Temp C Sunlight Experiment	0.00
Temp C Weather Station and Temp C Shade Experiment	0.00

Figure 4.3: Statistical comparison between weather station temperature data and experiment site temperature data for both microclimates.

The ADD for the shaded subjects appeared stagnant in the beginning for a longer period of time as decomposition was slower for this pair at the start of the experiment, whereas those in full sunlight rapidly began to decompose thus increasing the TBS leading to higher ADD's until mummification. As the scatterplot graphs below (Figure 4.4 and 4.5) display, ADD for shaded subjects was far higher in the end due to these subjects reaching skeletonization, where subjects in the sun halted at mummification yielding a lower overall ADD.

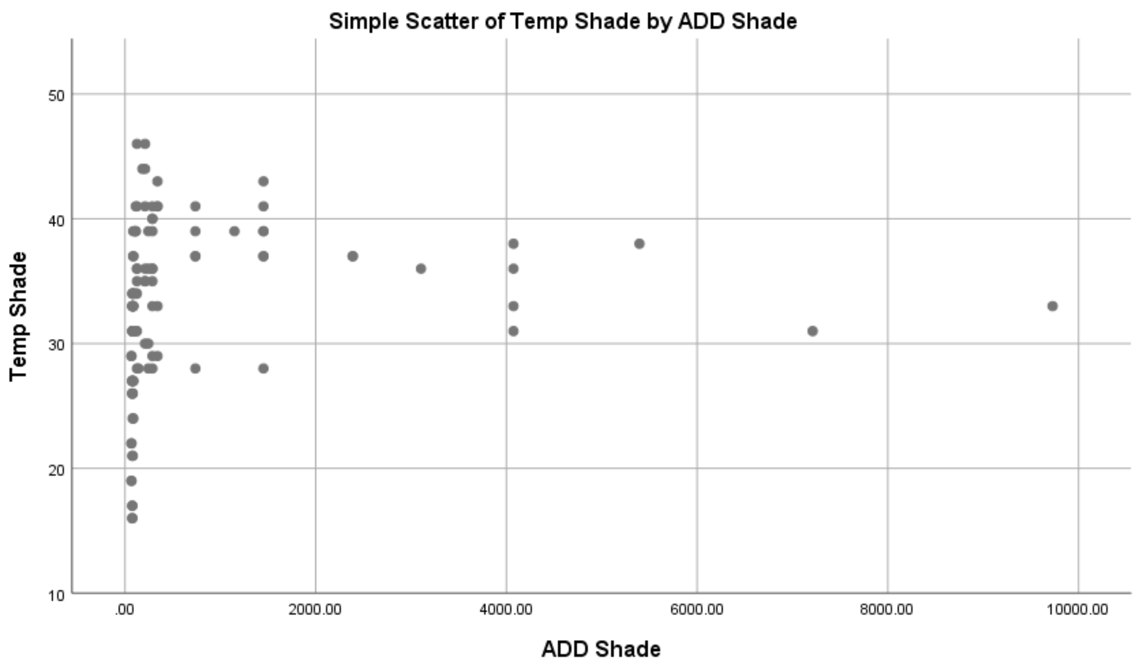

Figure 4.4: ADD by temperature for shaded subjects

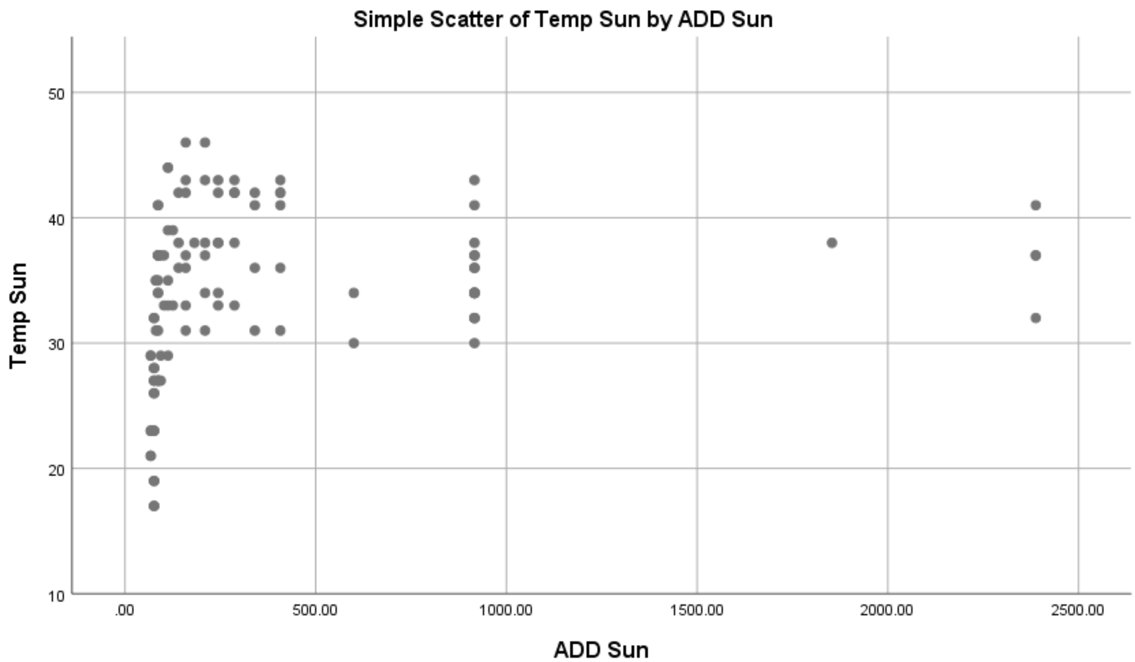

Figure 4.5: ADD by temperature for sunlit subjects

Decomposition Events

Subjects in full sunlight have an ADD that plateau's earlier on in the experiment due to mummification, whereas those in shade reach skeletonization thus yielding a higher TBS and ADD, as shown in figure 4.6. In the following scatter plot graph we can see just how big of an influence temperature plays over decomposition as TBS follows nearly an exact curvature as overall temperature in figure 4.7.

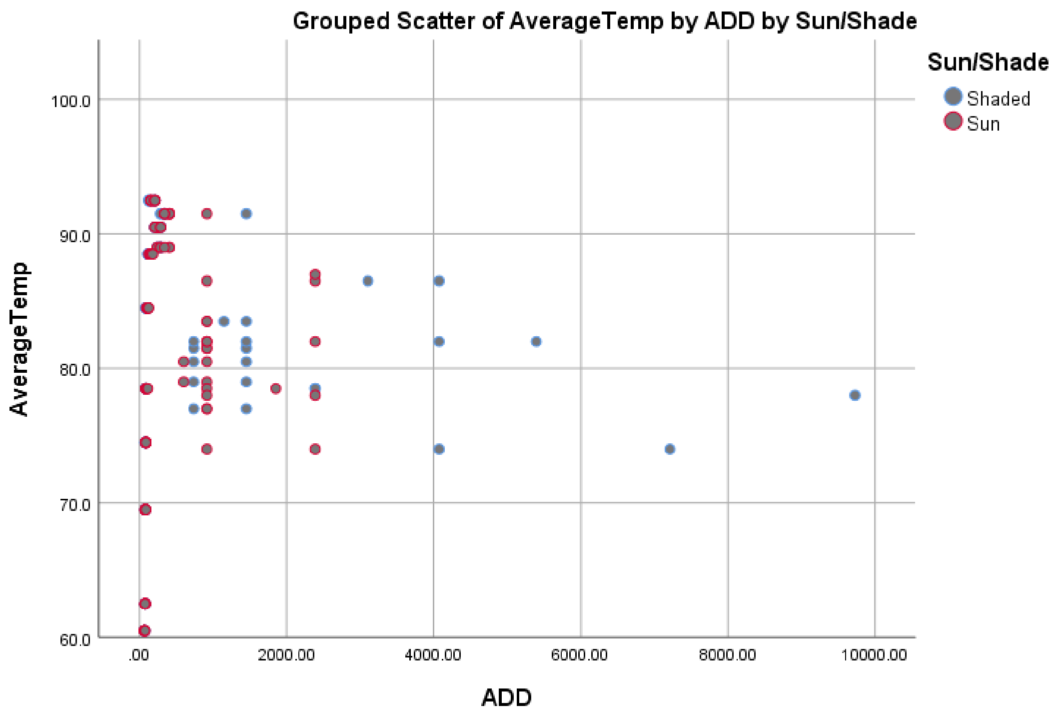

Figure 4.6: Sun and shaded subjects ADD by average temperature

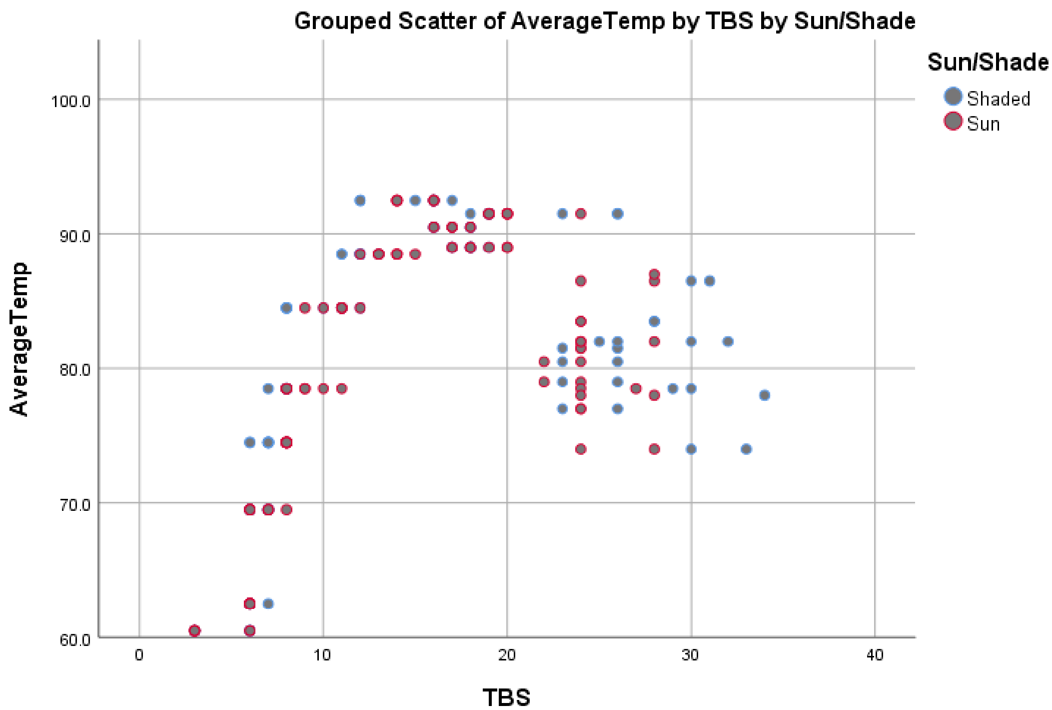

Figure 4.7: Sun and Shaded subjects TBS by average temperature

ADD was plotted against the TBS as well as average temperature to better illustrate the pattern of decomposition. Decomposition followed an exponential shape in the beginning stages and as it entered later stages, where decomposition became more variable, it entered a plateau phase as decomposition rate decreased. During this plateau phase it was noted that decomposition was somewhat stable and unchanged over a period of time, especially when comparing it to earlier stages. Each Carcass followed a similar and predictable pattern through decomposition events, despite some varied and unique changes that they individually experienced in later stages (Tables 4.1-4.4). By the end of the first day all carcass's showed signs of lividity, and predictably the carcass's placed in the sun began to go through the beginning stages of decomposition faster than those in full shade. We similarly predicted that those placed in full sunlight would mummify and stabilize for an extended period of time, whereas those in full shade, despite their slow start, would progress through decomposition faster in later stages as mummification would not be prolonged.

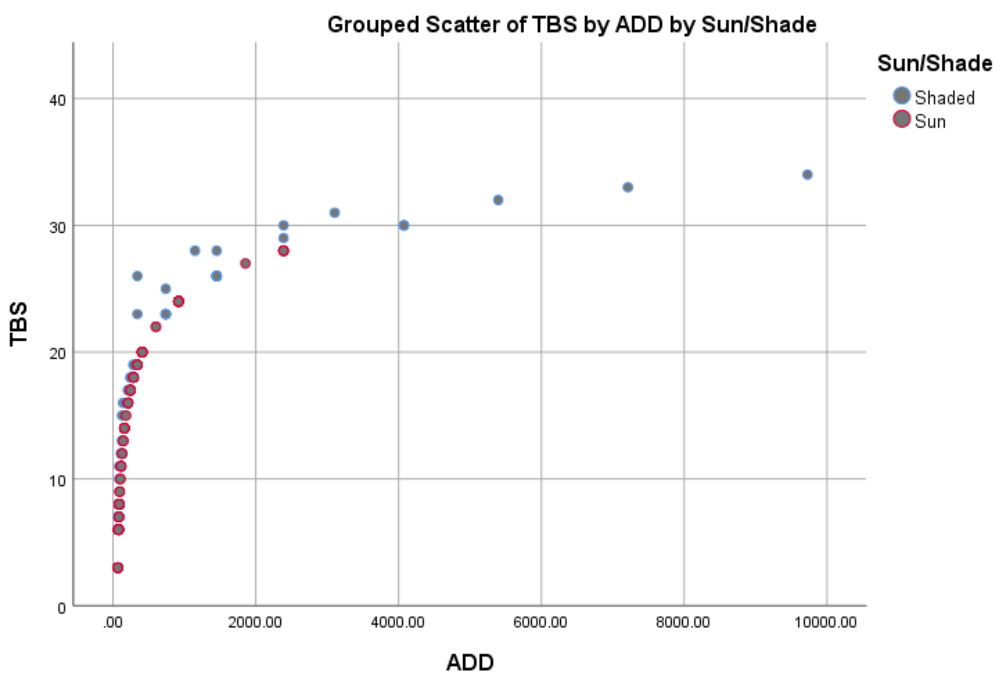

Figure 4.8: Shaded and sun subjects ADD by TBS

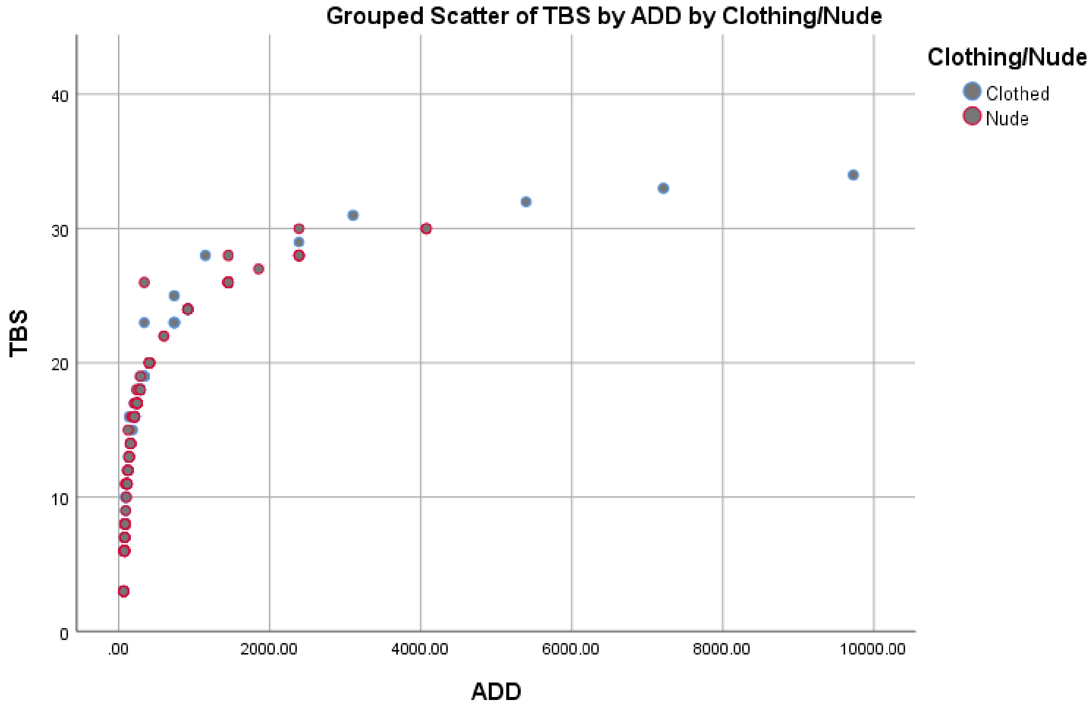

Figure 4.9: Clothed and Nude ADD by TBS

Nasal discharge was observed from all subjects upon the first day of observations, June 11th. Similar fluid purge was noted in the ears of the nude cadaver in sunlight as well as the shaded nude subject by day 3 of the experiment observations, June 13th. Anal purge did not occur until day four, June 14th, for all subjects with the exception of the clothed subject in full sunlight. It was difficult to differentiate between kill wound discharge and oral purge due to the fact that each pig was euthanized via a 22 long rifle into the mouth. All cadavers showed signs of kill wound discharge or oral purge on day 1 as red biological fluid expelled from the oral cavity. By day 2 a mixture of red and brown fluid appeared in the oral cavity of all subjects.

Figure 4.10: Domestic pig subject demonstrating lividity, where skin is darker red to purple on the inferior side.

Figure 4.11 Domestic pig subject displaying green discoloration

Figure 4.12 Domestic pig subject demonstrating nasal purge

The appearance of bloat across all cadavers followed a very similar pattern. All cadavers began to bloat on the first day between 3pm and 6pm. All cadavers displayed extreme bloat prior to abdominal rupture with the exception of the shaded nude subject, where abdominal rupture was not observed save for a 2 inch slit towards the posterior limbs. The other cadavers all experienced abdominal rupture between the 6^{th} and 9^{th} day of observation. The first to rupture was the clothed subject in full sunlight who began to rupture the evening of the 5^{th} day at 6pm, beginning with a slit in the torso of approximately 1inch. Within moments of that skin split, intestines were pushing their way through the skin and beginning to dry out due to the high temperatures and low humidity. The nude subject in full sunlight ruptured soon after in the afternoon (3:00pm) of the 6^{th} day. A large 6-8 inch split in the abdomen was observed where organs and intestines were immediately attempting to protrude and force their way out of the torso. The shaded cadavers were slower to rupture, with the clothed shaded subject rupturing 2 days after the sunlight clothed subject and the nude shaded subjects similarly passing through the bloat stage 2 days after the sunlit nude subject ruptured.

Figure 4.13: Domestic pig subject demonstrating bloat; in this case the rear limbs are elevated due to bloating

Figure 4.14: Domestic pig displaying a distended abdomen due to bloat and skin splitting prior to abdominal rupture

Figure 4.15: Domestic pig subject demonstrating abdominal rupture

Skin slip was observed on all cadavers by day 6th in the afternoon (3:00pm) of the experiment, with the exception of the clothed cadaver in full sunlight which exhibited skin slippage by day 5 in the morning (9:00am). However skin slippage was only noted just prior to abdominal rupture, as skin began to split due to extreme bloat. No fluid was observed building underneath the skin forming post mortem bulla. All subjects emitted a foul stench associated with the rotting of soft tissues. Odor was particularly noted from all cadavers as they neared abdominal rupture. The odor was more intense for the shaded subjects as the odor was enclosed by the sheets providing shade to the subjects. Odor was noted on the 4th day of observation for both shaded subjects, whereas odor was not noted for the sunlit subjects until the 6th day. Odor lasted for all subjects until the evening of the 11th day, post bloat.

Figure 4.16: Domestic pig subject, post bloat

All subjects experienced tooth loss on the 10th day of observations, with the exception of the shaded nude cadaver which began to experience tooth loss the day prior. Skeletonization of more than 50% of the cadavers did not occur until observations slowed down to weekly observations. In the case of the sunlit pair, mummification prevented skeletonization from occurring until after the experimental observation time period had ended. Some skeletonization of the innominate was observed on the shaded clothed cadaver by the 41st day, July 17th, of the experiment. Similarly skeletonization of the thoracic spine and portions of the cervical spine was observed on the nude cadaver in full sunlight on the 41st day. The nude cadaver in shade did not begin to show signs of skeletonization until the 55th day of observation, on July 31st. Disarticulation of skeletal elements were only noted on the shaded cadavers towards the end of the experimental time period. The shaded nude cadaver only exhibited minimal disarticulation at the scapula and innominate, whereas skeletal articulation of the spine and limbs of the shaded clothed subject was noted on the 55th day of observation and on the final day of observation (83rd day, August 28th) the subject was fully disarticulated.

Figure 4.17: Domestic pig cadaver demonstrating mummification

Figure 4.18: Skeletonization of domestic pig cadaver

Table 4.1: Visual observations of decomposition events for the shaded nude subject

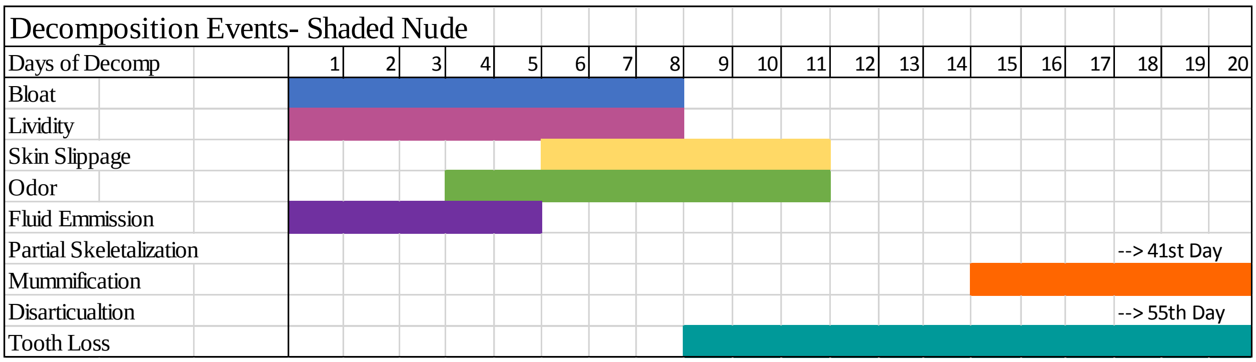

Table 4.2: Visual observations of decomposition events for the shaded clothed subject

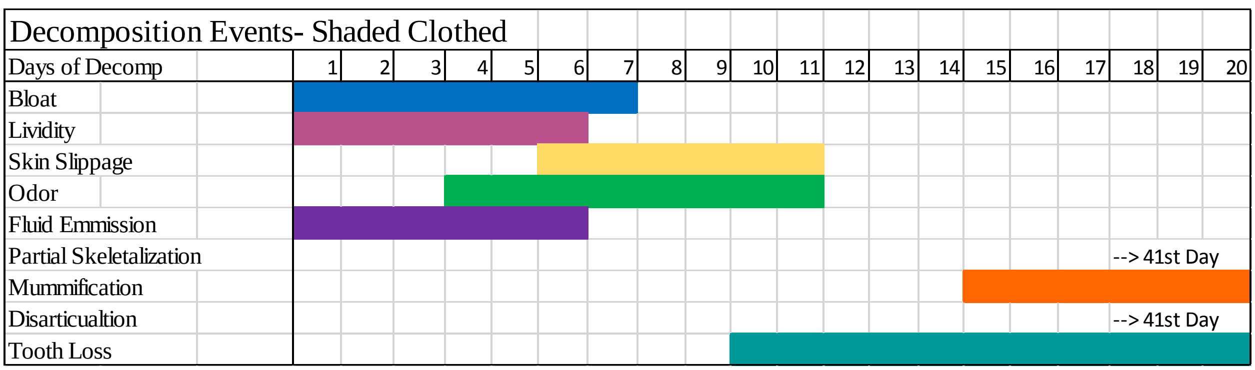

Table 4.3: Visual observations of decomposition events for the sunlit clothed subject

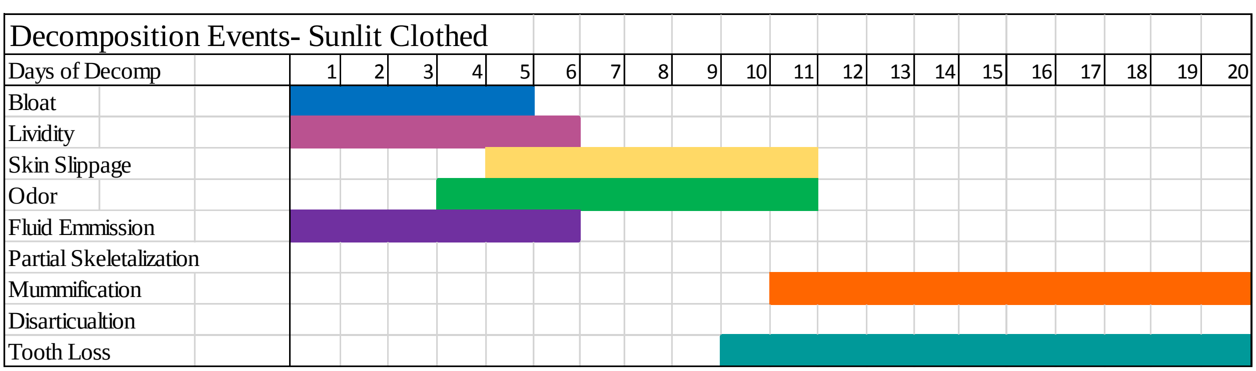

Table 4.4: Visual observations of decomposition events for the sunlit nude subject

Decomposition Events- Sunlit Nude																				
Days of Decomp	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Bloat																				
Lividity																				
Skin Slippage																				
Odor																				
Fluid Emmission																				
Partial Skeletalization																		--> 55th Day		
Mummification																				
Disarticualtion																		--> 55th Day		
Tooth Loss																				

A comparison between carcasses shows differences between the rates in which certain cadavers advanced into stages of decomposition. In the ‘fresh’ stage, bloat lasted 24 hours longer for the shaded pair than cadavers placed in full sunlight. Similarly lividity was observed 48 hours longer on the shaded pair than the sunlit pair. The sunlit pair reached the ‘early decomp’ stage faster than that of cadavers placed in shade and skin slippage and abdominal rupture was seen a full 24 hours earlier in the sunlit pair than the shaded pair. Similarly the cadavers in full sunlight also reached advanced decomposition faster than that of those the subjects placed in the shade, tissue mummified the fastest on the clothed subject placed in the sun (day 11) whereas the other cadavers didn’t begin to mummify until day 15. However it was the shaded pair that began to skeletonize much faster than that of the sunlit pair, partial skeletonization was seen at day 41 for both shaded subjects, yet skeletonization was not noted for the subjects in sun until day 55. Only the nude subject in sun was observed to have partial skeletonization and minor disarticulation on day 55, while the clothed subject in the sun still had yet to mummify.

Table 4.5: Decomposition timeline for all subjects

Subject	Decomposition Stage	Days of Study	Accumulated Degree Day	PMI
Sunlit Clothed	*Fresh*	1-6 Days	67.3-112.72	1-2 Days
	Early Decomposition	5-11 Days	112.72-340.41	2-5 Days
	Advanced	11- Days	340.41	5 Days
	Skeletonization	NA	NA	NA
Sunlit Nude	*Fresh*	1-8 Days	67.3-244.34	1-4 Days
	Early Decomposition	5-11 Days	86.7-407.38	1-6 Days
	Advanced	15-55 Days	599.79-2387.81	9-35 Days
	Skeletonization	55- Days	2387.81	35 Days-EO
Shaded Clothed	*Fresh*	1-7 Days	67.3-209.89	1-3 Days
	Early Decomposition	6-11 Days	86.7-340.41	1-5 Days
	Advanced	15-41 Days	737.9-2387.81	11-35 Days
	Skeletonization	41- Days	2387.81	35- EO
Shaded Nude	*Fresh*	1-8 Days	67.3-125.3	1-2 Days
	Early Decomposition	6-11 Days	86.7-340.41	1-5 Days
	Advanced	15-55 Days	1452.11- 2387.81	21-35 Days
	Skeletonization	41- Days	2387.81	35 Days

Arthropod Activity

One of the reasons that decomposition is measureable is due to the predictability of the insect succession that accompanies the decomposition process. Like any decomposing cadaver, the first to arrive followed by beetles. The first necrophagous species to arrive were from the *Diptera* family, both *Diptera Calliphoridae* and Diptera

Sarcophigidae were seen landing on the cadavers on day 1, June 11th. Both species were seen exploring the surface of the carcass, but tended to be more interested in orifices of the face particularly that of the mouth and ears. A third species, *Diptera Muscidae*, was observed in the following days. Fly eggs were notes in and around the mouth, ears and eyes by day two. By day 3 both sun subjects exhibited small maggots within the mouth and ears, whereas this did not occur for the shaded subjects until day 4 of the observation time period. High levels of fly activity were noted around the clothed cadaver in full sunlight between the 5th and 8th day, whereas high levels of fly activity around the other cadavers were more concentrated on days 7 and 8 of the experimental time period.

Figure 4.19: Diptera Calliphoridae, one of the first responders to a forensic scene

Maggot mass was noted first on the sun cadavers by the 3rd day and on the shaded cadavers by 5th day. Maggots matured through instars and towards migration to pupate outside the cadaver, Maggots were noted to migrate from the cadavers between the 11th and 15th day of observation. However on the 11th day Maggots on the subjects in the sun did not appear to be as active, often unmoving by mid-day as the heat soared into triple digits, whereas the maggots on the shaded subjects were extremely active covering the entirety of the carcass on day 11. Only by day 15 was it noted that maggot masses had migrated.

Figure 4.20: Maggot mass on domestic pig cadaver

Following the migration of maggots from the cadavers, necrophagous species of coleoptera were observed feeding on the tissues of the body. Namely members from families *carabidae and cleridae.* Members of Coleoptera were rarely, if ever, observed on the surface of the cadaver, but underneath the carcass's dried tissues or clothing, several were found. *Coleoptera carabidae* were noted on the shaded subjects first on the 37th day of observation, July 17th. Subjects in the sun did not show any visible signs of Coleoptera until day only the pupated casings surrounding the cadavers. There may have been members of Coleoptera far within the tissues of the mummified carcasses in the sun, but despite prodding with long tweezers, no live species were found.

The necrophagous species feeding upon the cadavers also attract predators that feed off of them. During this experiment the most common predator observed were yellow jackets, *Hymenoptera Vespula maculifrons,* which were observed in higher frequency during the appearance of maggot masses on the cadavers as this species seeks out members of the Dipteran family to feed from. Post bloat and following maggot migration, a praying mantis, *Mantodea*, was noted on the shaded clothed subject. A spider web was observed on the nude subject in shade, however no arachnid species was observed on any of the cadavers.

Taphonomic Processes

Due to the construction of the enclosures, scavenger activity was prevented with the exception of a blue bellied lizard (*Sceloporus occidentalis*) that was found under the clothing of the shaded subject foraging for beetles. This was observed on day 71st of the experiment, August 20th. The property owner had two dogs (*Canis familiaris*) that would occasionally sniff around the cages, but the chicken wire prevented them from picking at the cadaver. Turkey vultures (*Carthartes aura*) were witnessed to circle overhead during early and advanced decomposition stages. Bird droppings were noted on both subjects in sunlight, but the vultures were unable to access the flesh of the cadavers.

Both of the shaded subjects exhibited bone bleaching on exposed bone. Due to the high temperature and low humidity, exposed bone quickly dried out and took on a lighter appearance than bones that were covered by clothing or desiccated tissue. The shaded clothed subject was fully skeletonized, thus exhibited more bone weathering than that of the other cadavers. The limbs of the shaded clothed subject were more bleached in other elements due to the fact that they weren't covered by clothing and at certain times of the day where exposed to sunlight when the sun would shift. The shaded nude subject was less skeletonized, however the top of the iliac crest was exposed and unprotected by clothing or skin, therefore it exhibited a lighter shade of color than that of bone still mostly protected by skin or tissue. Both sun subjects were in a mummified and greasy state and did not exhibit bone weathering by the end of the observation period.

CHAPTER 5- DISCUSSION

In this chapter I will discuss the findings of this experimental study, highlighting the rate of decomposition to skeletonization and the effects of the variables that may accelerate or retard the rate of decomp.

Weather Data

ADD was calculated using weather station data gathered from Lincoln Regional Karl Harder Field (KLHM). KLHM is the recommended weather station for the area of Sheridan from the National Oceanic and Atmospheric Agency (NOAA), however when running a statistical comparison by a paired t-test for unequal variances it was seen that there was a statistical difference between our experimental locations and the weather station data. This will be further discussed in the limitations section.

Decomposition Events:

Overall this study found that, similar to other experiments, decomposition moved through a predictable sequence. In the beginning decomposition progressed in an exponential fashion and in later stages, plateaued as more variability was introduced. Temperature had a greater impact on decomposition than clothing as those subjects in direct sunlight progressed more rapidly than those in shade. However due to the extreme temperatures and lack of humidity, mummification retarded the decomposition process in later stages preventing the onset of skeletonization. Shaded cadavers moved slower through the initial stages of decomposition, but quickly bypassed mummification and entered skeletonization. Clothing seemed to have little impact on overall decomposition as the sunlit clothed subject progressed more rapidly than the sunlit subject, but the reverse was seen in the shaded subjects. However in later stages it was observed that clothing provided protective habitats for arthropods, primarily Coleoptera, which allowed faster skeletonization to occur.

Arthropod Activity

Necrophagous species such as flies (Diptera) and beetles (Coleoptera) were critical in aiding the carcass through the decomposition process. Similar to other studies, this study saw the onset of Dipteran species in early stages of decomposition. Calliphoridae and Sarcophagidae were first responders, arriving at the cadavers within 30 minutes of placement. Calliphoridae was the predominant species throughout the early stages of decomposition, though both Muscidae and Sarcophagidae were observed in fewer numbers. Overall few differences were found between microclimates in regards to the arrival of Dipterans and their numbers. Coleopterans predictably arrived in later stages of decomp and were seen more amongst the shaded subjects than those in the sun, further the shaded clothed subject showed more coleopteran activity as the clothing appeared to provide a protective habitat in which they could feed.

Direct Comparisons with Related Studies:

Similar to this experiment, like studies (Srnka 2003, Rottenstein 2006, Sharplin 2012) showed that subjects in full sunlight decomposed rapidly through initial stages of decomposition, while later stages of decomposition were more variable. Like Sharplin's 2012 study, desiccation dominated the latter stages of decomposition unlike studies executed in more humid climates. Unlike other experimental studies, not all subjects reached skeletonization during the experimental time period. The subjects in this study as well as Sharplin's (2012) did not lose biomass as rapidly as other experiments (Shean et. al 1993, Srnka 2003, Rottenstein 2006). Similar to Snka's observations, we also noted that overall decomposition was faster for the shaded subjects as opposed to those placed in direct sunlight. This study did not support the findings of Shean (1993) which observed that overall decomposition was faster in subjects placed in direct sunlight.

Like Miller (2002) and Kelly (2006) which found no statistical differences between the decomposition rates for those subjects clothed or nude, this study found that differences in condition did not appear to drastically alter decomposition rates. While clothing may have provided a protective habitat for necrophagous species in later stages of decomposition, it was still observed that while the shaded clothed subject did skeletonize faster, the sunlit clothed subject did not when compared with its sunlit nude counterpart. This study showed, like Myburgh (2013) that overall decomposition followed a curvilinear progression, where early stages followed a linear progression while later stages of decomposition where much more variable especially where TBS scores were higher. Differences in humidity, season and seasonal insect activity are just some of the many variables that may account for the similarities and differences noted between experiments.

Limitations and Recommendations

One limitation of this study was the statistical difference between the weather station and the experimental site. This came partially down to the sensitivity of the (ActiveAir™ Indoor-Outdoor Digital Thermometer) in the extreme temperature. Often the (ActiveAir™ Indoor-Outdoor Digital Thermometer) would change readings after a few minutes. The weather station was also 12 miles from the experiment site which proved challenging. Further this study struggled in the first day to find a proper shade covering that withstood the wind force that was hitting the experiment site in the first 48 hours. The first canopy collapsed, forcing a last minute solution of tying the shade covering around the cages instead of providing shade to the cadavers overhead, similar to a tree. This tie down solution may have increased decomp for the first 24 hours of the shaded cadavers due to the warmer, tent-like, environment that was created preventing air-flow. It is our recommendation that future studies look at re-enforcing the legs of the canopy they use in windy climates. Re-erecting a new canopy, this study drilled steel rods into the earth and re-enforced the canopy top with zip-ties.

CHAPTER 6 – CONCLUSIONS

The major goal of this research was to investigate the rate of decomposition in a northern California environment during summer months as previous research in this environment had not been conducted. (Insert which one produced a skeleton first and which one decomposed faster). In Sheridan, CA which is characterized by dry, hot summers, we saw that those cadavers placed in full shade reached skeletonization before those subjects placed in full sunlight. Subjects placed in full sunlight, however, progressed through initial stages of decomposition at a much faster rate yet little to no changes occurred once mummification set in. This study showed that overall temperature or microclimate had a more dramatic effect over decomposition than clothing. Clothing did not play a significant role in the acceleration or deceleration of the decomposition process however it proved important in providing a protective environment for necrophagous species to continue feeding.

Due to the fact that decomposition is a continuous process dependent on environmental variables, this study's findings are specific to the summer in the northern California valley and to cadavers around 100lbs. Future researchers would be wise to keep in mind that PMI estimates made on cadavers found in full sunlight may be underestimated due to the extreme lack of change that occurs in later stages. This is the first study in northern California to directly address decomposition, however other studies in northern California are necessary to evaluate seasonal effects to decomposition rates.

Testing other variables would also be important to truly understand decomposition rates in this area.

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APPENDICES

APPENDIX I: WEATHER DATA

Lincoln Regional Karl Harder Field (KLHM) Weather Station Data

Lat: 38.9092°N Lon: 121.3513°W

Date and Time	TempF	TempC	RELH%
6/11/2017 9:01am	61	16	48%
6/11/2017 12:01pm	63	17	45%
6/11/2017 3:10pm	69	20	26%
6/11/2017 6:02pm	54	12	71%
6/12/2017 9:07am	57	14	63%
6/12/2017 12:00pm	64	18	46%
6/12/2017 3:03pm	70	21	35%
6/12/2017 5:58pm	73	23	27%
6/13/2017 9:00am	64	18	49%
6/13/2017 12:00pm	73	23	38%
6/13/2017 3:00pm	81	27	28%
6/13/2017 6:00pm	82	28	26%
6/14/2017 9:08am	72	22	47%
6/14/2017 12:00pm	81	27	28%
6/14/2017 3:00pm	88	31	21%
6/14/2017 6:00pm	90	32	15%
6/15/2017 9:00am	72	22	41%
6/15/2017 12:00pm	81	27	35%
6/15/2017 3:00pm	91	33	17%
6/15/2017 6:00pm	95	35	16%
6/16/2017 9:00am	77	25	41%
6/16/2017 12:00pm	88	31	31%
6/16/2017 3:00pm	97	36	36%
6/16/2017 6:00pm	100	38	19%
6/17/2017 9:00am	81	27	39%
6/17/2017 12:00pm	90	32	30%

6/17/2017 3:00pm	99	37	20%
6/17/2017 6:00pm	99	37	17%
6/18/2017 9:00am	73	23	53%
6/18/2017 12:00pm	97	36	25%
6/18/2017 3:00pm	104	40	16%
6/18/2017 6:00pm	105	41	18%
6/19/2017 9:00am	86	30	35%
6/19/2017 12:00pm	100	38	23%
6/19/2017 3:00pm	106	41	20%
6/19/2017 6:00pm	108	42	16%
6/20/2017 9:00am	86	30	33%
6/20/2017 12:00pm	95	35	27%
6/20/2017 3:00pm	104	40	23%
6/20/2017 6:00pm	106	41	22%
6/21/2017 9:00am	81	27	42%
6/21/2017 12:00pm	91	33	34%
6/21/2017 3:00pm	100	38	26%
6/21/2017 6:00pm	104	40	23%
6/25/2017 3:00pm	90	32	30%
6/28/2017 3:00pm	90	32	23%
7/1/2017 3:00pm	86	30	29%
7/4/2017 3:00pm	97	36	13%
7/10/2017 3:00pm	99	37	17%
7/17/2017 3:00pm	99	37	14%
7/24/2017 3:00pm	93	34	12%
7/31/2017 3:00pm	95	35	23%
8/7/2017 3:00pm	91	26	33%
8/14/2017 3:00pm	84	29	33%
8/20/2017 3:00pm	Na	na	na
8/28/2017 3:00pm	108	42	11%

Lincoln Regional Karl Harder Field (KLHM) Weather Station Minimum, Maximum and Average Temperatures

Date	Min	Max	Average	Average Celcius
6/11/2017	52	69	60.5	16
6/12/2017	51	74	62.5	17
6/13/2017	56	83	69.5	21
6/14/2017	59	90	74.5	23
6/15/2017	63	94	78.5	26
6/16/2017	69	100	84.5	29
6/17/2017	74	103	88.5	31
6/18/2017	77	108	92.5	34
6/19/2017	74	107	90.5	32
6/20/2017	72	106	89	32
6/21/2017	75	108	91.5	33
6/25/2017	62	96	79	26
6/28/2017	64	97	80.5	27
7/1/2017	65	98	81.5	28
7/4/2017	59	95	77	25
7/10/2017	67	97	82	28
7/17/2017	65	102	83.5	29
7/24/2017	62	95	78.5	26
7/31/2017	71	102	86.5	31
8/7/2017	66	98	82	28
8/14/2017	60	88	74	23
8/20/2017	63	93	78	26
8/28/2017	66	108	87	31

APPENDIX II: EXPERIMENTAL SITE WEATHER DATA AND ENVIRONMENT

Shaded Experimental Site Weather Observations

Date	Time	Ambient Temp C	Ambient Temp F	RELH%	Ground Temp C	Ground Temp F	Weather
6/11/2017	9:00am	19	66	43%	20	68	Cloudy
	12:00pm	22	72	38%	21	70	Partially Cloudy
	3:00pm	29	84	24%	26	78	Cloud Cover
	6:00pm	17	63	71%	17	62	Cloud Cover
6/12/2017	9:00am	16	60	72%	17	62	Partially Cloudy
	12:00pm	27	80	41%	26	78	Partially Cloudy
	3:00pm	27	81	32%	22	72	Sunny
	6:00pm	26	79	31%	24	76	Sunny
6/13/2017	9:00am	21	70	42%	20	68	Sunny
	12:00pm	31	87	27%	23	74	Sunny
	3:00pm	33	91	24%	27	80	Sunny
	6:00pm	31	88	24%	27	80	Sunny
6/14/2017	9:08am	26	79	40%	22	72	Sunny
	12:00pm	33	91	29%	29	84	Sunny
	3:00pm	34	94	23%	28	82	Sunny
	6:00pm	33	91	19%	27	80	Sunny
6/15/2017	9:00am	24	76	41%	24	76	Sunny
	12:00pm	34	94	25%	25	77	Sunny
	3:00pm	37	98	17%	27	80	Sunny
	6:00pm	33	92	20%	27	80	Sunny
6/16/2017	9:00am	27	80	43%	24	76	Sunny
	12:00pm	31	87	44%	28	83	Sunny
	3:00pm	39	103	23%	29	84	Sunny
	6:00pm	39	102	23%	27	80	Sunny
6/17/2017	9:00am	31	88	38%	26	78	Sunny
	12:00pm	34	94	31%	32	90	Sunny
	3:00pm	41	105	20%	33	92	Sunny
	6:00pm	36	97	23%	31	88	Sunny

6/18/2017	9:00am	28	82	44%	24	76	Sunny
	12:00pm	35	95	31%	32	90	Sunny
	3:00pm	46	114	14%	31	88	Sunny
	6:00pm	44	111	20%	34	94	Sunny
6/19/2017	9:00am	30	86	35%	33	92	Sunny
	12:00pm	35	95	30%	44	112	Sunny
	3:00pm	41	105	24%	29	84	Sunny
	6:00pm	36	96	24%	34	94	Sunny
6/20/2017	9:00am	28	82	43%	29	84	Sunny
	12:00pm	36	96	33%	27	80	Sunny
	3:00pm	39	102	29%	30	86	Sunny
	6:00pm	40	104	27%	34	94	Sunny
6/21/2017	9:00am	29	85	46%	NA	NA	Sunny
	12:00pm	33	91	43%	32	90	Sunny
	3:00pm	41	105	24%	32	90	Sunny
	6:00pm	43	110	22%	31	91	Sunny
6/25/2017	3:00pm	39	102	28%	34	94	Sunny
6/28/2017	3:00pm	28	82	42%	27	80	Sunny
7/1/2017	3:00pm	37	98	30%	27	80	Sunny
7/4/2017	3:00pm	37	98	24%	28	82	Sunny
7/10/2017	3:00pm	41	105	23%	31	88	Sunny
7/17/2017	3:00pm	39	102	16%	32	90	Sunny
7/24/2017	3:00pm	37	99	14%	34	93	Sunny
7/31/2017	3:00pm	36	96	32%	31	88	Sunny
8/7/2017	3:00pm	38	101	29%	33	92	Sunny
8/14/2017	3:00pm	31	87	43%	29	84	Sunny
8/20/2017	3:00pm	33	91	39%	37	98	Sunny
8/28/2017	3:00pm	NA	NA	NA	NA	NA	Sunny

Sunlit Experimental Site Weather Observations

Date	Time	Ambient Temp C	Ambient Temp F	RELH%	Ground Temp C	Ground Temp F	Weather
6/11/2017	9:01am	21	70	40%	22	72	Cloud Cover
	12:01pm	23	74	38%	28	82	Partially Cloudy
	3:10pm	29	84	24%	28	82	Cloud Cover
	6:02pm	17	63	71%	17	62	Cloud Cover **
6/12/2017	9:07am	19	67	58%	16	60	Partially Cloudy
	12:00pm	26	78	44%	22	72	Partially Cloudy
	3:03pm	27	81	32%	26	78	Sunny
	5:58pm	28	82	33%	27	80	Sunny
6/13/2017	9:00am	23	73	46%	23	74	Sunny
	12:07pm	32	90	30%	32	90	Sunny
	3:00pm	35	95	24%	32	90	Sunny
	6:00pm	31	89	24%	33	92	Sunny
6/14/2017	9:08am	27	81	40%	24	76	Sunny
	12:00pm	34	94	29%	29	84	Sunny
	3:00pm	41	105	21%	33	92	Sunny
	6:00pm	37	98	22%	32	90	Sunny
6/15/2017	9:00am	27	81	41%	26	78	Sunny
	12:00pm	37	100	24%	39	102	Sunny
	3:00pm	37	100	21%	40	104	Sunny
	6:00pm	35	95	20%	38	100	Sunny
6/16/2017	9:00am	29	84	44%	27	80	Sunny
	12:00pm	33	92	39%	40	104	Sunny
	3:00pm	44	111	20%	42	108	Sunny
	6:00pm	39	102	24%	41	106	Sunny
6/17/2017	9:00am	33	92	30%	32	90	Sunny
	12:00pm	36	96	31%	39	102	Sunny
	3:00pm	42	107	29%	43	111	Sunny
	6:00pm	38	101	23%	43	111	Sunny
6/18/2017	9:00am	31	88	44%	31	88	Sunny
	12:00pm	37	100	29%	43	110	Sunny
	3:00pm	46	114	18%	48	118	Sunny
	6:00pm	43	109	21%	49	120	Sunny

6/19/2017	9:00am	34	94	32%	36	96	Sunny
	12:00pm	38	101	20%	44	112	Sunny
	3:00pm	43	109	25%	49	121	Sunny
	6:00pm	42	108	16%	42	109	Sunny
6/20/2017	9:00am	33	91	42%	38	100	Sunny
	12:00pm	38	100	33%	43	109	Sunny
	3:00pm	42	107	27%	49	121	Sunny
	6:00pm	41	105	29%	49	120	Sunny
6/21/2017	9:00am	31	87	45%	NA	NA	Sunny
	12:00pm	36	97	40%	46	115	Sunny
	3:00pm	42	108	23%	49	121	Sunny
	6:00pm	43	110	23%	44	112	Sunny
6/25/2017	3:00pm	34	93	34%	50	122	Sunny
6/28/2017	3:00pm	30	86	41%	38	100	Sunny
7/1/2017	3:00pm	32	90	34%	49	121	Sunny
7/4/2017	3:00pm	34	93	30%	50	122	Sunny
7/10/2017	3:00pm	36	97	30%	50	122	Sunny
7/17/2017	3:00pm	34	94	30%	54	130	Sunny
7/24/2017	3:00pm	38	101	18%	50	122	Sunny
7/31/2017	3:00pm	37	99	31%	53	128	Sunny
8/7/2017	3:00pm	37	99	31%	51	124	Sunny
8/14/2017	3:00pm	32	90	37%	49	120	Sunny
8/20/2017	3:00pm	41	105	26%	49	120	Sunny
8/28/2017	3:00pm	42	107	14%	42	108	Sunny

**** ¾” of rain was recorded during this time.**

APPENDIX III: DECOMPOSITION OBSERVATIONS

Decomposition observations for clothed subject in sunlight

Date and Time	Head and Neck Score	Head and Neck Notes	Trunk Score	Trunk Notes	Limbs Score	Limbs Notes	TBS
6/11/17 9:01am	1		1		1		3
6/11/2017 12:01pm	1		1		1	Rigor	3
6/11/2017 3:10pm	1	Nasal Discharge; Bloat; Rigor	1	Rigor; Bloat	1	Rigor; Bloat	3
6/11/2017 6:02pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/12/2017 9:07am	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/12/2017 12:07pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/12/2017 3:03pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/12/2017 5:58pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6

6/13/2017 9:00am	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/13/2017 12:07pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/13:2017 3:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	7
6/13/2017 6:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth	3	Extreme Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Rigor; Lividity	8
6/14/2017 9:08am	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth	3	Extreme Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Rigor; Lividity	8
6/14/2017 12:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth	3	Extreme Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Rigor; Lividity	8
6/14/2017 3:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth	3	Extreme Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Rigor; Lividity	8

6/14/2017 6:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	3	Extreme Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Rigor; Lividity	8
6/15/2017 9:00am	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	4	Bloat; Rigor; Lividity; Green Discoloration; Distended abdomen with approx.. 1 inch opening releasing fluid	2	Bloat; Rigor; Lividity;	9
6/15/2017 12:00pm	3	Nasal Discharge; Bloat; Maggot activity in mouth and ears	4	Bloat; Rigor; Lividity; Green Discoloration; Distended abdomen with approx.. 4 inch opening releasing fluid; Large and Small intestine released through abdominal opening	2	Bloat; Rigor; Lividity;	9

6/15/2017 3:00pm	4	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots	4	Bloat; Rigor; Lividity; Green Discoloration; Distended abdomen with approx 6 inch opening releasing fluid; Large and Small intestine released through abdominal opening	2	Bloat; Rigor; Lividity;	10

6/15/2017 6:00pm	4	Nasal Discharge; Bloat; Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots	4	Bloat; Green Discoloration; Distended abdomen with approx. 6 inch opening releasing fluid; Large and Small intestine released through abdominal opening. Bodily fluids releasing from abdomen and intestines drying out.	3	Bloat	11

6/16/2017 9:00am	4	Nasal Discharge; Bloat; Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots	4	Bloat; Green-black Discoloration; Distended abdomen with approx. 6 inch opening releasing fluid; Large and Small intestine released through abdominal opening. Bodily fluids releasing from abdomen and intestines drying out. Fluids seeping from near limbs	3	Bloat	11

6/16/2017 12:00pm	4	Nasal Discharge; Bloat; Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots	4	Bloat; Green-black Discoloration; Distended abdomen with approx. 6 inch opening releasing fluid; Large and Small intestine released through abdominal opening. Bodily fluids releasing from abdomen and intestines drying out. Fluids seeping from near limbs	3	Bloat	11

6/16/2017 3:00pm	4	Nasal Discharge; Bloat; Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots	4	Bloat; Green-black Discoloration; Distended abdomen with approx. 6 inch opening releasing fluid; Large and Small intestine released through abdominal opening. Bodily fluids releasing from abdomen and anus; intestines drying out. Fluids seeping from near limbs	3	Bloat	11

6/16/2017 6:00pm	4	Bloat; Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots	4	Bloat; Green-black Discoloration; Distended abdomen with approx. 6 inch opening releasing fluid; Large and Small intestine released through abdominal opening. Bodily fluids releasing from abdomen and anus; intestines drying out. Fluids seeping from near limbs	4	Fluid releasing from tops of limbs; darkening of skin	12
6/17/2017 9:00am	5	Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots; 3 inch opening on neck with maggots	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	4	Fluid releasing from tops of limbs; darkening of skin	14

6/17/2017 12:00pm	5	Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots; 3 inch opening on neck with maggots	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	4	Fluid releasing from tops of limbs; darkening of skin	14
6/17/2017 3:00pm	5	Maggot activity in mouth and ears; Nasal and mouth tissue being removed by maggots; 3 inch opening on neck with maggots	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	4	Fluid releasing from tops of limbs; darkening of skin	14
6/17/2017 6:00pm	6	Maggot Mass on head and neck; black and orange greasy skin and tissue; tissue loss to the face	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	4	Fluid releasing from tops of limbs; darkening of skin	15
6/18/2017 9:00am	6	Maggot Mass on head and neck; black and orange greasy skin and tissue; tissue loss to the face	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	5	Drying of skin; Maggots at skin slippage sights	16

6/18/2017 12:00pm	6	Maggot Mass on head and neck; black and orange greasy skin and tissue; tissue loss to the face	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	5	Drying of skin; Maggots at skin slippage sights	16
6/18/2017 3:00pm	6	Maggot Mass on head and neck; black and orange greasy skin and tissue; tissue loss to the face	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	5	Drying of skin; Maggots at skin slippage sights	16
6/18/2017 6:00pm	6	Maggot Mass on head and neck; black and orange greasy skin and tissue; tissue loss to the face	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	5	Drying of skin; Maggots at skin slippage sights	16
6/19/2017 9:00am	6	Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face	5	Blackening of skin; loss of fluid from torso; internal organs dry. Maggot Mass on torso.	5	Drying of skin; Maggots at skin slippage sights	16

6/19/2017 12:00pm	6	Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face	5	Black skin; Maggot Mass on torso; Internal organs deflated and dry; Skin beginning to dry out	5	Drying of skin; Maggots at skin slippage sights	16
6/19/2017 3:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Tissue beginning to dry out	6	Black skin; Decreased Maggot Mass on torso; Maggots unmoving; Internal organs deflated and dry; Skin beginning to dry out;	5	Decreased maggot mass; drying skin	18
6/19/2017 6:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Tissue beginning to dry out	6	Black skin; Decreased Maggot Mass on torso; Maggots unmoving; Internal organs deflated and dry; Skin beginning to dry out;	5	Decreased maggot mass; drying skin	18

6/20/2017 9:00am	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Tissue beginning to dry out	6	Black skin; Decreased Maggot Mass on torso; Internal organs deflated and dry; Skin beginning to dry out;	5	Decreased maggot mass; drying skin	18
6/20/2017 3:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Tissue beginning to dry out-Mummification	6	Black skin; Decreased Maggot Mass on torso; Maggots unmoving; Internal organs deflated and dry; Skin beginning to dry out;	5	Decreased maggot mass; drying skin	18
6/20/2017 6:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Mummification	6	Black skin; Decreased Maggot Mass on torso; Maggots unmoving; Internal organs deflated and dry; Skin beginning to dry out;	5	Decreased maggot mass; drying skin	18

6/21/2017 9:00am	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Mummification	7	Black skin; Loss of torso tissue; tissue and skin drying out and mummifying; reduced maggot presence	5	Decreased maggot mass; drying skin	19
6/21/2017 12:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Mummification	7	Black skin; Loss of torso tissue; tissue and skin drying out and mummifying; reduced maggot presence	5	Decreased maggot mass; drying skin	19
6/21/2017 3:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Mummification	7	Black skin; Loss of torso tissue; tissue and skin drying out and mummifying; reduced maggot presence	5	Decreased maggot mass; drying skin	19

6/21/2017 6:00pm	7	Decreased Maggot Mass on head and neck; black greasy skin and tissue; tissue loss to the face; Mummification	7	Black skin; Loss of torso tissue; tissue and skin drying out and mummifying; reduced maggot presence	5	Decreased maggot mass; drying skin	19
6/25/2017 3:00pm	9	Black mummified tissue; no insect activity;	8	Dry mummified tissue; no insect activity	7	Dry mummified tissue; no insect activity	24
6/28/2017 3:00pm	9	Dry mummified tissue; Flies (calliphoridae and Muscidae) covering cages	8	Dry mummified tissue; Flies (calliphoridae and Muscidae) covering cages	7	Dry mummified tissue; Flies (calliphoridae and Muscidae) covering cages	24
7/1/2017 3:00pm	9	Dry mummified tissue; few flies	8	Dry mummified tissue; few flies; 1 yellow jacket	7	Dry mummified tissue; few flies	24

7/4/2017 3:00pm	9	Dry mummified; some grease still noted. No insect activity	8	Dry mummified; some grease still noted. No insect activity	7	Dry mummified; some grease still noted. No insect activity	24
7/10/2017 3:00pm	9	Dry mummified; some grease still noted. No insect activity	8	Dry mummified; some grease still noted. No insect activity	7	Dry mummified; some grease still noted. No insect activity	24
7/17/2017 3:00pm	9	Dry mummified tissue; No insect activity	8	Dry mummified; some grease still noted. No insect activity	7	Dry mummified; some grease still noted. No insect activity	24

7/24/2017 3:00pm	9	Dry mummified tissue; No insect activity	8	Dry mummified; some grease still noted. No insect activity	7	Dry mummified; some grease still noted. No insect activity	24
7/31/2017 3:00pm	9	Dry mummified tissue; No insect activity	8	Dry mummified; some grease still noted. No insect activity	7	Dry mummified; some grease still noted. No insect activity	24
8/7/2017 3:00pm	9	Dry mummified tissue	8	Dry mummified; some grease still noted	7	Dry mummified; some grease still noted.	24
8/14/2017 3:00pm	9	Dry mummified tissue	8	Dry mummified; some grease still noted	7	Dry mummified; some grease still noted.	24

8/20/2017 3:00pm	9	Dry mummified tissue	8	Dry mummified; some grease still noted; Lizard and Praying Mantis under clothing	7	Dry mummified; some grease still noted.	24
8/28/2017 3:00pm	9	Dry mummified tissue	8	Dry mummified; some grease still noted	7	Dry mummified; some grease still noted.	24

Decomposition observations for nude subject in sunlight

Date and Time	Head and Neck Score	Head and Neck Notes	Trunk Score	Trunk Notes	Limbs Score	Limbs Notes	TBS
6/11/17 9:01am	1	Fresh	1	Fresh	1	Fresh	3
6/11/2017 12:01pm	1	Fresh	1	Rigor	1	Rigor	3
6/11/2017 3:10pm	1	Nasal Discharge; Rigor	1	Rigor	1	Rigor	3
6/11/2017 6:02pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity	6
6/12/2017 9:07am	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Rigor; Lividity	6
6/12/2017 12:07pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Rigor; Lividity	6
6/12/2017 3:03pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Rigor; Lividity	6
6/12/2017 5:58pm	2	Nasal Discharge; Bloat; Rigor; Lividity	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Lividity	6

6/13/2017 9:00am	2	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Lividity	6
6/13/2017 12:07pm	2	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Lividity	6
6/13:2017 3:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears; Maggots activity in mouth	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Lividity	7
6/13/2017 6:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears; Maggots activity in mouth	2	Bloat; Rigor; Lividity; Red Marbling	2	Bloat; Lividity	7

6/14/2017 9:08am	3	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears; Maggots activity in mouth	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8
6/14/2017 12:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears; Maggots activity in mouth	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8
6/14/2017 3:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Fluid in Ears; Maggots activity in mouth	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8

6/14/2017 6:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8
6/15/2017 9:00am	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8
6/15/2017 12:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8
6/15/2017 3:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	3	Bloat; Rigor; Lividity; Green Discoloration	2	Bloat; Lividity	8

6/15/2017 6:00pm	3	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears	3	Bloat; Green Discoloration	2	Bloat; Lividity	8
6/16/2017 9:00am	4	Nasal Discharge; Bloat; Rigor; Lividity; Maggot activity in mouth and ears; Nasal and mouth tissue loss due to maggot activity	3	Bloat; Green Discoloration	2	Bloat; Lividity	9
6/16/2017 12:00pm	4	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity	4	Extreme Bloat; Green Discoloration	2	Bloat; Lividity	10

6/16/2017 3:00pm	4	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity	4	Extreme Bloat; Green and dark purple Discoloration; 6-8 inch split in skin	3	Bloat; Green and purple discoloration on upper limbs	11
6/16/2017 6:00pm	4	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity	4	Bloat; Green and dark purple discoloration; internal organs rupturing from torso split; skin slippage	3	Bloat; Green and purple discoloration on upper limbs	11
6/17/2017 9:00am	4	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity	5	Bloat; Dark purple discoloration; Internal Organs drying out	3	Bloat; Green and purple discoloration on upper limbs	12

6/17/2017 12:00pm	5	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity; Loss of tissue to the head and darkening of the skin	5	Bloat; purple discoloration; internal organs dry; maggot eggs present at rupture site	3	Bloat; purple discoloration on limbs	13
6/17/2017 3:00pm	5	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity; Loss of tissue to the head and darkening of the skin	5	Bloat; purple discoloration; internal organs dry; maggot eggs present at rupture site	3	Bloat; purple discoloration on limbs	13

6/17/2017 6:00pm	5	Bloat; Maggot activity in mouth and ears; Nasal and Mouth tissue loss due to maggot activity; Loss of tissue to the head and darkening of the skin	5	Bloat; purple discoloration; internal organs dry; maggot eggs present at rupture site	3	Bloat; purple discoloration on limbs; Maggot mass at base of limbs	13
6/18/2017 9:00am	6	Bloat; Maggot activity in mouth, ears, eyes and back of head. Skin and tissue dark and greasy	5	Bloat; Maggot mass on torso at skin slippage site and base of limbs; purple and orange discoloration; bodily fluids releasing from skin slippage sites	3	Bloat; purple discoloration on limbs; Maggot mass at base of limbs	14

6/18/2017 12:00pm	6	Bloat; Maggot activity in mouth, ears, eyes and back of head. Skin and tissue dark and greasy	5	Bloat; Maggot mass on torso at skin slippage site and base of limbs; purple and orange discoloration; bodily fluids releasing from skin slippage sites	3	Bloat; purple discoloration on limbs; Maggot mass at base of limbs	14
6/18/2017 3:00pm	6	Bloat; Maggot activity in mouth, ears, eyes and back of head. Skin and tissue dark and greasy	5	Bloat; Maggot mass on torso at skin slippage site and base of limbs; purple and orange discoloration; bodily fluids releasing from skin slippage sites	3	Bloat; purple discoloration on limbs; Maggot mass at base of limbs	14
6/18/2017 6:00pm	6	Bloat; Maggot activity in mouth, ears, eyes and back of head. Skin and tissue dark and greasy	5	Bloat; Maggot mass on torso at skin slippage site and base of limbs; purple and orange discoloration; bodily fluids releasing from skin slippage sites	3	Bloat; purple-black discoloration on limbs; Maggot mass at base of limbs	14

6/19/2017 9:00am	7	Maggot activity back of head, base of neck and inside mouth. Skin and tissue dark, greasy and mummifying	6	Maggot Mass on Torso and back, Skin and Tissue drying, Orange to black discoloration	4	Skin and tissue dark and greasy; black and orange discoloration; maggots at open tissue sites	17
6/19/2017 12:00pm	7	Maggot activity back of head, base of neck and inside mouth. Skin and tissue dark, greasy and mummifying	6	Maggot Mass on Torso and back, Skin and Tissue drying, Orange to black discoloration	4	Skin and tissue dark and greasy; black and orange discoloration; maggots at open tissue sites	17
6/19/2017 3:00pm	7	Maggot activity back of head, base of neck and inside mouth. Skin and tissue dark, greasy and mummifying	6	Maggot Mass on Torso and back, Skin and Tissue drying, Orange to black discoloration	4	Skin and tissue dark and greasy; black and orange discoloration; maggots at open tissue sites	17

6/19/2017 6:00pm	7	Maggot activity back of head, Skin and tissue dark, greasy and mummifying	6	Maggot Mass on torso and back, Skin and Tissue drying, Orange to black discoloration	4	Skin and tissue dark and greasy; black and orange discoloration; maggots at open tissue sites	17
6/20/2017 9:00am	7	Maggot activity back of head, Skin and tissue dark, greasy and mummifying	6	Maggot Mass on torso and back, Skin and Tissue drying, Black discoloration	4	Skin and Tissue black, greasy. Maggots at open tissue sites	17
6/20/2017 12:00pm	7	Maggot activity back of head, Skin and tissue dark, greasy and mummifying	6	Maggot Mass on torso and back, Skin and Tissue drying, Black discoloration	4	Skin and Tissue black, greasy. Maggots at open tissue sites	17
6/20/2017 3:00pm	8	Decreased Maggot presence. Skin dark, greasy and mummifying	8	Decreased maggot presence, Dead Maggots in Torso, Black greasy tissue and skin	4	Skin and Tissue black, greasy. Decreased Maggots at open tissue sites	20

6/20/2017 6:00pm	8	Decreased Maggot presence. Skin dark, greasy and mummifying	8	Decreased maggot presence, Dead Maggots in Torso, Black greasy tissue and skin	4	Skin and Tissue black, greasy. Decreased Maggots at open tissue sites	20
6/21/2017 9:00am	8	Decreased Maggot presence. Skin dark, greasy and mummifying	8	Decreased maggot presence, Dead Maggots in Torso, Black greasy tissue and skin	4	Skin and Tissue black, greasy. Decreased Maggots at open tissue sites	20
6/21/2017 12:00pm	8	Decreased Maggot presence. Skin dark, greasy and mummifying	8	Decreased maggot presence, Dead Maggots in Torso, Black greasy tissue and skin	4	Skin and Tissue black, greasy. Decreased Maggots at open tissue sites	20
6/21/2017 3:00pm	8	Decreased Maggot presence. Skin dark, greasy and mummifying	8	Decreased maggot presence, Dead Maggots in Torso, Black greasy tissue and skin	4	Skin and Tissue black, greasy. Decreased Maggots at open tissue sites	20
6/21/2017 6:00pm	8	Decreased Maggot presence. Skin dark, greasy and mummifying	8	Decreased maggot presence, Dead Maggots in Torso, Black greasy tissue and skin	4	Skin and Tissue black, greasy. Decreased Maggots at open tissue sites	20

6/25/2017 3:00pm	9	Black Mummified tissue; no insect activity	8	Dry mummified tissue; no insect activity	5	Dry mummified tissue; no insect activity	22
6/28/2017 3:00pm	9	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	8	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	5	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	22
7/1/2017 3:00pm	9	Dry mummified tissue; few flies	10	Dry mummified tissue; few flies	5	Dry mummified tissue; few flies	24
7/4/2017 3:00pm	9	Dry mummified; some grease still noted. No insect activity	10	Dry mummified; some grease still noted. No insect activity	5	Dry mummified; some grease still noted. No insect activity	24
7/10/2017 3:00pm	9	Dry mummified; some grease still noted. No insect activity	10	Dry mummified; some grease still noted. No insect activity	5	Dry mummified; some grease still noted. No insect activity	24
7/17/2017 3:00pm	9	Dry black mummified tissue; no insect activity	10	Dry mummified tissue; some skeletonization at the innominate; no insect activity	5	Dry mummified; some grease still noted. No insect activity	24

7/24/2017 3:00pm	11	Dry black mummified tissue; Beetle casings noted; some skeletonization of neck	10	Dry mummified tissue; some skeletonization at the innominate; beetle casings notes; some skeletonization at ribs	6	Dry mummified; some grease still noted. Beetle Casings noted; some skeletonization on limbs	27
7/31/2017 3:00pm	11	Dry black mummified tissue; Beetle casings noted; some skeletonization of neck	10	Dry mummified tissue; some skeletonization at the innominate; beetle casings notes; some skeletonization at ribs; grease still noted on torso	7	Dry mummified; some grease still noted. Beetle Casings noted; some skeletonization on limbs	28
8/7/2017 3:00pm	11	Dry black mummified tissue; Beetle casings noted; some skeletonization of neck	10	Dry mummified tissue; some skeletonization at the innominate; beetle casings notes; some skeletonization at ribs; grease still noted on torso	7	Dry mummified; some grease still noted. Beetle Casings noted; some skeletonization on limbs	28

8/14/2017 3:00pm	11	Dry black mummified tissue; Beetle casings noted; some skeletonization of neck	10	Dry mummified tissue; some skeletonization at the innominate; beetle casings notes; some skeletonization at ribs; grease still noted on torso	7	Dry mummified; some grease still noted. Beetle Casings noted; some skeletonization on limbs	28
8/20/2017 3:00pm	11	Dry black mummified tissue; Beetle casings noted; some skeletonization of neck	10	Dry mummified tissue; some skeletonization at the innominate; beetle casings notes; some skeletonization at ribs; grease still noted on torso	7	Dry mummified; some grease still noted. Beetle Casings noted; some skeletonization on limbs	28
8/28/2017 3:00pm	11	Dry black mummified tissue; Beetle casings noted; more skeletonization of neck, head and mouth	10	Dry mummified tissue; some skeletonization at the innominate; beetle casings notes; some skeletonization at ribs; grease still noted on torso	7	Dry mummified; some grease still noted. Beetle Casings noted; some skeletonization on limbs	28

Decomposition observations for nude subject in shade

Date and Time	Head and Neck Score	Head and Neck Notes	Trunk Score	Trunk Notes	Limbs Score	Limbs Notes	TBS
6/11/17 9:01am	1		1		1		3
6/11/2017 12:01pm	1		1		1	Rigor	3
6/11/2017 3:10pm	1	Rigor	1	Rigor	1	Rigor	3
6/11/2017 6:02pm	2	Rigor; Lividity; Bloat	2	Rigor; Lividity; Bloating	2	Rigor; Lividity	6
6/12/2017 9:07am	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/12/2017 12:07pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/12/2017 3:03pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/12/2017 5:58pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6

6/13/2017 9:00am	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/13/2017 12:07pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/13:2017 3:00pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/14/2017 9:08am	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/14/2017 12:00pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/14/2017 3:00pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6
6/14/2017 6:00pm	2	Nasal Discharge; Fluid purging from ears; Bloat; Rigor	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	6

6/15/2017 9:00am	3	Nasal Discharge; Fluid purging from ears; Bloat; Rigor; Maggot activity in ears	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	7
6/15/2017 12:00pm	3	Nasal Discharge; Fluid purging from ears; Bloat; Rigor; Maggot activity in ears	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	7
6/15/2017 3:00pm	3	Nasal Discharge; Fluid purging from ears; Bloat; Rigor; Maggot activity in ears	2	Red Marbling on torso; Rigor; Bloat	2	Rigor; Bloat; Lividity	7
6/15/2017 6:00pm	3	Nasal Discharge; Bloat; Maggot activity in ears and mouth	3	Red Marbling on torso; grey discoloration; Bloat	2	Rigor; Bloat; Lividity	8
6/16/2017 9:00am	3	Nasal Discharge; Bloat; Maggot activity in ears and mouth	3	Red Marbling on torso; grey discoloration; Bloat	2	Rigor; Bloat; Lividity	8
6/16/2017 12:00pm	3	Nasal Discharge; Bloat; Maggot activity in ears and mouth	3	Red Marbling on torso; grey discoloration; Bloat	2	Rigor; Bloat; Lividity	8
6/16/2017 3:00pm	3	Nasal Discharge; Bloat; Maggot activity in ears and mouth	3	Bloat; Maggot activity on torso at skin slippage sites	2	Bloat	8

6/16/2017 6:00pm	3	Nasal Discharge; Bloat; Maggot activity in ears and mouth	3	Bloat; Maggot activity on torso at skin slippage sites	2	Bloat	8
6/17/2017 9:00am	4	Tissue loss from face; large maggot mass; tissue loss from nasal and mouth	4	Bloat; Skin slippage on torso with fluid drainage; dark purple, orange and grey discoloration; maggot mass on torso near rear limbs	3	Bloat; some maggot activity; Grey/ Green Discoloration	11
6/17/2017 12:00pm	4	Tissue loss from face; large maggot mass; tissue loss from nasal and mouth	4	Bloat; Skin slippage on torso with fluid drainage; dark purple, orange and grey discoloration; maggot mass on torso near rear limbs	3	Bloat; some maggot activity; Grey/ Green Discoloration	11
6/17/2017 3:00pm	4	Tissue loss from face; large maggot mass; tissue loss from nasal and mouth	4	Bloat; Skin slippage on torso with fluid drainage; dark purple, orange and grey discoloration; maggot mass on torso near rear limbs	3	Bloat; some maggot activity; Grey/ Green Discoloration	11

6/17/2017 6:00pm	4	Tissue loss from face; large maggot mass; tissue loss from nasal and mouth	4	Bloat; Skin slippage on torso with fluid drainage; dark purple, orange and grey discoloration; maggot mass on torso near rear limbs; anal discharge	3	Bloat; some maggot activity; Grey/ Green Discoloration	11
6/18/2017 9:00am	5	Facial bloat done; facial tissue loss near nose and mouth	4	Bloat; Skin slippage; opening in skin approx. 2 inches near rear limbs; maggot mass on torso; Flies landing on torso	3	Bloat; some maggot activity; Grey/ Green Discoloration	12
6/18/2017 12:00pm	5	Facial bloat done; facial tissue loss near nose and mouth	4	Bloat; Skin slippage; opening in skin approx. 2 inches near rear limbs; maggot mass on torso; Flies landing on torso	3	Bloat; some maggot activity; Grey/ Green Discoloration	12

6/18/2017 3:00pm	5	Facial bloat done; facial tissue loss near nose and mouth	4	Bloat; Skin slippage; opening in skin approx. 2 inches near rear limbs; maggot mass on torso; Flies landing on torso	3	Bloat; some maggot activity; Grey/ Green Discoloration	12
6/18/2017 6:00pm	5	Facial bloat done; facial tissue loss near nose and mouth	4	Bloat; Skin slippage; opening in skin approx. 2 inches near rear limbs; maggot mass on torso; Flies landing on torso	3	Bloat; some maggot activity; Skin Darkening	12
6/19/2017 9:00am	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	4	Bloat; Skin slippage; opening in skin approx. 2 inches near rear limbs; maggot mass on torso; Flies landing on torso	4	Bloat; maggot activity; Skin Darkening	15
6/19/2017 12:00pm	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso; Flies landing on torso	4	Bloat; maggot activity; Skin Darkening	16

6/19/2017 3:00pm	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso; Flies landing on torso	4	Bloat; maggot activity; Skin Darkening	16
6/19/2017 6:00pm	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso; Flies landing on torso	4	Bloat; maggot activity; Skin Darkening	16
6/20/2017 9:00am	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso	5	Front limbs black in color; rear limbs orange and greasy from skin slippage; maggot activity	16
6/20/2017 12:00pm	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso	5	Front limbs black in color; rear limbs orange and greasy from skin slippage; maggot activity	17
6/20/2017 3:00pm	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso	5	Front limbs black in color; rear limbs orange and greasy skin slippage; maggot activity	17

6/20/2017 6:00pm	7	facial tissue loss near nose and mouth; Skeletonization of the mandible and maxilla; tooth loss noted	5	Skin slippage; Purple and black discoloration; maggot mass on torso	5	Front limbs black in color; rear limbs orange and greasy from skin slippage; maggot activity	17
6/21/2017 9:00am	7	Facial tissue loss; eye gone; skeletonization of the jaw beginning; reduced maggot activity	6	Skin slippage; Tissue loss Purple and black discoloration; Reduced maggot mass on torso	5	Front limbs black in color and drying; rear limbs dark purple with skin slippage; reduced maggot activity	18
6/21/2017 12:00pm	7	Facial tissue loss; eye gone; skeletonization of the jaw beginning; reduced maggot activity	6	Skin slippage; Tissue loss Purple and black discoloration; Reduced maggot mass on torso	5	Front limbs black in color and drying; rear limbs dark purple with skin slippage; reduced maggot activity	18
6/21/2017 3:00pm	7	Facial tissue loss; eye gone; skeletonization of the jaw beginning; reduced maggot activity	6	Skin slippage; Tissue loss Purple and black discoloration; Reduced maggot mass on torso	5	Front limbs black in color and drying; rear limbs dark purple with skin slippage; reduced maggot activity	18

6/21/2017 6:00pm	8	Facial tissue loss; eye gone; skeletonization of the jaw beginning; reduced maggot activity	6	Skin slippage; Tissue loss Purple and black discoloration; Reduced maggot mass on torso	5	Front limbs black in color and drying; rear limbs dark purple with skin slippage; reduced maggot activity	19
6/25/2017 3:00pm	11	Black Mummified tissue; no insect activity; skeletonization of the mandible, maxilla and gonial angle	8	Dry mummified tissue; no insect activity	7	Dry mummified tissue; no insect activity	26
6/28/2017 3:00pm	11	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	8	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	7	Dry mummified tissue; Flies (calliphoridae and Muscidae) covering cages	26
7/1/2017 3:00pm	11	Dry mummified tissue; few flies	8	Dry mummified tissue; few flies	7	Dry mummified tissue; few flies	26
7/4/2017 3:00pm	11	Dry mummified tissue, no insect activity	8	Dry mummified tissue, no insect activity	7	Dry mummified tissue, no insect activity	26

7/10/2017 3:00pm	11	Dry mummified tissue, no insect activity	8	Dry mummified tissue, no insect activity; More tissue than sunlit pair	7	Dry mummified tissue, no insect activity	26
7/17/2017 3:00pm	11	Dry mummified tissue, beetle casings found	8	Dry mummified tissue, no insect activity; some beetle casings noted	7	Dry mummified tissue, beetle casings found	26
7/24/2017 3:00pm	11	Dry mummified tissue, beetle casings found	8	Dry mummified tissue, no insect activity; some beetle casings noted; 1 yellow jacket	7	Dry mummified tissue, beetle casings found	26
7/31/2017 3:00pm	11	Dry mummified tissue, beetle casings found; skeletonization if the neck	8	Dry mummified tissue, no insect activity; some beetle casings noted; 1 Coleoptera; skeletonization of the shoulder	9	Dry mummified tissue, beetle casings found; Bone exposure of the limbs	28

8/7/2017 3:00pm	11	Dry mummified tissue, beetle casings found; skeletonization if the neck	10	Dry mummified tissue, no insect activity; some beetle casings noted; skeletonization of the shoulder; Canopy broke- still lots of mummified tissue	9	Dry mummified tissue, beetle casings found; Bone exposure of the limbs	30
8/14/2017 3:00pm	11	Dry mummified tissue, beetle casings found; skeletonization if the neck	10	Dry mummified tissue, no insect activity; some beetle casings noted; skeletonization of the shoulder; Canopy broke- still lots of mummified tissue	9	Dry mummified tissue, beetle casings found; Bone exposure of the limbs	30

8/20/2017 3:00pm	11	Dry mummified tissue, beetle casings found; skeletonization of the neck	10	Dry mummified tissue, no insect activity; some beetle casings noted; skeletonization of the shoulder; Spider web noted near hips; more hair loss	9	Dry mummified tissue, beetle casings found; Bone exposure of the limbs	30
8/28/2017 3:00pm	11	Dry mummified tissue (dry leather), beetle casings found; skeletonization of the neck; some bone bleaching occurring on neck and face	10	Dry mummified tissue, ; some beetle casings noted; Bone exposure and bone bleaching at hips	9	Dry mummified tissue, beetle casings found; Bone exposure of the limbs	30

Decomposition observations for clothed subject in shade

Date and Time	Head and Neck Score	Head and Neck Notes	Trunk Score	Trunk Notes	Limbs Score	Limbs Notes	TBS
6/11/17 9:01am	1		1		1		3
6/11/2017 12:01pm	1		1		1		3
6/11/2017 3:10pm	1	Rigor	1	Rigor	1	Rigor	3
6/11/2017 6:02pm	2	Rigor; Nasal Discharge; Lividity; Bloat	2	Rigor; Lividity; Bloat	2	Rigor; Lividity; Bloat	6
6/12/2017 9:07am	2	Rigor; Nasal Discharge; Bloat; Red Marbling on Ear;	2	Rigor; Bloat; Lividity	2	Rigor; Bloat; Lividity	6
6/12/2017 12:07pm	2	Rigor; Nasal Discharge; Bloat; Red Marbling on Ear;	2	Rigor; Bloat; Lividity	2	Rigor; Bloat; Lividity	6
6/12/2017 3:03pm	2	Rigor; Nasal Discharge; Bloat; Red Marbling on Ear;	2	Rigor; Bloat; Lividity	2	Rigor; Bloat; Lividity	6
6/12/2017 5:58pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on Ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	6

6/13/2017 9:00am	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/13/2017 12:07pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/13:2017 3:00pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/13/2017 6:00pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/14/2017 9:08am	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/14/2017 12:00pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/14/2017 3:00pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7

6/14/2017 6:00pm	2	Rigor; Nasal Discharge; Bloat; Red marbling on ear;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	7
6/15/2017 9:00am	3	Rigor; Nasal Discharge; Bloat; Red marbling on ear; Maggot activity in mouth	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	8
6/15/2017 12:00pm	3	Rigor; Nasal Discharge; Bloat; Red marbling on ear; Maggot activity in mouth and ears	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	8
6/15/2017 3:00pm	3	Rigor; Nasal Discharge; Bloat; Red marbling on ear; Maggot activity in mouth and ears	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	8
6/16/2017 6:00pm	3	Rigor; Nasal Discharge; Bloat; Red marbling on ear; Maggot activity in mouth and ears	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	8

6/16/2017 9:00am	3	Rigor; Nasal Discharge; Bloat; Red marbling on ear; Maggot activity in mouth and ears;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	8
6/16/2017 12:00pm	3	Rigor; Nasal Discharge; Bloat; Red marbling on ear; Maggot activity in mouth and ears;	3	Rigor; Bloat; Lividity; Green/ Grey Coloring on torso	2	Rigor; Bloat; Lividity	8
6/16/2017 3:00pm	3	Bloat; Red marbling on ear; Maggot activity in mouth and ears;	4	Bloat; Green/ Grey/ Black marbling on torso; Flies gathering at skin slippage sights in torso	3	Bloat; fluid release from skin slippage at proximal end of limbs	10
6/16/2017 6:00pm	4	Bloat; Darkening of skin; Maggot activity on head and neck; fluids draining from neck	4	Bloat; Green/ Grey/ Black marbling on torso; Flies gathering at skin slippage sights in torso	3	Bloat; fluid release from skin slippage at proximal end of limbs	11

6/17/2017 9:00am	4	Bloat; Darkening of skin; Maggot activity on head and neck; fluids draining from neck; Tissue loss from the mouth	4	Bloat; Purple and black marbling on tissue; Ruptured organs and fluid purge	4	Bloat; fluid release from skin slippage at proximal end of limbs; Maggot mass on limbs	12
6/17/2017 12:00pm	4	Bloat; Darkening of skin; Maggot activity on head and neck; fluids draining from neck	4	Bloat; Purple and black marbling on tissue; Ruptured organs and fluid purge	4	Bloat; fluid release from skin slippage at proximal end of limbs	12
6/17/2017 3:00pm	4	Bloat; Darkening of skin; Maggot activity on head and neck; fluids draining from neck	4	Bloat; Purple and black marbling on tissue; Ruptured organs and fluid purge	4	Bloat; fluid release from skin slippage at proximal end of limbs	12
6/17/2017 6:00pm	4	Bloat; Darkening of skin; Maggot activity on head and neck; fluids draining from neck	4	Bloat; Purple and black marbling on tissue; Ruptured organs and fluid purge	4	Bloat; fluid release from skin slippage at proximal end of limbs	12

6/18/2017 9:00am	4	Bloat; Darkening of skin; Maggot activity on head and neck; fluids draining from neck	5	Bloat; Black and orange skin discoloration; Internal organs drying, fluid purge from torso	4	Bloat; fluid release from skin slippage at proximal end of limbs	13
6/18/2017 12:00pm	5	Bloat; Tissue and hair loss; Eye gone; maggot mass on head and neck	5	Bloat; Black and orange skin discoloration; Internal organs drying, fluid purge from torso	6	Extreme bloating of limbs; Flies landing at fluid purge sites; maggots present	16
6/18/2017 3:00pm	5	Bloat; Hair loss; Maggot mass on head and neck	5	Bloat; Black and orange skin discoloration; Internal organs drying, fluid purge from torso	6	Extreme bloating of limbs; Flies landing at fluid purge sites; maggots present	16
6/18/2017 6:00pm	5	Bloat; Hair loss; Maggot mass on head and neck	5	Bloat; Black and orange skin discoloration; Internal organs drying, fluid purge from torso	6	Extreme bloating of limbs; Flies landing at fluid purge sites; maggots present	16

6/19/2017 9:00am	5	Bloat; Hair loss; Maggot mass on head and neck	6	Bloat; Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Extreme bloating of limbs; Flies landing at fluid purge sites; maggots present	17
6/19/2017 12:00pm	6	Hair and tissue loss; Maggot mass on head and neck	6	Bloat; Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Extreme bloating of limbs; Flies landing at fluid purge sites; maggots present	18
6/19/2017 3:00pm	6	Hair and tissue loss; Maggot mass on head and neck	6	Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	18
6/19/2017 6:00pm	6	Hair and tissue loss; Maggot mass on head and neck	6	Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	18
6/20/2017 9:00am	6	Hair and tissue loss; Maggot mass on head and neck	6	Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	18

6/20/2017 12:00pm	6	Hair and tissue loss; Maggot mass on head and neck	6	Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	18
6/20/2017 3:00pm	6	Hair and tissue loss; Maggot mass on head and neck	6	Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	18
6/20/2017 6:00pm	6	Hair and tissue loss; Maggot mass on head and neck	6	Blackening of skin; internal organs dry and deflating; Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	18
6/21/2017 9:00am	7	Hair and tissue loss; Maggot mass on head and neck; black discoloration	6	Blackening of skin; internal organs dry and deflating; reduced Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	19
6/21/2017 12:00pm	7	Hair and tissue loss; Maggot mass on head and neck; black discoloration	6	Blackening of skin; internal organs dry and deflating; reduced Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	19

6/21/2017 3:00pm	7	Hair and tissue loss; Maggot mass on head and neck; black discoloration	6	Blackening of skin; internal organs dry and deflating; reduced Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	19
6/21/2017 6:00pm	7	Hair and tissue loss; Maggot mass on head and neck; black discoloration	6	Blackening of skin; internal organs dry and deflating; reduced Maggot mass on torso	6	Maggot mass on limbs, skin slippage and tissue loss	19
6/25/2017 3:00pm	8	Black mummified tissue; no insect activity	8	Dry mummified tissue; no insect activity	7	Dry mummified tissue; no insect activity	23
6/28/2017 3:00pm	8	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	8	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	7	Dry mummified tissue; Flies (Calliphoridae and Muscidae) covering cages	23
7/1/2017 3:00pm	8	Dry mummified tissue; few flies	8	Dry mummified tissue; few flies	7	Dry mummified tissue; few flies	23
7/4/2017 3:00pm	8	Dry mummified tissue, no insect activity	8	Dry mummified tissue, no insect activity	7	Dry mummified tissue, no insect activity	23

7/10/2017 3:00pm	8	Dry mummified tissue, no insect activity	8	Dry mummified tissue, no insect activity; More tissue than sunlit pair	7	Dry mummified tissue, no insect activity	23
7/17/2017 3:00pm	8	Dry mummified tissue, beetle casings	10	Dry mummified tissue, no insect activity; Spinal skeletonization and disarticulation (beetles must have arrived last week)	7	Dry mummified tissue, no insect activity; beetle casings	25
7/24/2017 3:00pm	10	Dry mummified tissue, beetle casings; skeletonization of the neck	10	Dry mummified tissue, no insect activity; Spinal skeletonization and disarticulation; beetle casings noted	8	Dry mummified tissue, no insect activity; beetle casings; skeletonization of the limbs	28
7/31/2017 3:00pm	10	Dry mummified tissue, beetle casings; skeletonization of the neck, cranium and mandible	10	Dry mummified tissue, no insect activity; Spinal skeletonization and disarticulation; beetle casings noted	9	Dry mummified tissue, no insect activity; beetle casings; skeletonization and disarticulation of the limbs	29

8/7/2017 3:00pm	11	Dry mummified tissue, beetle casings; skeletonization of the neck, cranium and mandible (head and neck 85% skeletonized)	11	Dry mummified tissue, no insect activity; Spinal skeletonization and disarticulation; beetle casings noted; nearly fully skeletonized	9	Dry mummified tissue, no insect activity; beetle casings; skeletonization and disarticulation of the limbs	31
8/14/2017 3:00pm	11	Dry mummified tissue, beetle casings; fully skeletonized head and neck; black beetles in soil and under carcass	11	Dry mummified tissue, black beetles in clothing and in soil; fully skeletonized torso	10	Dry mummified tissue, black beetles under carcass and in clothes. Fully skeletonized and disarticulated limbs- bones bleaching	32
8/20/2017 3:00pm	11	Dry mummified tissue, beetle casings; fully skeletonized head and neck; black beetles in soil and under carcass	12	Dry mummified tissue, black beetles in clothing and in soil; fully skeletonized torso; praying mantis on cage; lizard under clothing	10-	Dry mummified tissue, black beetles under carcass and in clothes. Fully skeletonized and disarticulated limbs- bones bleaching	33

8/28/2017 3:00pm	12	beetle casings; fully skeletonized head and neck; black beetles in soil and under carcass	12	black beetles in clothing and in soil; fully skeletonized torso	10	black beetles under carcass and in clothes. Fully skeletonized and disarticulated limbs- bones bleaching	34

Decomposition events for nude subject in shade

Date	Time	Bloat	Lividity	Skin Slippage	Odor	Kill Wound Discharge	Nasal Discharge	Anal Discharge	Skeletal Disarticulation	Toothloss	Arthropod
6/11/2017	9:01am	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	12:01pm	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	3:10pm	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	6:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
6/12/2017	9:07am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	12:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	3:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	5:58pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
6/13/2017	9:00am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	12:07pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	3:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	6:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
6/14/2017	9:08am	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Few
	12:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Few
	3:00pm	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
	6:00pm	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
6/15/2017	9:00am	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
	12:00pm	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
	3:00pm	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
	6:00pm	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
6/16/2017	9:00am	Present	Present	Absent	Present	Present	Present	Present	Absent	Absent	Few
	12:00pm	Present	Absent	Absent	Present	Present	Present	Present	Absent	Absent	Few
	3:00pm	Present	Absent	Present	Present	Present	Absent	Present	Absent	Absent	Some
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
6/17/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/18/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
6/19/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/20/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/21/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/25/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
6/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Many
7/1/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
7/4/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/10/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
7/17/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/24/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/31/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
8/7/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
8/14/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Some
8/20/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Some
8/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Some

Decomposition events for clothed subject in shade

Date	Time	Bloat	Lividity	Skin Slippage	Odor	Kill Wound Discharge	Nasal Discharge	Anal Discharge	Skeletal Disarticulation	Toothloss	Arthropod
6/11/2017	9:01am	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	12:01pm	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	3:10pm	Present	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent	
	6:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
6/12/2017	9:07am	Present		Absent	Absent	Present	Present	Absent	Absent	Absent	
	12:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	3:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	5:58pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
6/13/2017	9:00am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	12:07pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	3:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	6:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
6/14/2017	9:08am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	12:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	3:00pm	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Some
	6:00pm	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
6/15/2017	9:00am	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
	12:00pm	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
	3:00pm	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
	6:00pm	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
6/16/2017	9:00am	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
	12:00pm	Present	Present	Absent	Present	Present	Present	Absent	Absent	Absent	Few
	3:00pm	Present	Absent	Present	Present	Present	Present	Absent	Absent	Absent	Some
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
6/17/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/18/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/19/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
6/20/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/21/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/25/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
6/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Many
7/1/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
7/4/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/10/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/17/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	
7/24/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	
7/31/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	
8/7/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Few
8/14/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Some
8/20/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Some
8/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Present	Some

Decomposition events for nude subject in sun

Date	Time	Bloat	Lividity	Skin Slippage	Odor	Kill Wound Discharge	Nasal Discharge	Anal Discharge	Skeletal Disarticulation	Toothloss	Arthropod
6/11/2017	9:01am	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	12:01pm	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	3:10pm	Absent	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent	
	6:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
6/12/2017	9:07am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	12:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	3:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	5:58pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
6/13/2017	9:00am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	12:07pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	3:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	6:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Some
6/14/2017	9:08am	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	12:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	3:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	6:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
6/15/2017	9:00am	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	12:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	3:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	6:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
6/16/2017	9:00am	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	12:00pm	Present	Present	Absent	Absent	Present	Absent	Present	Absent	Absent	Some
	3:00pm	Present	Absent	Present	Present	Present	Absent	Present	Absent	Absent	Some
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/17/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/18/2017	9:00am	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	3:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
6/19/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
6/20/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/21/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/25/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
6/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Many
7/1/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
7/4/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/10/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/17/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/24/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/31/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/7/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/14/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/20/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	

Decomposition events for clothed subject in sun

Date	Time	Bloat	Lividity	Skin Slippage	Odor	Kill Wound Discharge	Nasal Discharge	Anal Discharge	Skeletal Disarticulation	Toothloss	Arthropod
6/11/2017	9:01am	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	12:01pm	Absent	Absent	Absent	Absent	Present	Absent	Absent	Absent	Absent	
	3:10pm	Present	Absent	Absent	Absent	Present	Present	Absent	Absent	Absent	
	6:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
6/12/2017	9:07am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	12:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	
	3:03pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	5:58pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
6/13/2007	9:00am	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	12:07pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Few
	3:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Some
	6:00pm	Present	Present	Absent	Absent	Present	Present	Absent	Absent	Absent	Some
6/14/2017	9:08am	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	12:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	3:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
	6:00pm	Present	Present	Absent	Absent	Present	Present	Present	Absent	Absent	Some
6/15/2017	9:00am	Present	Absent	Present	Present	Present	Present	Present	Absent	Absent	Some
	12:00pm	Present	Absent	Present	Present	Present	Present	Present	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Present	Present	Present	Absent	Absent	Many
	6:00pm	Present	Absent	Present	Present	Present	Present	Present	Absent	Absent	Many
6/16/2017	9:00am	Present	Absent	Present	Present	Present	Present	Present	Absent	Absent	Many
	12:00pm	Present	Absent	Present	Present	Absent	Present	Present	Absent	Absent	Many
	3:00pm	Present	Absent	Present	Present	Absent	Present	Present	Absent	Absent	Many
	6:00pm	Present	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/17/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
6/18/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Many
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Some
6/19/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Absent	Few
6/20/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/21/2017	9:00am	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	12:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	3:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
	6:00pm	Absent	Absent	Present	Present	Absent	Absent	Absent	Absent	Present	Few
6/25/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
6/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Many
7/1/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	Few
7/4/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/10/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/17/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/24/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
7/31/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/7/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/14/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/20/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	
8/28/2017	3:00pm	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Present	

APPENDIX IV: ARTHROPODS OBSERVED AND COLLECTED

Arthropods observed and collected from nude subject in sun

Date	Time	Arthropods Present
6/11/2017	9:01am	1 Yellow Jacket
	12:01pm	
	3:10pm	1 Calliphoridae
	6:02pm	
6/12/2017	9:07am	
	12:00pm	
	3:03pm	Few Caliphoridae
	5:58pm	Few Caliphoridae
6/13/2017	9:00am	Few Caliphoridae; Few Sarcophigidae
	12:07pm	Few Caliphoridae; Few Sarcophigidae
	3:00pm	Few Caliphoridae; Few Sarcophigidae; Maggots in Mouth
	6:00pm	Some Caliphoridae; Few Sarcophigidae; Maggots in Mouth

6/14/2017	9:08am	Some Caliphoridae; Few Sarcophigidae; Maggots in Mouth
	12:00pm	Some Caliphoridae; Maggots in Mouth
	3:00pm	Some Caliphoridae; Maggots in Mouth
	6:00pm	Some Caliphoridae; Maggots in Mouth
6/15/2017	9:00am	Some Caliphoridae; Few Muscidae; Maggots in Mouth and ears
	12:00pm	Some Caliphoridae; Few Muscidae; Maggots in Mouth and ears
	3:00pm	Some Caliphoridae; Few Muscidae; Maggots in Mouth and ears

	6:00pm	Some Caliphoridae; Few Muscidae; Maggots in Mouth and ears
6/16/2017	9:00am	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears
	12:00pm	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears
	3:00pm	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears
	6:00pm	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears; maggot mass on torso

6/17/2017	9:00am	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears; maggot mass on torso
	12:00pm	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears; maggot mass on torso
	3:00pm	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears; maggot mass on torso
	6:00pm	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears; maggot mass on torso

6/18/2017	9:00am	Many Caliphoridae; Some Muscidae; Maggots in Mouth and ears; maggot mass in parts of open torso and on back
	12:00pm	Some Calliphoridae; Maggots in torso and on back
	3:00pm	Some Calliphoridae; Maggots in torso and on back
	6:00pm	Some Calliphoridae; Maggots in torso and on back
6/19/2017	9:00am	Some Calliphoridae; Maggots in torso and on back
	12:00pm	Some Calliphoridae; Maggots in torso and on back

	3:00pm	Few Calliphoridae; Maggots in torso and on back
	6:00pm	Few Calliphoridae; Maggots in torso and on back
6/20/2017	9:00am	Maggots
	12:00pm	Maggots
	3:00pm	Maggots
	6:00pm	Maggots
6/21/2017	9:00am	Maggots
	12:00pm	Maggots
	3:00pm	Maggots
	6:00pm	Maggots (unmoving)
6/25/2017	3:00pm	None
6/28/2017	3:00pm	Calliphoridae; Muscidae (covering cage)
7/1/2017	3:00pm	Few Calliphoridae
7/4/2017	3:00pm	None
7/10/2017	3:00pm	None
7/17/2017	3:00pm	None
7/24/2017	3:00pm	None
7/31/2017	3:00pm	None
8/7/2017	3:00pm	None
8/14/2017	3:00pm	None
8/20/2017	3:00pm	Colleoptra casings
8/28/2017	3:00pm	Colleoptra casings

Arthropods observed and collected from clothed subject in sun

Date	**Time**	**Arthropods Present**
6/11/2017	9:01am	
	12:01pm	1 Yellow Jacket; 1 Sarcophigidae
	3:10pm	
	6:02pm	
6/12/2017	9:07am	1 Yellow jacket
	12:00pm	1 Calliphoridae, 2 Yellow Jackets;
	3:03pm	Few Caliphoridae
	5:58pm	3 Yellow Jackets; Few Caliphoridae
6/13/2017	9:00am	Few Caliphoridae; Few Sarcophigidae
	12:07pm	Few Caliphoridae; Few Sarcophigidae
	3:00pm	Few Caliphoridae; Few Sarcophigidae; Maggots in Mouth
	6:00pm	Some Caliphoridae; Few Sarcophigidae; Maggots in Mouth

6/14/2017	9:08am	Some Caliphoridae; Maggots in Mouth
	12:00pm	Some Caliphoridae; Maggots in Mouth
	3:00pm	Some Caliphoridae; Maggots in Mouth
	6:00pm	Some Caliphoridae; Maggots in Mouth and ears
6/15/2017	9:00am	Some Caliphoridae; Few Muscidae; Maggots in Mouth and ears
	12:00pm	Some Caliphoridae; Few Muscidae; Maggots in Mouth and ears
	3:00pm	Many Caliphoridae; some Muscidae; Maggots in Mouth and ears
	6:00pm	Many Caliphoridae; some Muscidae; Maggots in Mouth and ears

6/16/2017	9:00am	Many Caliphoridae; some Muscidae; Maggots in Mouth and ears
	12:00pm	Many Caliphoridae; some Muscidae; Maggots in Mouth and ears
	3:00pm	Many Caliphoridae; some Muscidae; Maggots in Mouth and ears
	6:00pm	Many Calliphoridae; Some Muscidae; Maggots Mass on skin slippage sites
6/17/2017	9:00am	Many Calliphoridae; Some Muscidae; Maggots Covering neck, limbs, torso, anus.
	12:00pm	Many Calliphoridae; Some Muscidae; Maggots Covering neck, limbs, torso, anus.

	3:00pm	Many Calliphoridae; Some Muscidae; Maggots Covering neck, limbs, torso, anus.
	6:00pm	Many Calliphoridae; Some Muscidae; Maggots Covering neck, limbs, torso, anus.
6/18/2017	9:00am	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggots Covering neck, limbs, torso, anus.
	12:00pm	Many Calliphoridae; Some Muscidae; Yellow Jacket; Maggots Covering neck, limbs, torso, anus.
	3:00pm	Some Calliphoridae; Few Muscidae; Maggots mass on torso, some maggots on face and limbs

	6:00pm	Some Calliphoridae; Few Muscidae; (Smaller)Maggot mass on torso, some maggots on face and limbs
6/19/2017	9:00am	Few Calliphoridae; Yellow Jacket; Mining Bee; Maggots
	12:00pm	Few Calliphoridae; Mining Bee?; Maggots
	3:00pm	Dead Maggot mass in torso tissue and head; some living maggots on the back
	6:00pm	Dead Maggot mass in torso tissue and head; some living maggots on the back
6/20/2017	9:00am	Maggots
	12:00pm	Maggots
	3:00pm	Maggots
	6:00pm	Maggots
6/21/2017	9:00am	Maggots
	12:00pm	Maggots; Muscidae
	3:00pm	Maggots
	6:00pm	Maggots (unmoving)
6/25/2017	3:00pm	None

6/28/2017	3:00pm	Calliphoridae; Muscidae (covering cage)
7/1/2017	3:00pm	Few Calliphoridae; one Yellow Jacket
7/4/2017	3:00pm	None
7/10/2017	3:00pm	None
7/17/2017	3:00pm	None
7/24/2017	3:00pm	None
7/31/2017	3:00pm	None
8/7/2017	3:00pm	None
8/14/2017	3:00pm	None
8/20/2017	3:00pm	Colleoptera casings
8/28/2017	3:00pm	Colleoptera Casings

Arthropods observed and collected from nude subject in shade

Date	**Time**	**Arthropods Present**
6/11/2017	9:01am	None
	12:01pm	None
	3:10pm	None
	6:02pm	None
6/12/2017	9:07am	None
	12:00pm	None
	3:03pm	None
	5:58pm	Few Caliphoridae
6/13/2017	9:00am	Few Caliphoridae
	12:07pm	1 Caliphoridae
	3:00pm	1 Caliphoridae
	6:00pm	Few Caliphoridae
6/14/2017	9:08am	Few Caliphoridae
	12:00pm	Few Caliphoridae
	3:00pm	Few Caliphoridae
	6:00pm	Few Caliphoridae
6/15/2015	9:00am	Few Caliphoridae; Maggots in mouth and ears
	12:00pm	Few Caliphoridae; Maggots in mouth and ears
	3:00pm	Few Caliphoridae; Maggots in mouth and ears
	6:00pm	Few Caliphoridae; Maggots in mouth and ears
6/16/2017	9:00am	Some Caliphoridae; Maggots mass in mouth and ears

	12:00pm	Some Caliphoridae; Maggots mass in mouth and ears
	3:00pm	Some Caliphoridae; Few Muscidae; Maggots mass in mouth and ears
	6:00pm	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso
6/17/2017	9:00am	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso
	12:00pm	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso
	3:00pm	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso

	6:00pm	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso
6/18/2017	9:00am	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso
	12:00pm	Many Calliphoridae, Some Muscidae, Maggot Mass Covering entire head and lower torso
	3:00pm	Some Calliphoridae and Muscidae; Maggot Mass covering entire head, neck and torso
	6:00pm	Some Calliphoridae and Muscidae; Maggot Mass covering entire head, neck and torso
6/19/2017	9:00am	Some Calliphoridae and Muscidae; Maggot Mass covering entire head, neck and

		torso
	12:00pm	Some Calliphoridae and Muscidae; Maggot Mass covering entire head, neck and torso
	3:00pm	Maggot Mass covering torso, head and neck
	6:00pm	Maggot Mass covering torso, head and neck
6/20/2017	9:00am	Maggots; Yellow Jacket
	12:00pm	Maggots
	3:00pm	Maggots
	6:00pm	Maggots
6/21/2017	9:00am	Maggots; Yellow Jacket
	12:00pm	Maggots; Yellow Jacket
	3:00pm	Maggots
	6:00pm	Maggots
6/25/2017	3:00pm	Coleoptera
6/28/2017	3:00pm	Calliphoridae; Muscidae (covering cage)
7/1/2017	3:00pm	Few Calliphoridae
7/4/2017	3:00pm	None
7/10/2017	3:00pm	None
7/17/2017	3:00pm	None

7/24/2017	3:00pm	Coleoptera; Coleoptera Casings under Carcass
7/31/2017	3:00pm	Coleoptera; Coleoptera Casings under Carcass
8/7/2017	3:00pm	Coleoptera; Coleoptera Casings under Carcass
8/14/2017	3:00pm	Coleoptera; Coleoptera Casings under Carcass
8/20/2017	3:00pm	Coleoptera; Coleoptera Casings under Carcass
8/28/2017	3:00pm	Coleoptera; Coleoptera Casings under Carcass

Arthropods observed and collected from clothed subject in shade

Date	Time	Arthropods Present
6/11/2017	9:01am	None
	12:01pm	None
	3:10pm	None
	6:02pm	None
6/12/2017	9:07am	None
	12:00pm	None
	3:03pm	1 Caliphoridae
	5:58pm	1 hover Fly; 1 Yellow Jacket
6/13/2017	9:00am	1 Yellow Jacket; 1 Caliphoridae
	12:07pm	Few Caliphoridae
	3:00pm	2 Caliphoridae
	6:00pm	Few Caliphoridae
6/14/2017	9:08am	Few Caliphoridae
	12:00pm	Few Caliphoridae
	3:00pm	Some Caliphoridae
	6:00pm	Few Calliphoridae; Maggots in mouth
6/15/2017	9:00am	Few Calliphoridae; Maggots in mouth
	12:00pm	Few Calliphoridae;Few Muscidae; Maggots in mouth and ears

	3:00pm	Few Calliphoridae;Few Muscidae; Maggots in mouth and ears
	6:00pm	Few Calliphoridae;Few Muscidae; Maggots in mouth and ears
6/16/2017	9:00am	Few Calliphoridae;Few Muscidae; Maggots in mouth and ears
	12:00pm	Few Calliphoridae;Few Muscidae; Maggots in mouth and ears
	3:00pm	Some Calliphoridae; Some Muscidae; Maggots in mouth and ears
	6:00pm	Some Calliphoridae; Some Muscidae; Maggots in mouth and ears

6/17/2017	9:00am	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	12:00pm	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	3:00pm	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	6:00pm	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck

6/18/2017	9:00am	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	12:00pm	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	3:00pm	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	6:00pm	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck

6/19/2017	9:00am	Many Calliphoridae; Some Muscidae; Yellow Jackets; Maggot Mass covering torso; Maggots on head and neck
	12:00pm	Some Calliphoridae; few muscidae; Maggot Mass covering torso and head.
	3:00pm	Few flying insects.Maggot Mass present
	6:00pm	Few flying insects.Maggot Mass present
6/20/2017	9:00am	Maggots; Yellow Jackets
	12:00pm	Maggots
	3:00pm	Maggots
	6:00pm	Maggots
6/21/2017	9:00am	Maggots; Yellow Jackets
	12:00pm	Maggots; Yellow Jackets
	3:00pm	Maggots; Grasshopper
	6:00pm	Maggots
6/25/2017	3:00pm	None
6/28/2017	3:00pm	Calliphoridae; Muscidae (covering cage)
7/1/2017	3:00pm	Few Calliphoridae

7/4/2017	3:00pm	None
7/10/2017	3:00pm	None
7/17/2017	3:00pm	None
7/24/2017	3:00pm	None
7/31/2017	3:00pm	Coleoptera; Coleoptera casings under carcass
8/7/2017	3:00pm	Coleoptera; Coleoptera casings under carcass
8/14/2017	3:00pm	Coleoptera; Coleoptera casings under carcass
8/20/2017	3:00pm	Coleoptera; Coleoptera casings under carcass
8/28/2017	3:00pm	Coleoptera; Coleoptera Casings under carcass