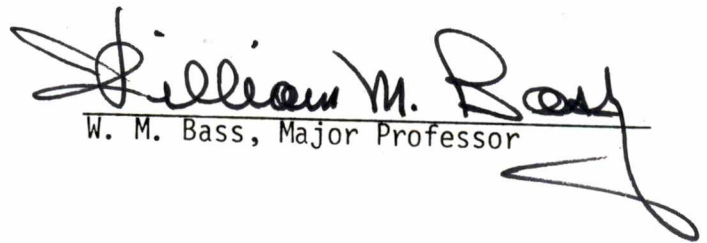
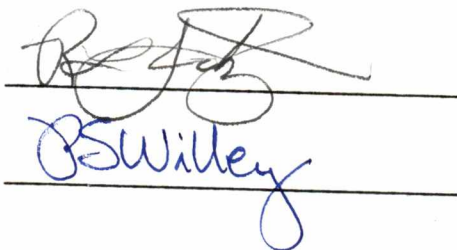


To the Graduate Council:

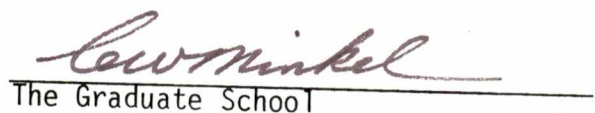
I am submitting herewith a thesis written by Lorna Lea Watkins entitled "Late Postmortem Changes in Three Human Bodies in Knox County, Tennessee." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Anthropology.


W. M. Bass, Major Professor

We have read this thesis and
recommend its acceptance:


B. Swilley

Accepted for the Council:


The Graduate School

LATE POSTMORTEM CHANGES IN THREE HUMAN BODIES IN
KNOX COUNTY, TENNESSEE

A Thesis
Presented for the
Master of Arts
Degree
The University of Tennessee, Knoxville

Lorna Lea Watkins

December 1983

DEDICATION

This work is dedicated to my parents, James F. and Reamae R. Watkins, who have always shown me so much love.

ACKNOWLEDGMENTS

I would like to express my appreciation to my committee members: Drs. William Bass (Chairman), Richard Jantz, and Patrick Willey for their interest and guidance throughout my graduate studies.

For their assistance and encouragement, I would like to thank Mark Smith, Steve Symes, and Carolyn Smith. I also wish to express my appreciation to Larry Mincey for his love and support.

ABSTRACT

The purpose of this study was to observe the last postmortem changes of human bodies in order to determine if the time since death could be predicted by the amount of decay and skeletonization that had occurred. The estimation of how long an individual has been dead is of importance to the forensic anthropologist aiding the law enforcement personnel.

This research was conducted in Knox County, Tennessee, at a facility constructed to allow full exposure of the cadavers to the weather and insects, but without the presence of carnivores. Three cadavers were acquired for this study and the postmortem physical changes which occurred were observed and documented with notes and photographs.

The findings utilizing the three cadavers indicate that the timing and sequence of postmortem changes were too variable to produce an accurate timetable for the prediction of time elapsed since death. It was found that not every cadaver goes through the same decompositional processes as has previously been suggested by Gonzales et al. (1954). Decomposition was observed to occur more rapidly in those cadavers placed at the facility during the warmer months.

It is hoped that the data obtained in this research can be of use to future studies conducted on the human decay rate at The University of Tennessee, Knoxville.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	1
Previous Studies	2
Purposes	4
II. VARIABLES AFFECTING LATE POSTMORTEM CHANGES	5
Factors Contributing to the Rate of Putrefaction	5
Adipocere Formation and Mummification	9
III. SETTING AND METHODOLOGY	11
The Study Area	11
Subject Handling and Data Collection	12
IV. OBSERVATIONS	17
V. DISCUSSION	20
Anthropological Applications	23
VI. CONCLUSION	25
LIST OF REFERENCES	27
APPENDIX	31
VITA	68

LIST OF TABLES

CHAPTER	PAGE
1. Postmortem Changes in Body Number 1-81	32
2. Postmortem Changes in Body Number 2-81	43
3. Postmortem Changes in Body Number 3-81	54

LIST OF FIGURES

FIGURE	PAGE
1. The Research Facility	13
2. The Average Monthly Temperature for the Knoxville, Tennessee Area from May 1981 through April 1982	15
3. The Average Monthly Precipitation for the Knoxville, Tennessee Area from May 1981 through April 1982	16
4. General Comparison of Various States of Late Postmortem Changes in the Three Cadavers	22
5. The Head and Neck Region of Body Number 1-81 On the Tenth Day	37
6. The Face of Body Number 1-81 on the Thirteenth Day	38
7. The Torso, Arms, and Upper Portion of the Legs of Body Number 1-81 on the Seventeenth Day	39
8. The Face of Body Number 1-81 on the Seventeenth Day	40
9. Anterior View of Body Number 1-81 on the Thirty-First Day	41
10. Anterior View of Body Number 1-81 on the Two Hundred and Fifty-Ninth Day	42
11. The Upper Chest and Face of Body Number 2-81 on the Third Day	47
12. Blood-Filled Blisters on the Chest of Body Number 2-81, the Fifth Day	48
13. An Anterior, Inferior View of Body Number 2-81 on the Fifth Day	49
14. The Torso and Upper Legs of Body Number 2-81 on the Sixth Day	50
15. An Anterior, Superior View of Body Number 2-81 on the Ninth Day	51
16. The Chest and Legs of Body Number 2-81, the Sixteenth Day	52

FIGURE	PAGE
17. An Anterior, Superior View of Body Number 2-81 after Remaining at the Facility for Two Hundred and Thirty-Seven Days	53
18. Side View of Body Number 3-81 on the Second Day	59
19. The Face and Upper Chest of Body Number 3-81, the Sixteenth Day	60
20. Side View of Body Number 3-81 on the Nineteenth Day	61
21. The Face and Upper Chest of Body Number 3-81 on the Twenty-Fifth Day	62
22. The Face of Body Number 3-81, the Twenty-Ninth Day	63
23. Side View of Torso, Body Number 3-81, the Thirty-Seventh Day	64
24. Body Number 3-81 on the Fifty-Third Day, Side View of the Abdomen	65
25. The Genital Area of Body Number 3-81 on the One Hundred and Tenth Day	66
26. An Anterior View of Body Number 3-81 on the One Hundred and Forty-Second Day	67

CHAPTER I

INTRODUCTION

The determination of time since death is of chief concern to forensic investigators, as well as law enforcement personnel. Throughout the years, a methodology for accurately determining the time of death has been sought without resolve (Fatteh, 1973). By examining a number of changes which occur immediately after death, a pathologist can provide a reliable estimation of time since death for the period from 24 to 48 hours after death (Fatteh, 1973). It is during the last post-mortem changes (Fatteh, 1973; Marshall, 1976) when decomposition, mummification, and/or adipocere formation occurs that a reliable estimate of time since death is extremely difficult to obtain (Fatteh, 1973).

It is due to the sparse amount of documentation on the time it takes for a body to decompose to the state of skeletonization that the present project was begun. In this thesis the bodies of three, unembalmed, nude, White males were placed in a decay facility located in a partially wooded area in Knoxville, Tennessee. The cadavers were placed in the facility at various times of the year and subjected to local climatological conditions and indigenous insects. The bodies were observed over a period of twelve, eleven, and seven months, respectively.

Previous Studies

One of the earliest studies on human decomposition and insect association was conducted by Motter (1898). He examined the remains of 150 unembalmed individuals disinterred from a cemetery in Washington, D.C. Motter noted that the thoracic and abdominal organs usually disappear prior to the muscles. He also states that the first parts to decompose are the face, hands, and feet. In one case the brain was a recognizable mass after eighteen years.

Reed (1953) observed the succession of insects on decomposing dogs in the Knoxville, Tennessee area. He arbitrarily divided the decomposition of dog carcasses into four stages: fresh, bloated, decay, and dry. Reed presented an excellent record of insects and their associated larvae.

Pig carrion decomposition was observed by Payne (1967). Here again, the succession of insects was presented. Payne observed that the separation of decomposition into distinct stages lent itself to wide variations. He did name stages of decomposition according to whether the pig carcasses were fully exposed to insects, minimally exposed, or not exposed at all. He, too, made excellent records for use by entomologists.

In a study by Rodriguez (1982), the insects frequenting four nude human cadavers placed in an open, wooded area of East Tennessee were observed. Three of the cadavers were elderly, White males, the fourth body was an autopsied, middle-aged, White female. None of the cadavers had been embalmed. The decomposition of the bodies was divided into

four stages as proposed by Reed (1953). Based on this research, Rodriguez reports a direct correlation existing between insect types frequenting human cadavers and the rate of decay.

G. S. W. deSaram (1957) observed the decomposition of 41 men who were executed by hanging and placed on tables in a room at room temperature (15.5°C, 60°F). His conclusions concerning putrefactive changes included the timing of the appearance of the blue discoloration of the abdomen, the swelling of the body, and the loosening of the epidermal casts of the hands and feet.

Marshall (1976) described the putrefactive changes that relate to an average adult, clothed, and in a room at about 15.5°C (60°F). A detailed description of the postmortem changes occurring weekly through the fourth week were given.

In instances where human remains are found which have a small amount of tissue or are completely skeletonized, law enforcement personnel request the assistance of a forensic anthropologist. The anthropologist is asked to aid in the identification of the individual, estimate the time since death, and suggest a possible cause of death (Stewart, 1979).

The difficulty in determining the time since death in a decomposing body is exemplified in the following case study. Bass (n.d.) reports a forensic case in which an embalmed body had been placed in a cast iron coffin in 1864. The coffin had been broken open and the body was left uncovered for about a week before discovery. The body was somewhat disarticulated, but still had pink flesh on the femur. The intestines

were recognizable and the smell of decay was strong. Initially Bass estimated a time since death of six to twelve months. Further investigation revealed that the body was that of a male who had been dead 113 years.

Purposes

The goals of this study are three-fold. The first is to describe and present the chronology of the late changes following death which occurred in the three cadavers used in this investigation. In addition to notes recorded during the periodic visits to the bodies, photographs were made to better illustrate these changes.

The second goal of this thesis is to determine if, from the data obtained, a timetable for the determination of time since death can be made for use by forensic investigators in the Knoxville Area. The observed results will be compared and contrasted to ascertain the reliability of a schedule of this nature.

The third and final goal of this study is to provide data for comparison in future research. Although the sample size is small and a great number of variables exist in the rate and type of postmortem change which may occur, the data are nonetheless of value to prospective studies at The University of Tennessee.

CHAPTER II

VARIABLES AFFECTING LATE POSTMORTEM CHANGES

Late postmortem changes of the body can occur through putrefaction/decomposition, adipocere formation, mummification, or a combination of these (Gonzales et al., 1954). The rate and type of postmortem change which may occur is quite variable and dependent on many factors. Putrefaction is the break up of the body tissues resulting in the formation of foul-smelling products. Putrefaction occurs through autolysis and bacterial action. Autolysis is the destruction of tissue by the enzymes released from the cells after death. This process will occur even under sterile conditions. The primary dissolution of tissue is the result of bacterial action. After death, the naturally occurring bacteria of the body (primarily the intestinal flora) will multiply throughout the body via the blood stream (Marshall, 1976; Polson, 1955). Such phenomena as the distention of the chest and abdomen, ballooning of the face, neck, scrotum and penis, blistering of the skin, and the discoloration of the skin that follows death are due to putrefaction (Gonzales et al., 1954).

Factors Contributing to the Rate of Putrefaction

There are sundry variables that have been found to influence the rate of putrefaction. One of the most important factors is the temperature of the body after death. "A body decomposes much faster in a warm atmosphere; whereas cold weather delays the process" (Fatteh, 1973:24). Temperature controls the amount of bacterial activity and the rate of autolysis (Gonzales et al., 1954; Marshall, 1976).

Body size is another factor contributing to the rate of decomposition. The obese will decompose more rapidly than the emaciated, "because the excess of fat slows the dissipation of the heat of the body and the excess blood furnishes favorable growth conditions for the putrefactive organisms" (Gonzales et al., 1954;63). Whereas, the newborn child will decompose more slowly because of the rapid loss of heat (Marshall, 1976).

A body lying in a state such that the blood vessels are congested (e.g., the prone position) favors more rapid putrefaction than a corpse in the supine position (Gonzales et al., 1954). The corpse which is clothed or buried in a coffin or dirt will decompose more slowly than the nude body. The pressure of clothing or burial prevents the full enlargement of the tissues and restricts the movement of organisms through the blood (Gonzales et al., 1954).

Polson (1955) notes that individuals with infectious diseases prior to death, as well as individuals who have been injured before or after death, putrefy more rapidly. Putrefaction will be slowed by the presence in the body of certain poisons which preserve the tissue and destroy the bacteria. This would include substances such as arsenic, antimony, zinc, mercuric chloride, and probably thallium. It is generally accepted that bodies exposed to air tend to decompose more quickly than those immersed in water or buried in soil. The formula is: one week in air is equivalent to two weeks in water or to eight weeks in the soil (Gonzales et al., 1954).

The accessibility of the corpse to insects and carnivorous animals will alter the rate of decomposition. Flies, for example, will effect the decompositional rate in more than one way. The fly larvae feed on a great amount of the decaying body tissue. By creating openings in the skin, the gases and fluids from the decaying organs are allowed to escape. During the pupating stage of fly development, the flies secrete a substance which causes the breakdown of molecules in organic compounds (Marshall, 1976). It is recommended that insects, both alive and dead, be collected from incompletely skeletonized remains for examination by an entomologist in order to get a better estimate of time of death (Mant, 1973).

There are variables which can affect the insect populations frequenting the cadaver. Barriers which affect the distribution of insect populations include geographical barriers such as the sea, desert, and mountain ranges (Folsom, 1906). Whereas daily changes in the natural barrier, weather, which consists of light, temperature, relative humidity, precipitation, and wind, affect the species populations. Great differences in insect populations existing within close proximity to one another can occur because local weather conditions differ notoriously. For example, Ross (1965:440) states that, "In hilly country the single night's frost would be most severe in the valleys and might not affect the portion of our insect population on the hill crests."

The distribution of land organisms is affected by altitude and by slope facings. The mean atmospheric temperature decreases approximately

0.5°C for each 100 meter rise in elevation (Raven et al., 1981). Therefore, a similar series of animal and insect communities can be found whether we travel north for hundreds of kilometers or ascend a mountain. Temperature and moisture will vary from slope to slope on a particular hill. In the winter, sunlight reaches only the southern and western slopes of mountains in the Northern Hemisphere. These slopes, therefore, are often drier than the northern and eastern slopes of the same hills (Raven et al., 1981).

The rate of decomposition of a body buried in dirt is to some degree dependent on the characteristics of the soil in which the body was buried. Five major groups of microorganisms are found in the soil. They are the bacteria, actinomycetes, fungi, algae, and protozoa. Soil type and cultivation practices influence the number and type of bacteria found. Decomposition progresses more slowly in an acid environment (pH of 6.0 or lower) than under basic conditions (Brandly et al., 1966). The number of soil microorganisms increase from cooler to warmer climates (Alexander, 1961).

The moisture content of the soil is also an important factor in the number and type of bacteria present. In the complete absence of water, microorganisms cannot grow. In waterlogged soil, the number of aerobic bacteria decreases sharply, while the anaerobic bacteria multiply (Alexander, 1961).

Depth is another variable affecting microbe number and type. Going from the upper layer of soil to the mineral layer underneath, the numbers of microorganisms declines and the ratio of aerobes to anaerobes declines (McLaren and Peterson, 1967).

Stewart (1979) has noted in his examination of the Korean War dead the differences in bodies recovered from deep burials as opposed to those in shallow graves. Those individuals in the shallow graves were skeletonized and ". . . were virtually indistinguishable in appearance from prehistoric skeletons recovered archaeologically" (1979:74). Some of the soldiers from the deeply buried graves were completely skeletonized while others were covered with adipocere.

The shortest reported length of time necessary for almost complete skeletonization was ten days. The case was that of a twelve and one-half-year-old White female homicide victim in Mississippi. The victim was killed in August during the hurricane season and the body was hidden under a vinyl-covered couch. This yielded a hot, humid environment where the body putrefied rapidly and insects fed readily (Stewart, 1979).

Adipocere Formation and Mummification

Adipocere is a greasy, grayish-white material that is composed of a mixture of fatty acids formed by the postmortem hydrolysis and hydrogenation of body fats in the presence of water (Mant and Furbank, 1957; Marshall, 1976). Mant and Furbank have found several factors which influence the formation of adipocere. A moist, warm environment is more conducive to adipocere formation than a dry environment or an environment with excessive amounts of water. Also, bacterial enzymes and anaerobic conditions aid in the production of adipocere. A physiological concentration of electrolytes appears to accelerate adipocere

formation. Due to the increasing acidity and dehydration of the tissues which occurs while adipocere is being produced, putrefaction is inhibited.

Mummification is that process whereby the body tissues shrivel, darken, become hardened, and will remain preserved for many years. This phenomenon is preceded or accompanied by putrefaction. Dry environmental conditions are necessary to bring about mummification (Gonzales et al., 1954; Marshall, 1976).

CHAPTER III

SETTING AND METHODOLOGY

The Study Area

Knox County is located in East Tennessee and lies within the Southern Appalachian Ridge and Valley physiographic province of the Southeast United States (Fenneman, 1938). East Tennessee is comprised of mountainous ranges with peaks rising to more than 6,000 feet as well as the foothills with elevations ranging from 1,000 to 1,500 feet. The elevation at Knoxville is approximately 1,000 feet above sea level (Brehm, 1926).

The climate of Tennessee is described by Gale Research Company (1978:911):

Most aspects of the State's climate are related to the widely varying topography within its borders. The decrease of temperature with elevation is quite apparent, amounting to, on the average, 3°F per 1000 foot increase in elevation. Thus higher portions of the State, such as the Cumberland Plateau and the mountains of the east, have lower average temperatures than the Great Valley of East Tennessee, which they flank, and other lower parts of the State. In the Great Valley temperature increases from north to south, reaching a value at the lower end comparable to that of Middle and West Tennessee where elevation variations are a generally minor consideration.

The Appalachia Mountains have a positive influence on the temperature, preventing extreme heat in the summer and cold in the winter. The mountains also protect the area from great windstorms (Brehm, 1926). The average annual rainfall for the Great Valley of East Tennessee increases from near 40 inches in the northern section to 50 inches in the southern part (Gale Research Company, 1978).

A facility for observing the decay process of human cadavers was built on property owned by The University of Tennessee in Knox County. The property is moderately wooded with dense undergrowth. The facility itself is a 4.88 m x 4.88 m (16 ft x 16 ft) concrete slab with a chain-link fence around the sides and top. A 1.83 m x 4.88 m (6 ft x 16 ft) wooden shelter was constructed inside the chain-link fence. Individual wire coffins approximately .61 m x .61 m x 2.13 m (2 ft x 2 ft x 7 ft) were made for each cadaver. The frames of the coffins were constructed with .61 m x 1.22 m (2 ft x 4 ft) boards and lined on all sides with 0.6 cm (1/4 in) hardward cloth. The coffins rested approximately 10 cm (4 in) off the floor, which allowed the liquefied products of putrefaction to drain off the cadavers. The coffins were placed in the open area of the facility to allow exposure to the elements. The construction of the facility and the coffins prevented larger animals and birds from disturbing the bodies (see Figure 1).

Subject Handling and Data Collection

The three human cadavers used in this research were donated to the Anthropology Department of The University of Tennessee, Knoxville. All of the subjects were elderly, White males who died of natural causes. Upon death, each cadaver was kept in a morgue cooler until placement at the research facility. None of the cadavers were autopsied. An identification number was assigned to each body upon receipt. All clothing was discarded and any bandages or tags were removed from the cadavers soon after arrival. Each cadaver was placed in a wire coffin in the supine position.

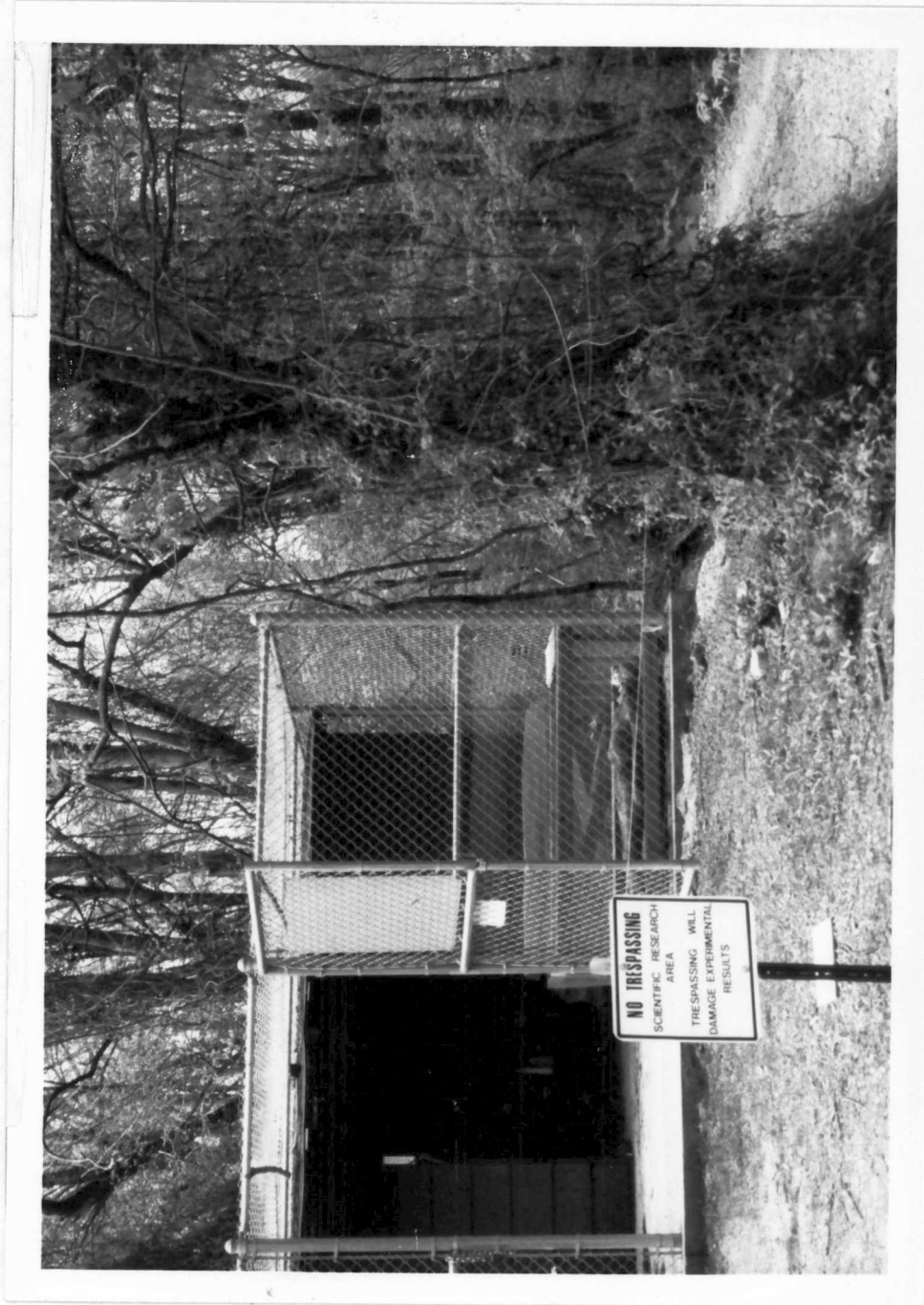


Figure 1. The research facility.

During the first few months after the placement of each cadaver, daily visits were made to the facility for observation purposes. Later, as decomposition of the bodies slowed, weekly excursions to the facility were made. Physical changes in the bodies and weather conditions were recorded during each visit. Color slides and black and white prints were made using two 35 mm cameras to better document the decompositional changes which occurred.

The local temperature and precipitation readings were obtained from the National Weather Service at McGhee Tyson Airport which is located 16 km (10 mi.) from the facility). The average monthly temperature and rainfall for the Knoxville area are presented in Figures 2 and 3.

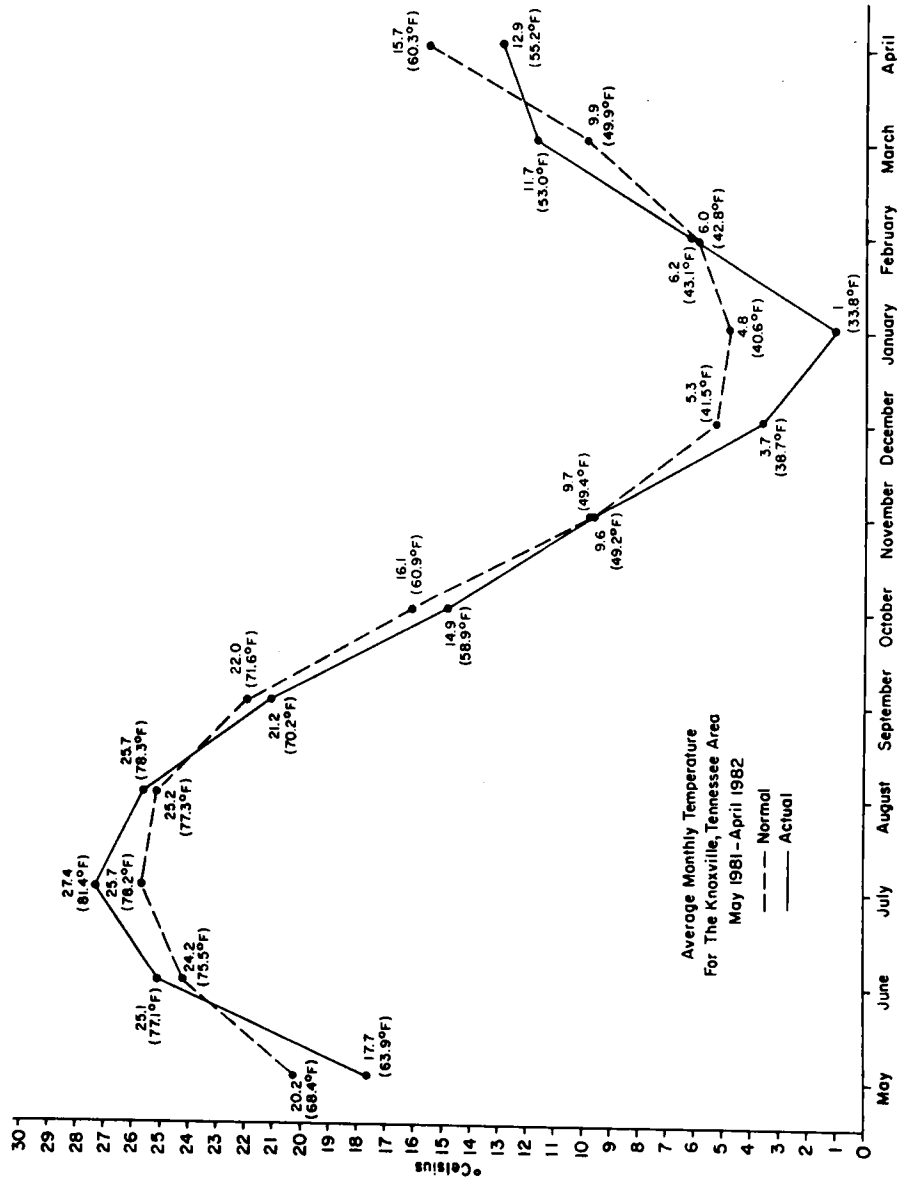


Figure 2. The average monthly temperature for the Knoxville, Tennessee area from May 1981 through April 1982.

Adapted from the National Weather Service Local Climatological Data.

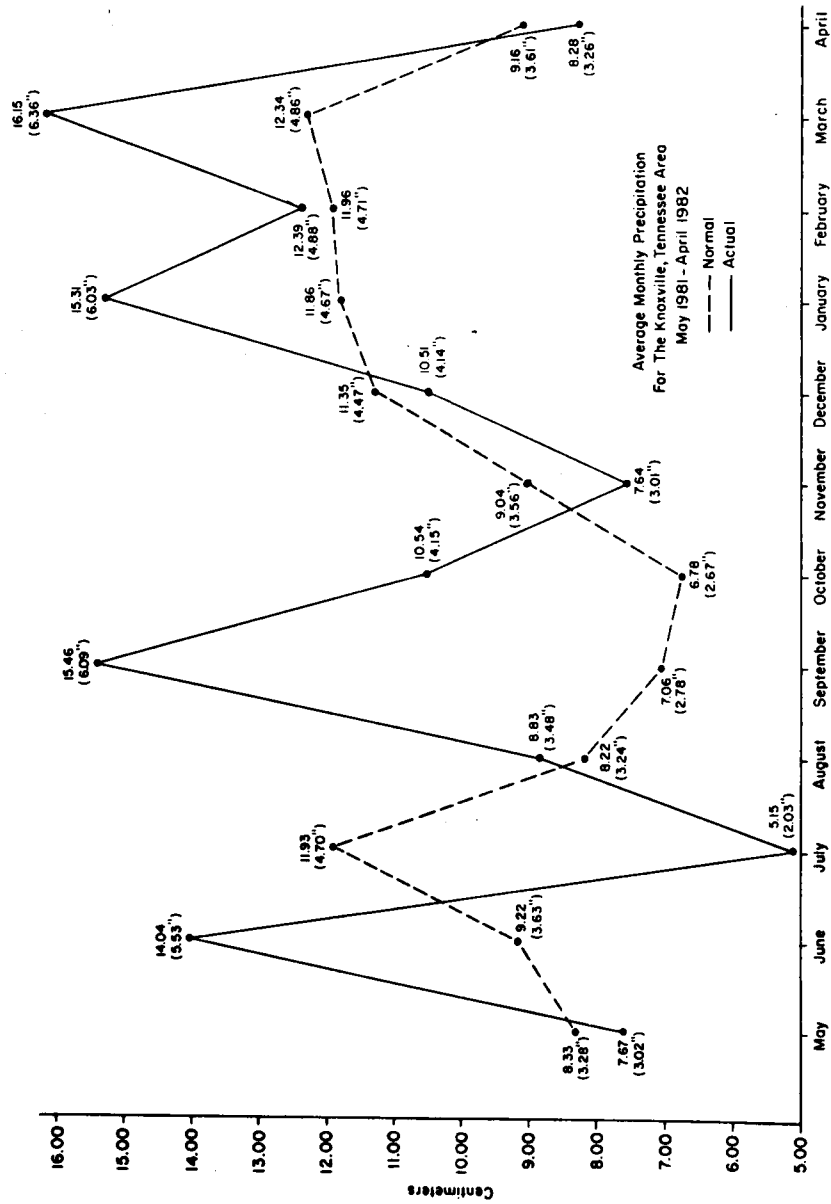


Figure 3. The average monthly precipitation for the Knoxville, Tennessee area from May 1981 through April 1982.

Adapted from the National Weather Service Local Climatological Data.

CHAPTER IV

OBSERVATIONS

Body Number 1-81 is that of a 73 year old, White male who expired May 1981. He was of medium stature and ectomorphic. The cadaver was received by the Anthropology Department of The University of Tennessee, Knoxville, four days after death. The outstanding visual changes which occurred after death are found in Table 1 (in the Appendix).

Found in Table 2 (see Appendix) are the critical observations noted in Body Number 2-81. This cadaver was also a 73 year old, White male. This individual was tall, slightly overweight yet mesomorphic. He expired June 1981 and was brought to the research facility on the day of his death.

A third cadaver, Body Number 3-81, is that of a White male, 72 years of age. He was of medium stature and fairly ectomorphic. He died in October of 1981 and was placed in the facility two days thereafter. Table 3 (see Appendix) contains a description of the significant changes following the arrival of the corpse at the research facility.

In this study two processes occurred after approximately the same amount of time (plus or minus two days) in all cadavers: the appearance of the green discoloration of the abdomen (Day 3 in Body Number 1-81, Day 2 in Body Number 2-81, and Day 4 in Body Number 3-81), which was due to "the presence in the nearby tissues of sulfhemoglobin and iron sulfide, produced by the action of a hemoglobin derivative, of the hydrogen sulfide formed in the large intestine" (Gonzales et al.,

1954:60); and the time that an odor of decay was first noted (Day 3 in Body Number 2-81, Day 5 in Bodies Number 1-81 and 3-81). But in almost every other aspect, the three cadavers differed from one another in the amount of time lapsed before various changes were noted as well as the sequence of these events. Also, not all of the bodies had the same type of postmortem changes occur.

Body Number 1-81 was the only cadaver in which the intestines were exposed in the rectal area (Day 18) and where fecal material was exuded from the anus during the decay process (Day 17). Only in the first body did the exposure of more than just the bones of the skull occur. No rancid smell nor oily appearance of the skin was ever noted in the first cadaver. A small amount of tissue remained on Body Number 1-81 at the end of this study.

The processes of putrefaction occurred with great rapidity in Body Number 2-81 until the onset of mummification (Day 18). Various postmortem changes were observed in the second cadaver that were not noted with the other bodies. While the abdomen was distended in Body Number 2-81, blood was seen flowing from the nostrils (Day 3) and on the fifth day, blood-filled blisters appeared on the chest and legs. Mottled cream and brown discolorations were present on the torso on the sixth day. This stained appearance on the skin was due to decomposed liquefied fat that had soaked through the skin (Gonzales et al., 1954:62).

Body Number 3-81, who expired in the fall of the year, was the only cadaver in which the scrotum did not swell and burst, and the formation

of adipocere was observed. When the temperatures became warmer in April, the skin no longer was dry, but had a moist appearance.

During the growth of many bacteria, alcohols and fatty acids are formed which inhibit some of the putrefactive microorganisms (Brandly et al., 1966). This corresponds with the rancid smell associated with Bodies Number 2-81 (Day 9) and 3-81 (Day 29) and the subsequent reduced rate of decay.

It is of interest to note the ability of the insects and their larvae to move objects such as bones, fingernails, and dentures, respectively (Table 1, Day 18; Table 2, Day 9). Also of interest, after the deflation of the abdomen, mold was observed growing on each of the bodies. Characteristically, molds are aerobic, capable of growing in the presence of high concentrations of salt or sugar, and with little moisture. They are able to grow at low temperatures (0°C or 32°F) as well as warmer temperatures (Brandly et al., 1966).

CHAPTER V

DISCUSSION

All three cadavers observed in this study were elderly (72 to 73 years of age), White males. The body build did vary somewhat, although none were emaciated nor extremely obese. The number of days passed from the time of death until placement at the research facility located in Knox County, Tennessee, ranged from zero to four. Important to any discussion of these cadavers is the limited amount of time they were allowed to remain at the research facility. Body Number 1-81 was at the facility for twelve months, Body Number 2-81 for eleven months, and Body Number 3-81 for seven months.

Gonzales et al. (1954:63) state that the following processes can be observed in the decay process of human cadavers:

. . . general distention of the body cavities, tissue and blood vessels with gas, causing a ballooning of the face, neck, trunk, scrotum and penis; and a red, green, brown or black discoloration of the skin, mucous membranes and irides caused by hemolysis and the action of hydrogen sulfide on the blood pigment. The gas in the body cavities exerts a marked internal pressure, causing the eyes to bulge, the tongue to project between the teeth, the lips to protrude in a frog-like fashion, blood to exude from the nose, stomach contents from the mouth and fecal material from the anus.

Not all of these processes occurred in all three of the observed cadavers. While the face of each cadaver did enlarge, the tongue was not seen projecting between the teeth. Only in Body Number 2-81 (Table 2, Appendix, Day 3) was blood seen oozing from the nose. Fecal material from the anus was observed in association with Body

Number 1-81, only (Table 1, Appendix, Day 17). The ballooning and subsequent bursting of the scrotum occurred in the first two cadavers, but not in the third.

Found in Figure 4 is a general comparison of various states of late postmortem changes in the three bodies. The sequence of these changes was somewhat variable from one cadaver to the other. It can also be observed that the late postmortem changes occurred most rapidly in Body Number 2-81, followed by Body Number 1-81, and more slowly in the third cadaver. Referring to Figures 2 and 3 (pps. 15 and 16), it can be seen that when Body Number 2-81 was placed at the facility in June the average temperature was 7.4°C (13.2°F) warmer, and the average precipitation 6.37 cm (2.51 in) greater than in May when the first body was received. The weather conditions which existed when Body Number 3-81 was obtained in October were cooler temperatures (14.9°C, 58.9°F) and rainfall approximately midway between the average May and June precipitation.

These findings indicate that putrefaction occurs more rapidly in warmer temperatures. The influence of the amount of precipitation on the rate of putrefaction is uncertain in this study, primarily because the design of the coffins allowed for good drainage of liquids off the cadavers.

The actual temperatures for Knox County during this research period were fairly typical. The rainfall, however, was irregular as can be seen in Figure 3. Since weather conditions influence the rate of decomposition, a somewhat different putrefactive rate might be expected if the rainfall and temperature had been different.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	15	26
	DAY																														WEEK	
Green discoloration of abdomen	—	Δ	○	□																												
Odor	—	Δ	Δ	⊕																												
Abdomen beginning to swell	—	⊕								□																						
Face unrecognizable	—	Δ					□	○																								
Veins in chest visible	—	Δ						○									□															
A portion of the mandible exposed	—							Δ				○													□							
Veins in legs visible	—			Δ								○					□															
Scrotum swollen	—		Δ									○																				
Generalized swelling	—		Δ									○					□															
Scrotum burst	—			Δ									○																			
Facial bones exposed	—							Δ									○								□							
Abdomen deflated	—							Δ										○							□							
Tissue dry	—											Δ												○		□						
Mold	—												Δ											○		□						
Reappearance of moist tissue	—																															□

Body Number 1-81 = ○
 Body Number 2-81 = Δ
 Body Number 3-81 = □

Figure 4. General comparison of various states of late postmortem changes in the three cadavers.

This study has been conducted under partially controlled circumstances to better facilitate data collection. Results obtained are, to a certain degree, limited to the conditions in which the research was performed. If these cadavers had been buried in soil or immersed in water, a slower rate of putrefaction would be expected. Conversely, had the bodies been positioned differently (e.g., the prone position) or had no physical barriers been present to prevent large animals from disturbing the bodies, a more rapid destruction of the body tissues and organs would be anticipated. Direct contact with the ground would have encouraged a more rapid rate of decomposition in the three cadavers due to the access of soil microorganisms to the body and the retention of moisture beneath the cadavers.

Anthropological Applications

Snow (1982:129) suggests that physical anthropologists should put to greater use "their knowledge of human biochemical, physiological, and anatomical variability" to better serve as experts in related areas of forensic science. This research was conducted to better aid in the determination of time since death in the Knoxville region, and expands the traditional areas of inquiry investigated by physical anthropologists.

Important to the study of fossil remains and archaeological reconstructions is the taphonomic process. Recovered fossils are rarely a random sample of the once-living organism. Body parts can be displaced by scavengers and by nature itself (e.g., water). It was

observed in this study that when insects and their larvae had access to a cadaver, they were capable of moving small bones, fingernails, and dentures. Decomposition can thus be seen as one of the first events in the taphonomic process.

CHAPTER VI

CONCLUSION

The accurate determination of time since death is one of the most difficult problems faced by forensic pathologists and anthropologists. Within the first 24 to 48 hours postmortem, algor mortis, rigor mortis, lividity, and various chemical changes which will occur in the body provide a reliable method for determining the time of death (Bell, 1982; Fatteh, 1973).

Late physical changes (e.g., decomposition, mummification, and adipocere formation) can occasionally be used to make a rough estimate of the time since death (Fatteh, 1973). Gonzales et al. (1954:66) state that:

Any estimation of the postmortem interval based on the degree of postmortem decomposition must necessarily be an approximation. Since varying external conditions will speed or retard the process, it is difficult to select criteria which can be used as a basis for judgement. Not infrequently two or more bodies undergo bacterial decomposition simultaneously in the same place and apparently exposed to identical external conditions will show different stages of the process.

Three goals were outlined in this research. The first goal was to describe and give the chronology of the late changes of death which occurred in the three cadavers used in this study. The feasibility of developing a timetable for the determination of time since death in the Knoxville area based on the findings obtained was the second goal of this thesis. The final goal was to provide data for comparison in future research.

Three, nude, elderly, White males were observed for physical changes in the deterioration of their bodies after death. The cadavers were placed in a structure where they could be subjected to external weather conditions and insects, but without the contact of carnivorous animals or with the soil. The observation period ranged from seven months (Body Number 3-81) to twelve months (Body Number 1-81). This relatively short time period inhibited this study somewhat since total tissue decomposition had not occurred in any cadaver at the time of their removal from the research facility.

Documentation of the late changes of death which occurred in each cadaver was made. It was observed that putrefaction proceeded more rapidly during warmer weather. The findings indicate that some similar processes occurred in each cadaver, however some variability in the timing and sequence of these changes exists. To produce a reliable timetable for the determination of time since death for remains found in the Knoxville area does not seem feasible at this time based solely on the sample used for this study.

It is anticipated that further data obtained from subsequent studies at The University of Tennessee, Knoxville, in combination with the information gained thus far, will better substantiate the time since death of human remains found in the Knoxville region. It must be remembered, however, that these results will have a limited geographical distribution. These limitations can only be determined by further research conducted in areas affected by differing physical factors.

LIST OF REFERENCES

LIST OF REFERENCES

- Alexander, M.
1961 Introduction to Soil Microbiology. John Wiley & Sons,
New York, New York.
- Bass, W. M.
n.d. The time interval since death: a difficult decision.
Unpublished manuscript, Department of Anthropology, The
University of Tennessee, Knoxville.
- Bell, J. S.
1982 Time of death--art + science. Tennessee Forensic
Headliner, 4:12.
- Brandly, P. J., G. Migaki and K. E. Taylor
1966 Meat Hygiene. 3rd ed., Lea and Febiger, Philadelphia,
Pennsylvania.
- Brehm, C. E.
1926 Tennessee. Dept. of Agriculture, State of Tennessee,
Nashville.
- deSaram, G. S. W.
1957 Estimation of the time of death by medical criteria.
Journal of Forensic Medicine, 4:47-57.
- Fatteh, A.
1973 Handbook of Forensic Pathology. J. B. Lippincott Company,
Philadelphia, Pennsylvania.
- Fenneman, N. M.
1938 Physiography of Eastern United States. McGraw-Hill,
New York, New York.
- Folsom, J. W.
1906 Entomology. P. Blakiston's Son & Company, Philadelphia,
Pennsylvania.
- Gale Research Company
1978 Climates of the States. Book Tower, Detroit, Michigan.
- Gonzales, T. A., M. Vance, M. Helpern and C. J. Umberger
1954 Legal Medicine, Pathology, and Toxicology. 2nd ed.,
Appleton-Century-Crofts, Inc., New York, New York.

- Mant, A. K.
1973 The Pathologist's Role and Modern Scientific Techniques at the Scene of the Crime. Butterworth & Company, Ltd., London, England.
- Mant, A. K., and R. Furbank
1957 Adipocere--a review. Journal of Forensic Medicine, 4:18-35.
- Marshall, T. K.
1976 Changes after death. In: Gradwohl's Legal Medicine. F. E. Camps, A. E. Robinson, and B. G. B. Lucas, eds. John Wright & Sons, Ltd., Bristol, England, pp. 78-100.
- McLaren, A. B., and G. H. Peterson
1967 Soil Biochemistry. Marcel Dekker, Inc., New York, New York.
- Motter, M. G.
1898 A contribution to the study of the fauna of the grave. A study of one hundred and fifty disinterments, with some additional experimental observations. Journal of the New York Entomological Society, 6:201-231.
- Payne, J. A.
1967 A comparative ecological study of pig carrion decomposition and animal succession with special reference to the insects. Ph.D. dissertation, Clemson University, Clemson, South Carolina.
- Polson, C. J.
1966 The Essentials of Forensic Medicine. English Universities Press Limited, London, England.
- Raven, P. H., R. F. Evert and H. Curtis
1981 Biology of Plants. 3rd ed., Worth Publishers, Inc., New York, New York.
- Reed, H. B., Jr.
1953 Ecological studies of dog carcass communities near Knoxville, Tennessee, with special reference to the insects. Ph.D. dissertation, The University of Tennessee, Knoxville.
- Rodriguez, W. C.
1982 Insect activity and its relationship to decay rates of human cadavers in East Tennessee. Master's Thesis, The University of Tennessee, Knoxville.

- Ross, H. H.
1965 A Textbook of Entomology. John Wiley & Sons, Inc.,
New York, New York.
- Snow, C. C.
1982 Forensic anthropology. Annual Reviews of Anthropology,
11:97-131.
- Stewart, T. D.
1979 Essentials of Forensic Anthropology. Charles C. Thomas,
Springfield, Illinois.

APPENDIX

TABLE 1
Postmortem Changes in Body Number 1-81

Day ^a	Description of Significant Changes	Corresponding Figure
3 (May 18)	Eggs deposited by flies are present around the eyes and the gum line of the mandibular teeth. The right hand originally positioned on the right thigh has fallen to the side due to a slight amount of swelling of the abdomen. There is a slight amount of green discoloration of the abdomen. This individual has no teeth present in the maxilla. The following teeth are present in the mandible: left and right central and lateral incisors, left and right canines, and the left and right premolars.	
5 (May 20)	The first day that the odor of decay was noted. The arms are red in color.	
7 (May 22)	The lower face and the neck are brown in color. The lips are merely a red outline. Maggots have eaten a hole in the back of the tongue. The sclera of the eyes are yellow. There are a great number of flies around the mouth, eyes, nose, and genital area. The abdomen is distended and there is a greater area of green discoloration.	
10 (May 25)	The face is being destroyed by the numerous maggots. The brown-black tissue remaining on the face is sloughing off. Flies are present beneath the epidermal layer of tissue on the chest and are laying eggs. There are several maggots around the genital area. The veins beneath the skin of the upper chest and shoulder are visible as a purple-red network. The lower portion of the left arm is blue-black in color.	Figure 5

TABLE 1 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
12 (May 27)	Due to the swelling of the abdomen, the left arm which was originally draped over the abdomen is now at the side of the body. Tissue is sloughing off the arms, hands, abdomen, and legs. The veins beneath the skin of the inner sides of the legs are visible as a red-purple network. The face and neck are swollen and distorted. Carion beetles tear at pieces of tissue on the chin leaving the mandible partially exposed. Maggots are present on both arms.	
13 (May 28)	The face is grossly enlarged and distorted. The majority of tissue in the mouth area is gone. The hair on the anterior half of the scalp has fallen out. The entire chest is distended. The skin has come off the hands in a glove-like fashion with the fingernails attached. Pockets of maggots are beneath the epidermis on both legs. The scrotum is ballooned.	Figure 6
14 (May 29)	The scrotum has burst. The body is orange and purple in color. A small portion of the right half of the maxilla is exposed. The veins beneath the skin in the legs are clearly seen. Maggots are present on the bottom of the feet.	
17 (June 1)	The entire body is covered with maggots. Most of the genital area is gone. Feces are laying on the hardware cloth between the legs. The legs are further apart and bent slightly at the knees. The body and the interior portion of the ascending rami of the mandible, the maxillas, frontal, nasal bones, parietals, zygomatics, zygomatic arches, the midshaft of the left radius and the proximal phalanx of one of the fingers of the left hand are now visible. The left central and lateral incisors and the right second premolar have fallen out of their sockets in the mandible.	Figures 7 and 8

TABLE 1 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
18 (June 2)	Maggots cover the entire genital area and the intestines are exposed in this area. Maggots are feeding on the right side of the chest. The shaft of the right humerus can be seen. The metacarpals and phalanges of the left hand are exposed and some disarticulation has occurred. One distal and one middle row, left phalanx and fingernails have been moved, probably by carion beetles, to a position between the legs.	
19 (June 3)	The sides of the chest are black, while the rest of the trunk is orange-tan with purple-red discolorations present. The abdomen has begun to deflate.	
20 (June 4)	The legs appear much thinner. The ribs and sternum are outlined beneath the skin. Four upper right ribs on the dorsal side are exposed.	
21 (June 5)	Ossified thyroid cartilage in the neck is exposed.	
24 (June 8)	The tissue on the chest has a brown leathery appearance with white mold present. The ribs have begun to collapse. The anterior, superior portion of the clavicles, the shaft of the left humerus, a portion of the iliac crests and the pubis are now visible. There are small shallow holes in the bottom of the feet.	
25 (June 9)	The heads of both humeri, the distal end of the right humerus, and the head of the left radius are visible.	

TABLE 1 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
31 (June 15)	The mandible has tilted to his (1-81's) right. The lateral edges of the bodies of the cervical vertebrae, the glenoid cavities of the scapulae, and the distal end of the left humerus are exposed. The left radius has separated from the humerus and the humeri are separated from the scapulae.	Figure 9
39 (June 23)	Due to the shrinkage of the tissues of the chest, the clavicles and sternum have been pulled toward the feet. The jugular notch and a small portion of the body of the sternum are exposed. The cervical vertebrae are completely clear of tissue.	
68 (July 22)	The obturator foramina of the innominates has been cleared of tissue. The right radius has disarticulated from the right humerus.	
82 (August 5)	Tissue shrinkage has occurred over the entire body. The first phalanx of the right hand is clear of tissue and separate from the first metacarpal.	
104 (August 27)	The skull and the cervical vertebrae are out of alignment from the coffin being moved. Through the foramen magnum of the skull it can be seen that only putrefactive fluid remains in the skull vault. The manubrium has separated from the body of the sternum. The thoracic vertebrae are cleared of tissue.	
153 (October 15)	The fifth thoracic vertebrae has split horizontally through the body. The ventral surface of both scapulae are exposed.	

TABLE 1 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
259 (January 29)	The remaining phalanges as well as the metacarpals of the right hand are cleared of tissue. Less tissue is present on the chest and the innominates.	Figure 10

^aIndicates day since placed at the facility.



Figure 5. The head and neck region of Body Number 1-81 on the tenth day.



Figure 6. The face of Body Number 1-81 on the thirteenth day.



Figure 7. The torso, arms, and upper portion of the legs of Body Number 1-81 on the seventeenth day.



Figure 8. The face of Body Number 1-81 on the seventeenth day.



Figure 9. Anterior view of Body Number 1-81 on the thirty-first day.



Figure 10. Anterior view of Body Number 1-81 on the two hundred and fifty-ninth day.

TABLE 2

Postmortem Changes in Body Number 2-81

Day ^a	Description of Significant Changes	Corresponding Figure
2 (June 8)	The shoulder area and arms are purple-black in color. The network of veins in the shoulder area and arms can be seen. The right side of the abdomen has a small amount of green discoloration. The sides of the face are red and purple in color. Upper and lower dentures are in the subject's mouth. Multiple skin cancers and moles are present on the chest. The inner side of the upper half of the legs are red in color.	Figure 11
3 (June 9)	The head and neck are enlarged and darkened. There is blood outside the left nostril. Flies cover the nose and mouth. Eggs fill the mouth, the right nostril, and the urethral opening of the penis. The shoulder area, arms, and the tops of both hands are gray-black in color. The abdomen is more discolored and is distended. The scrotum is swollen. This is the first day that the odor of decay was noted.	
4 (June 10)	The face is distorted by maggot activity. Blood is present on the lower lip. The arms are red in color.	
5 (June 11)	There are many maggots on the face. The scalp hair is beginning to fall out. There is a generalized swelling of the body. Blisters, filled with a bloody fluid, appear on the chest, left arm, lower left leg, and in the groin area. The fingers have bent in toward the palms. A purple network of veins is visible in the legs. The legs are further apart.	Figures 12 and 13

TABLE 2 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
6 (June 12)	The scrotum has burst and the genital area is covered with maggots. Blood-filled blisters now appear on both legs. The face is completely covered with maggots. Most of the scalp hair has fallen out. There are mottled cream and brown discolorations on the torso.	Figure 14
9 (June 15)	The entire body has a slick, oily appearance accompanied by a rancid smell. The chest is beginning to deflate. The head and arms have a black, tarry appearance. The right half of the mandible, the right maxilla, the right zygomatic, and a small portion of the right temporal are exposed. The upper denture is laying on top of the left maxilla and the lower denture is on the hardware cloth to his right. (These were probably moved to their new location by the action of the maggots and carion beetles.) A black, stringy tissue covers the abdomen and the groin. The skin on the trunk and legs is reddish-brown in color.	Figure 15
10 (June 16)	The nasal bones and the orbit area of the frontal are visible. Large folds in the skin of the chest and arms are present. Maggots cover the groin and the inner portions of the upper legs. The abdomen is beginning to deflate.	
12 (June 18)	Black, sinewy tissue, veins, and tendons are exposed on the inner sides of the upper portion of the legs. A considerable amount of tissue on the left side of the neck has been destroyed by the insects.	

TABLE 2 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
13 (June 19)	Sieve-like holes have appeared in the left upper side of the chest and on the medial aspect of the left arm. The fingernails on the right hand have fallen off. The skin on the body has a taut, dark brown, leathery appearance.	Figure 16
16 (June 22)	Water and mold have gathered in the deflated abdominal region. The bodies of the cervical vertebrae located between the maxilla and the mandible are exposed. The fingernails of the left hand have fallen off. The chest and abdomen are completely deflated.	
17 (June 23)	White mold is seen on both legs.	
18 (June 24)	The oily appearance of the tissue is gone. Mold is present on other body parts.	
27 (July 3)	The anterior surface of the acetabulum of the left innominate is visible.	
33 (July 9)	The water has evaporated from the abdomen surface.	
41 (July 17)	Sieve-like holes are in the tissue of the abdominal cavity. The upper dentures have fallen into the mouth. A portion of the head of the left femur is exposed. Mold still covers most of the skin.	
45 (July 21)	A portion of the head of the right femur and the sacrum are visible.	

TABLE 2 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
237 (January 29)	The hyoid, ossified thyroid cartilage in the neck, and the right clavicle are exposed. The cervical vertebrae are completely cleared of tissue and the vertebral column curves upward at the neck. The skin on the arms is very dry and wrinkled.	Figure 17
314 (April 16)	The trunk, legs, and hands are more dry and wrinkled. The medial sides of the upper femora are exposed.	

^aIndicates day since placed at the facility.



Figure 11. The upper chest and face of Body Number 2-81 on the third day.



Figure 12. Blood-filled blisters on the chest of Body Number 2-81, the fifth day.



Figure 13. An anterior, inferior view of Body Number 2-81 on the fifth day.



Figure 14. The torso and upper legs of Body Number 2-81 on the sixth day.



Figure 15. An anterior, superior view of Body Number 2-81 on the ninth day.

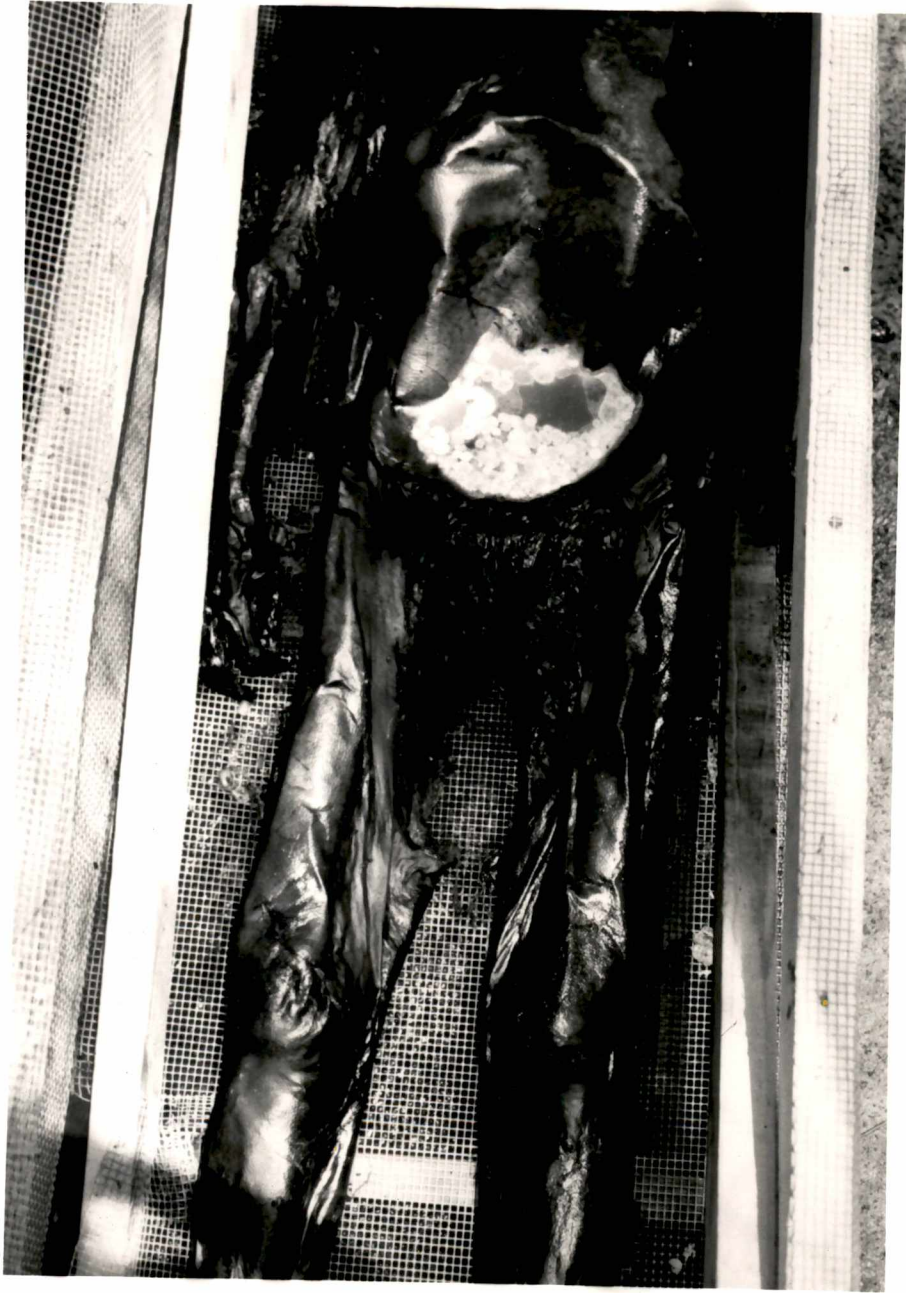


Figure 16. The chest and legs of Body Number 2-81, the sixteenth day.



Figure 17. An anterior, superior view of Body Number 2-81 after remaining at the facility for two hundred and thirty-seven days.

TABLE 3

Postmortem Changes in Body Number 3-81

Day ^a	Description of Significant Changes	Corresponding Figure
2 (October 13)	Upper and lower dentures are present in the mouth. Flies are laying eggs in the mouth. Both nostrils are filled with eggs. Dried, brown fluid is present on the right side of the mouth. The left hand is draped on the thigh. A small scar is present on the left side of the chest.	Figure 18
4 (October 15)	The left eye is now full of eggs. Larvae is present in the nostrils and mouth. The lips have dried up (reddish-black). A small amount of green discoloration in the abdomen is present.	
5 (October 16)	The smell of decay is noted. Flies are present on the penis and the left hand. More green discoloration of the abdomen is noted.	
6 (October 17)	The tissue around both eyes is blackened. The lips are black and dry. The lower lip has sunken in. Eggs are now present on the penis and the left side of the head.	
7 (October 18)	The left hand has fallen off the thigh to the side of the body. The left wrist is flexed.	
8 (October 19)	The tissue of the entire face is blackened. The tissue in the upper mouth is enlarged due to the activity of the maggots and the upper dentures have fallen out of place. The larvae are dormant due to the cold temperature. The neck and chin are green in color. The tip of the penis is gone. The top, right side of the scrotum is red and raw. Orange blisters are present on the left thigh.	

TABLE 3 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
9 (October 20)	Both ears are black in color. The left ear is almost eaten away. Small, white, dry blisters are on both feet. Purple veins on right upper arm can be seen. There is a lot of maggot activity in the nostrils, eyes, and mouth.	Figure 19
11 (October 22)	Orange blisters are present around the genital area. The mouth area is disfigured. Tissue is sloughing off the face. The neck area is brownish-green. There is a slight amount of swelling of the abdomen.	
16 (October 27)	The head and neck are brown in color. The face is infiltrated with maggots and appears grossly enlarged. The upper abdomen is swollen. The scar on the chest has opened up. The skin is peeling in the genital area, also there are maggots beneath the epidermis. A pocket of flies is present on the right hand. The areas around the sternum and the right shoulder are green. Small, reddish-purple spots are noted in several areas--chest, abdomen, thigh.	
18 (October 29)	The epidermal layer of skin of the upper chest and right shoulder and thigh is peeling. Purple-black veins can be seen in the lower neck, upper chest, and upper legs. The penis is black and shriveled. The entire chest and abdomen is fully distended.	Figure 20
19 (October 30)	Only pieces of the right ear are left. Purple-red veins can be seen on the right arm. On the inner side of both legs, beneath the knees, the skin is green in color. There are pockets of maggots on the legs. The tissue of the arms, legs, chest, and genital area is still peeling.	

TABLE 3 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
22 (November 2)	The nasal bones, portions of the maxilla and zygomatics, and the orbital area of the frontal are exposed. On the right side of the face is a tan, foamy substance. The inside of the skull is still full of maggots. Blue-black veins can be seen in the upper left arm and the inner sides of both legs. Pockets of maggots are present on the legs and feet. Below the knees, the legs are black. The scrotum is black.	
23 (November 3)	The upper denture is on the right side of the mouth, probably moved by maggot activity. Flies have laid eggs on the left underarm.	
25 (November 5)	The face is extremely distorted and covered with maggots. The inferior nasal conchae, palate bones, and the alveolar region of the mandible are exposed. More of the left maxilla and frontal are exposed. The upper denture has fallen out of the mouth onto the hardware cloth. The entire body is covered with maggots. White tissue is peeling off the palm of the right hand and the bottom of both feet.	Figure 21
29 (November 9)	The body has a rancid smell similar to Body Number 2-81. The lower denture can now be seen deep in the mouth. The right orbit is free of tissue while a small amount is still present in the left orbit. The maxilla and right zygomatic are also free of tissue. Black, stringy tissue is hanging from the right side of the face. The upper chest and abdomen have sunken slightly. The tissue of the chest and abdomen is dry and wrinkled. The left leg has a wet, oily appearance.	Figure 22

TABLE 3 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
31 (November 11)	The anterior portion of the right parietal is exposed. Maggots are very active in the head area. The scrotum is black and shriveled.	
37 (November 17)	The tissue on the inner side of both hands is peeling off in a glove-like manner. The fingernails are still attached to the fingers. The outline of the rib cage can be seen.	Figure 23
44 (November 24)	The abdomen and chest are completely deflated. The lower denture is now hanging over the side of the mouth.	
53 (December 3)	Exposed facial bones are bleached white by the sun. The tissue of both upper legs is wrinkled. Adipocere is noted on the inner sides of both upper legs.	Figure 24
110 (January 29)	The lateral edges of the cervical vertebrae can be seen in the area between the maxilla and the mandible. The tissue of the hands, upper left arm, knees and feet have a salt and pepper mold-like appearance to the tissue. There is a hole in the tissue to the left of the scrotum. The scrotum itself has dried up to the point of practically not existing. Adipocere is present on the inner side of the right leg.	Figure 25
142 (March 2)	More adipocere noted--left underarm. Salt and pepper appearance extended to include the abdomen, chest, and arm. The hands, feet, and several areas on the rest of the body are black.	Figure 26

TABLE 3 (continued)

Day ^a	Description of Significant Changes	Corresponding Figure
187 (April 16)	Adipocere is still present on the body. The skin appears moist, no longer leathery. No additional tissue has been lost up to this point.	

^aIndicates day since placed at the facility.

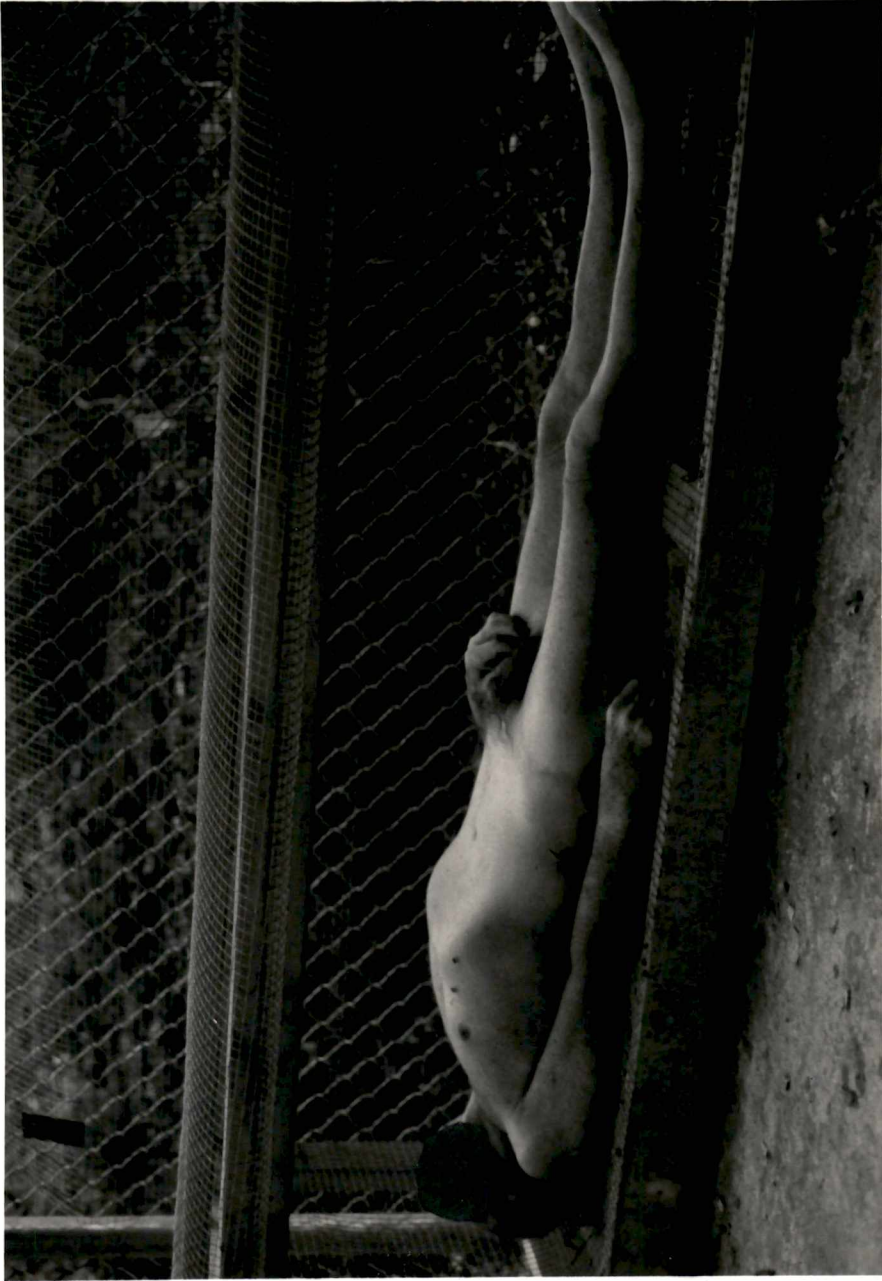


Figure 18. Side view of Body Number 3-81 on the second day.



Figure 19. The face and upper chest of Body Number 3-81, the sixteenth day.



Figure 20. Side view of Body Number 3-81 on the nineteenth day.



Figure 21. The face and upper chest of Body Number 3-81 on the twenty-fifth day.



Figure 22. The face of Body Number 3-81, the twenty-ninth day.



Figure 23. Side view of torso, Body Number 3-81, the thirty-seventh day.



Figure 24. Body Number 3-81 on the fifty-third day, side view of the abdomen.



Figure 25. The genital area of Body Number 3-81 on the one hundred and tenth day.



Figure 26. An anterior view of Body Number 3-81 on the one hundred and forty-second day.

VITA

Lorna Lea Watkins was born on May 12, 1956, in Atlanta, Georgia. In May 1974 she graduated from Jefferson High School, Jefferson City, Tennessee. The following June she entered Carson-Newman College and received a Bachelor of Science degree in Medical Technology in 1978.

The author has been employed as a medical technologist at Morristown-Hamblen Hospital in Morristown, Tennessee, for six years. She is a member of the American Society of Clinical Pathologists.