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Factors Affecting the Stages of Decomposition in Burnt Remains

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Abstract:
Estimation decomposition and PMI for burned remains in scenes of crimes is considers as one of the most difficult problems in the field of forensic investigation because the classical thanatology methods cannot be used in case of burning corpses because the fire will burn the skin, lack the tissues and destroy the body, For this reason other methods like entomology have to be used in case of burning for study stages of decomposition and PMI estimation, This study was done to investigate the influence of burning on body decomposition, and insects succession, and in order to develop a useful approach for the PMI estimation. In this study we used 14 corpses of gutted rabbits (1kg) and divided into two groups to perform two experiments, 8 rabbits were used in the first experiment and 6 in the second one , in each experiment 2 rabbits were used as control samples and the rest were burned, three different flammable liquids in different amounts were used as accelerants to burn the rabbits , the results showed that during the fresh stage in spring was shorter compared to winter and the active decay was approximately equal, the burned samples in each experiment were faster in decomposition than the control samples, the clothed samples reached the dry stage faster than non-clothed samples, the advanced decay was very long in kerosene samples, the spring experiment was faster than the winter experiment due to the rose of temperature, we concluded that the burned remains reached the dry/skeleton stage before the non-burned remains, temperature plays an important role in the rate of decomposition and affects PMI estimation where the decomposition process was faster during the warm seasons than during the cold seasons, clothed corpses reached the skeleton stage earlier than without clothes corpses and finally oviposition plays an important role in the speed of decomposition and affects by temperature.

Keywords: Stages of decomposition, Post-mortem interval (PMI), burnt remains, skeletonization.

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العوامل المؤثرة على مراحل التحلل في البقايا المحترقة

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الملخص
يعتبر تقدير نسبة التحلل وتحديد زمن الوفاة للبقايا المحترقة في مواقع الجرائم من أصعب المشاكل التي تواجه خبراء التحقيقات الجنائية والطب الشرعي ،حيث انه لا يمكن استخدام الطرق التقليدية لتحديد زمن وقوع الجريمة في حالة الجثث المحترقة وذلك لأن النار ستحرق الجلد وتدمر الأنسجة ، لهذا السبب يجب استخدام طرق أخرى مثل علم الحشرات وذلك لتقدير نسبة التحلل وتحديد زمن الوفاه في مثل هذه الحالات، أجريت هذه الدراسة لمعرفة تأثير الحرق والحشرات على تحلل الجسم ، ومن أجل تطوير منهجية لتقدير زمن الوفاة للبقايا المحترقة، علاوة على ذلك قمنا بدراسة الفرق بين البقايا المحترقة وغير المحترقة في تقدير زمن الوفاة، استخدمنا في هذه الدراسة عدد 14 جثة من الأرانب المسلوخة (1 كجم) وتم تقسيمها إلى مجموعتين لإجراء تجربتين في وقتين مختلفين ، واستخدمت في التجربة الأولى عدد 8 عينات م بينما استخدمت البقية وعددها 6 في التجربة الثانية ، في كل تجربة تم استخدام ارنبين كعينة أساسية والباقي تم حرقها في ظروف مختلفة ، واستخدمت ثلاثة سوائل قابلة للاشتعال بكميات مختلفة كمسرعات لحرق العينات ، وأظهرت النتائج أن التحلل خلال فصل الربيع في التجربة الثانية كان أقصر مقارنة بالشتاء في التجربة الاولى. وأيضا كانت مرحلة التحلل النشط متساويًا تقريبًا في كل العينات في كل من التجربتين ، وكانت مرحلة التحلل المتقدم طويلًا جدًا في العينات التي استخدم فيها الكيروسين، ووصلت العينات المغطاة بقطعة قماش إلى المرحلة الاخيرة من التحلل أسرع من العينات المكشوفة، ، خلصنا إلى أن العينات المحترقة وصلت إلى نهاية التحلل (الهيكل العظمي) أسرع من العينات غير المحترقة ، وايضا تلعب درجة الحرارة دورًا مهمًا في سرعة التحلل وتؤثر على تقدير زمن الوفاة حيث كانت عملية التحلل أسرع خلال المواسم الدافئة منها في المواسم الباردة ، وأخيراً الحشرات وعملية وضع البيض والتي تتأثر بدرجة الحرارة لها دور مهمم جدا كذلك في سرعة تحلل البقايا المحترقة.

الكلمات المفتاحية: مراحل التحلل، زمن الوفاة، الهيكل العظمي، البقايا المحترقة.

Introduction

When human or animals die then the soft tissues from the dead body will be broken down into fluid and gas compounds, this process is known as Decomposition and is considered as a complex process whereas the soft tissues collapse until they become remains and then reach the state of skeletonization. Decomposition process starts to happen immediately after death and increases gradually with the passage of time. The rate of decomposition is changes and affected by some factors such as environment, ambient temperature, bacterial activities, cause of death, body size and insects. But in moderate temperature the changes of decomposition will not occur in the first 24 hours after death, decomposition also occurs more quickly at a location of wounds or injury where bacteria and insects can enter through wounds to the inside of the body [1]. Decomposition can be divided into two main processes, which are Putrefaction and Mummification; both of them lead to another phase which is skeletonization [2]. Putrefaction is a breaking down for dead body tissues, this stage of the decomposition occurs as a result of the activity of bacteria, the bacteria normally start to breakdown the dead body from the inside to the outside and cause lots of changes that occur with the passage of time, we then link these changes with a person who has died or been killed for a long period of time to estimate the real time of death [3]. Mummification occurs when the surrounding environment to the body is dry normally, such dry outside location as a desert or in heated indoor environment during the winter when the relative humidity is low, first darkening and stiffness will happen to the skin, these will development to produce flaking of the surface of the skin, the skin will begin to split and eventually the skin and soft tissues under the skin will be lost [4]. both putrefaction and mummification eventually lead to skeletonization of the body, the loss of soft tissues progresses at a variable rate, depending on the environmental conditions and access of the body to a variety of animals and insects. The face and ends of the extremities are the first areas where bone is exposed and pelvic soft tissues are the last to be lost. According to study has been performed at the Anthropologic research Facility at the university of Tennessee in Knoxville has confirmed that complete skeletonization of a body can take place within days in suitable conditions [5]. Decomposition process has been defined into four or five basic stages, all these changes that take place in the period of time between the moment of death until the body become only bones [6]. The first stage is fresh stage of decay that carries on immediately after death and continues from the second of death up to reach to the first marks of bloating which is the second stage, although on obvious signs of decomposition may be apparent, despite this internal bacterium starts gradually to destroy the internal organs of the body and digest it, this bacterial activity causes an unpleasant odor which indicator to bring and attract the insects [7]. bloated stage is a sign to the beginning of putrefaction process, bacteria produce gases and metabolic processes will be the result for this stage, then this process will cause distension of the abdomen of the corpse, during this stage

a lot of flies come to the dead body and this may as a result to the odor which attaches the insects due to breakdown gases, when gases leak out from the body and escape and the remains come to be deflated , that is mean the beginning of active decay stage, dipteran larvae forming big maggots, this will be the most important observation in this stage, by the end of active decay stage most of the flesh will be removed from the body, after that post decay or advanced decay stage will start, this stage of decomposition is characterized by the declining of components of the body and its tissues, reducing of the body will happen to skin, cartilages and bones, and many insects especially beetles that feed on the dry remains will be exist and very clear during this stage [8]. Then skeleton or dry remains which consider as the final stage of decomposition process will start, during this stage all the remains almost will be disappeared except the hair and bones, and most insects will have gone, the mainly mites which has been leaved considered as useful indicators for estimating PMI and calculate the period of this stage of decomposition [9].

Aims

This study was done to investigate the influence of burning on body decomposition, and insect succession and in order to develop a useful approach for estimate time after death through changes and different stages that occur by the body. The aims and objectives of this paper can be summarized as following:

- To study the changes and stages of decomposition in burned bodies and to find out how long each of these stages takes time.
- To serve forensic experts and police investigators to form proper guidelines and to help reaching the correct conclusion at the scene of burned bodies.
- To compare between estimation of time after death for burned and non-burned remains and to find out the effect of burning on correctly determining the time after death.
- To test the effect of insects and their activity on burned remains by check the accuracy of stages of decomposition and calculate it by naked eye observation and compare it with scientific methods such as forensic entomology.
- To evaluate the effect of weather and temperature on the decomposition of corpses

Methods and materials

The material for the current study required animals, the animals which have used in this study were rabbits, a total of 14 rabbits (1kg) were obtained from a local farm shop, the rabbits were dead skinned and gutted, and then divided into two groups to perform two experiments at two different times , 8 rabbits were used in the first experiment and rest 6 used to perform the second trial , in each experiment two samples were used as a control samples (not burned) and the rest were burned with slightly different conditions, Three different flammable liquids in different amounts were used as accelerants to set the fire and burn the rabbits, this materials were (methylated spirit - white spirit - kerosene) in the second trial clothes were used to cover two samples while the other two were burned without clothes (table 1&2).

each sample were placed in plastic cages and small aluminum boxes, two trials were conducted during two different seasons, the first trial was in the winter and the second trial took place during the spring, the reason for conducting the experiments during different seasons was because the result will give the experiment more information about different decomposition rate.

Table (1) Details of the First experiment

No. of sample	Flammable liquid	Time of burn (minutes)	Amount of accelerant (ml)
1	Methylated spirits	6	100
2	Methylated spirits	7	200
3	White spirits	8	100
4	White spirits	21	200
5	Kerosene	18	100

6	Kerosene	35	200
7	Control sample	Not burned	No accelerant
8	Control sample	Not burned	No accelerant

Table (2) Details of the Second experiment

No. of sample	Flammable liquid	Time of burn (minutes)	Amount of accelerant (ml)
9	White spirits	7	300
10	White spirits + clothes	8	300
11	Kerosene	21	300
12	Kerosene + clothes	35	300
13	Control sample	Not burned	No accelerant
14	Control sample	Not burned	No accelerant

Results:

According to my results I observed that a bloat stage was not present during both trials in all samples because the corpses where skinned and without bowels, in the present study the decomposition process was evident in the form of four successive stages. These were fresh, active decay, advanced decay and dry stage. It was easy to make out the various between decomposition stages by the presence, absence or activity of the insects and their immature stages, the decomposition process for all samples were similar with the only difference observed in the duration of each stage and the level of overlap between the stages. The results of this study are summarized in table (3) and Figures from (1) to (7).

Table (3) general summary and characteristic of decomposition stages in first trial

Stage	feature	duration	Insect activation
Fresh	Immediate & early signs, no odor	3-5 days	Eggs
Active decay	Strong odor, Colliquative putrefaction	4-8 days	Larval stages
Advanced decay	Little dry tissue Remaining, odors, Skeleton visible	1-2 weeks	Maggots stage & all stages
Dry / Remains	Dry carcass, cartilage, Bones & tissue remaining in a few patchy areas completely dried out	>1-2 months	Empty Puparia & Beetles

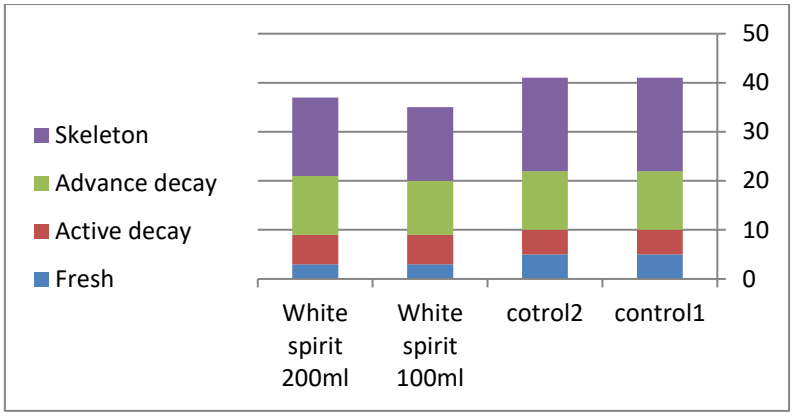

Figure (1) Stages of Decomposition for White spirit samples.

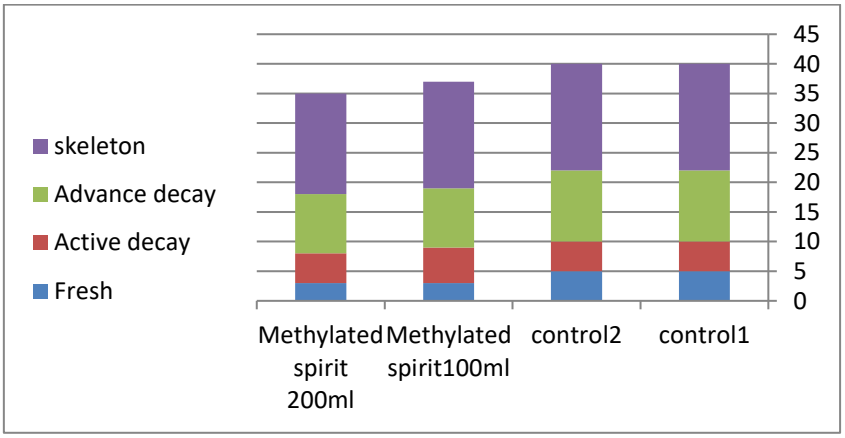

Figure (2) Stages of Decomposition for Methylated spirit samples.

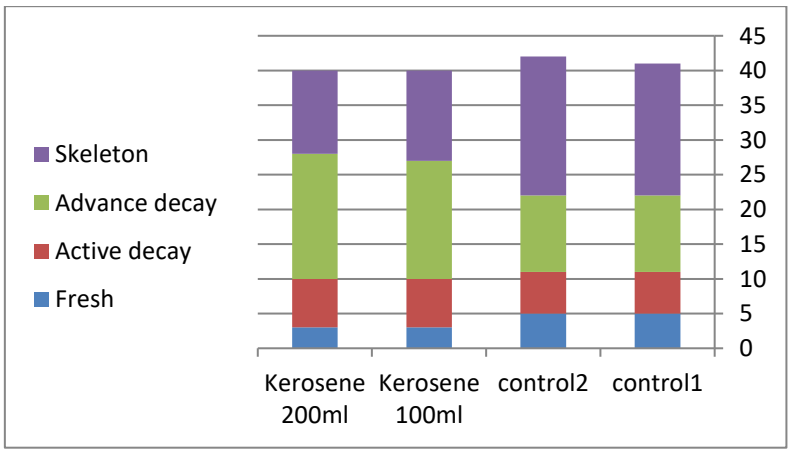

Figure (3) Stages of Decomposition for Kerosene samples.

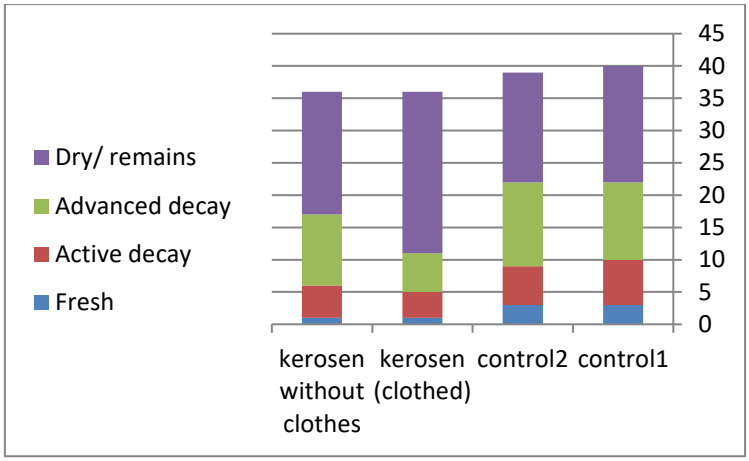

Figure (4) Stages of Decomposition for Clothed Kerosene samples.

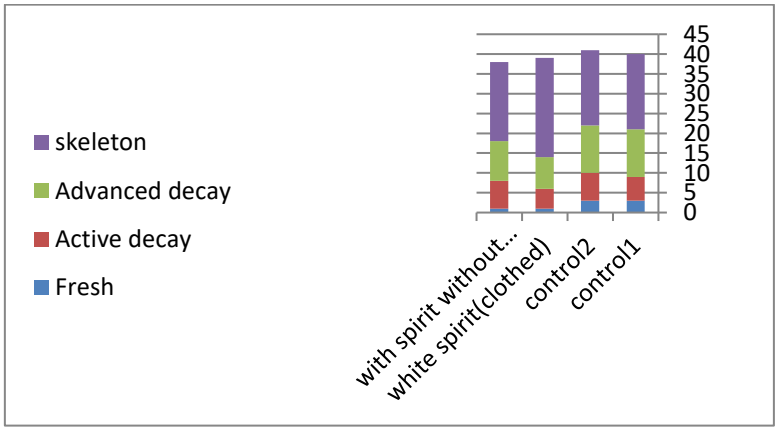

Figure (5) Stages of Decomposition for Clothed white spirit samples**.**

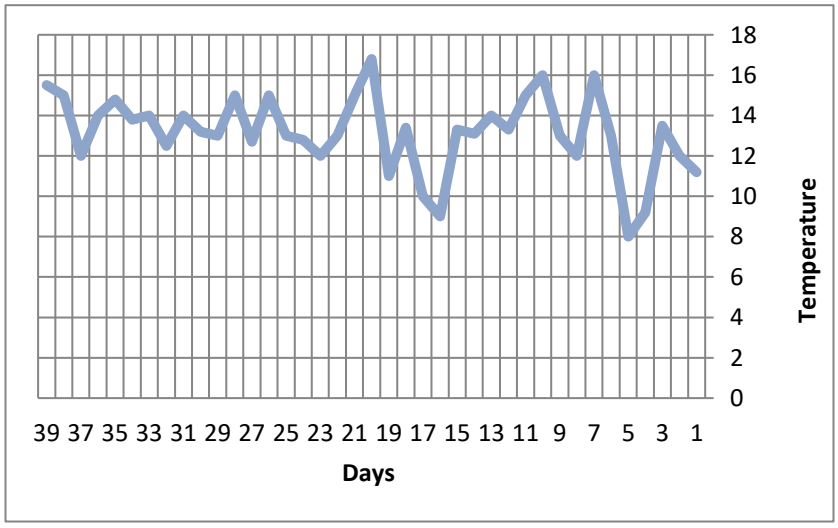

Figure (6) Temperature rate during the first experiment.

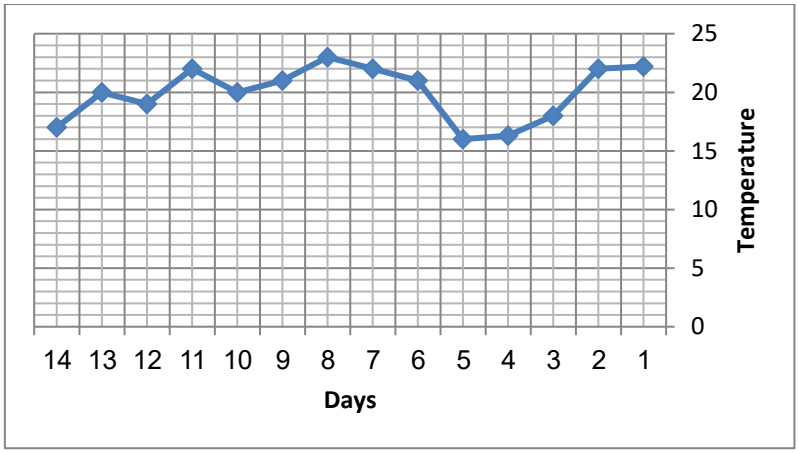

Figure (7) Temperature rate during the second experiment.

Discussion

Effects of burning on decomposition and PMI estimation

The most important observation performed during these two experiments is that the burned remains reached to the dry/skeleton stage before the non-burned remains. The observation in this study about the influence of the burning was that the control sample corpse Richard the advanced stages of decomposition faster than the hard burned corpse such as the kerosene samples, whereas it was later than the slightly burned corpse such as the white spirit and methylated spirit samples in the first experiment, and these samples wet through the same stages of decomposition during the second experiment and were at a similar rate. The Kerosene samples corpse was the last to reach the dry remains stage and the decomposition process was very slow in these samples; this is because the large portion of burned corpse was not consumed by insects and flies whereas the hard burned samples were not attractive to the maggot or insects due to the flesh of these samples being very hard to be digested because it was charred.

Effects of temperature on the speed of decomposition

Temperature plays an important role in the speed of decomposition; thus, it has an effect on PMI estimation whereas the decomposition process will be more accelerated during warm seasons than cold seasons from the year. During the first experiment, which was done in winter the decomposition rate was not fast and the samples went through different rates depending on the burning conditions, but during the second experiment which done in warmer season (spring) the decomposition rate was fast where the control sample and slightly burned corpses where decomposed at almost similar rates, but the slightly burned samples were faster than the control samples and then the hard burned corpse were the last one to reach to decomposition, however we observed that during the colder weather the decomposition process was slow, the slightly burned corpses decomposed faster than the control corpses which came later then the slowest decomposed corpses occurred with the heavily burned corpses.

Effects of clothing on the speed of decomposition

The other observation was that the clothed samples in the second experiment were reached to skeleton stage very early whereas the without clothed samples came later, this was very clear where the corpses which clothed by tissues were very fast in decomposition and reached to skeleton within about 22 only days, this because of that samples was very hot from inside and temperature was higher than non-clothed samples and this is the reason which made the decomposition process very fast.

Effects of insects on the speed of decomposition and MPI estimation

The oviposition process plays an important role in acceleration of decomposition where whenever the oviposition then the decomposition will begin more quickly (according to my own observation) and the time of oviposition was different between the control samples and the burned samples, this is very influential on estimation of PMI where the worms play an important role and the observation of this study was in warmer season, the oviposition takes place much faster than the cold seasons. Also the

time of oviposition was simultaneous in burnt and control samples, and because of this the maggot were a similar age of all samples and most samples had two oviposition. On the other hand, during the cold seasons the time of oviposition was different between each sample and the maggots and insects were at different ages, because of the accurate PMI estimation will be easier in warmer seasons than colder seasons due to a similar number of insects and adults and the same masses of maggots in all corpses. This is a result of a lack of competition; however, we will still be able to estimate PMI due to a larger diversity of species of the carcasses and by using the largest maggots as indicator of PMI.

Conclusion

The burnt remains have reached the Dry/skeleton stage before the non-burned remains, and Temperature plays an important role on the rate of decomposition and effects on estimation the time after death, where decomposition process was faster during the warm seasons than during the cold seasons from the year. Insects also had a very important role in decomposition process through the time and number of Oviposition, which were affected by environmental temperature. finally Clothed bodies have reached the skeleton stage earlier compared to the samples without clothes.

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