

# To Examine the Entomological Evidences of Goat's Flesh for Examining the Changes Observed on Different Pieces of Meat Placed in Different Places through Life Cycle of Insects

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**Abstract:** This study is one of the important study which will help us out to study the difference in life cycle of insects along with difference in different types of insects if different person dies in different environment and at different places. This study will help more in the field of forensic entomology as study of this study majorly focuses on the changes occurring on dead body due to insects at two different places which are away from each other and differs in environmental conditions and also differ in case of varieties of insects found at the different places. This study is done at two places of Madhya Pradesh State which are Mandasaur and Indore and these places are 250km away from each other. We need to study the differences on entomological evidences in two compartments of four parts each. This study will add few more advancements in the field of forensic entomology and forensic science.

**Keywords:** Forensic entomology, life cycle of insects, entomological evidences, forensic science.

## 1. Introduction

Forensic entomology is the study of insects and other arthropods found on a corpse and are used to solve crime especially in medico-legal cases. Forensic Entomology is the use of insects and other arthropods that feed on decaying remains to aid legal investigations [1].

### Forensic Entomology – Introduction

According to Univ. of FL Professor and Forensic Entomologist Dr. Jason Byrd,

□ "Forensic Entomology is the use of the insects, and their arthropod relatives that inhabit decomposing remains to aid legal investigations. The broad field of forensic entomology is commonly broken down into three general areas: medicolegal, urban, and stored product pests."

- **Medicolegal:** Typically the need is to determine the postmortem interval or the time since death occurred. This typically involves the collection of necrophagous feeding insects at the scene followed by ascertaining the stage of the insects' life cycles.
- **Urban:** This aspect of entomology has two aspects: civil and legal. The former reflects the damage that insects cause to property and crops. From a legal perspective, the insects leave bite marks that must be interpreted correctly.
- **Stored products:** This relates to insects found in foodstuffs.

Bernard Greenberg is regarded as the father of modern Forensic Entomology [2].

### History of Forensic Entomology



- Sung Tz'u (1235 AD) – Chinese "death investigator" wrote "*The Washing Away of Wrongs*".
- First forensic entomology case recorded -

A murder by slashing occurred in a village, and the local death investigator was ordered to solve the crime. The investigator had all villagers bring their sickles to one spot and lay them out before the crowd. Flies were attracted to one of the sickles, probably because of invisible remnants of tissue still remaining on it, and the owner subsequently broke down and confessed to the crime.

Role of Forensic Entomologists are,

- 1) Identification of insects at various stages of their life cycle.
- 2) Collection and preservation of insects as evidence.
- 3) Determining an estimate for the post-mortem interval or PMI (the time between death and the discovery of the body) using factors such as insect evidence, weather conditions etc.
- 4) Testifying in the court to explain insect-related evidence found at a crime scene [3].

Forensically important insects:

Insects are ubiquitous in nature. Even if we don't see them, they are likely to be involved in crime scene. Entomologists can help forensic pathologist in determining TOD, by looking at the insects that are feeding on and around the body.

**Flies:** Flies are the first one to get attracted towards the dead bodies. Carrion Flies includes Calliphoridae (blow flies), Sarcophagidae (flesh flies) and Muscidae (house flies) and belong to order-Diptera. These are the most wide-spread and accurate insects for determining TOD.

**Beetles:** These are often found on old cadavers, or in dry conditions. Beetles includes Silphidae (Carrion beetles), Staphylinidae (Rove beetles) and Dermestids (Carpet beetles) and belong to order- Coleoptera.



| Time          | Temperature | Open Area   |   |   |  | Closed Area  |  |   |  |
|---------------|-------------|---|---|---|--|--|--|---|--|
|               |             | Container A   | Container B   | Container C   | Container D  | Container A'   | Container B'   | Container C'  | Container D'   |
| 6 hour, 2 pm  | 32°C        | Flies started feeding over the meat.  | Flies started to eat the meat .   | No changes are seen on meat piece.  | No changes are seen on meat piece.   | Flies are seen late on meat piece and less in number as compared to container A.   | Flies are seen late on meat piece and less in number as compared to container B but more than container A'.  | No changes are seen on meat piece.  | No changes are seen on meat piece.   |
| 12 hour, 8 pm | 22°C        | Ants are seen on meat pieces and around the meat.   | Ants are now seen on the surface of meat as well as in soil.  | Internal rotting of meat piece started.   | No changes are seen on meat piece.   | Ants are seen on the meat and around the meat piece.   | Ants are seen on the meat and around the meat piece are less than that in open area and container A'..   | No changes are seen on meat piece.  | No changes are seen on meat piece.   |
| 24 hour, 8 am | 19°C        | The eggs changes into larva with pungent smell along with very small flies over and on meat piece.              | Eggs of insects are seen on the meat surface and in soil and are more in numbers than container A along with small flies on and over the meat piece and more than on container A. | Internal rotting is increased and pungent smell is also felt.   | Foul smell and internal rotting of meat piece started.   | Eggs are seen on the meat piece and pungent smell is felt and small flies are also seen on meat piece but are less than that in open area.                   | Eggs are seen on the meat piece and pungent smell is felt and small flies are also seen on meat piece but are less than that in open area.                 | Internal rotting started and pungent smell is felt.   | Foul smell and internal rotting of meat started.   |
| 36 hour, 8 pm | 24°C        | 2 - 3 Worms are seen over meat and pungent smell increases and small flies are seen over and on the meat piece. | 6 – 8 worms are seen over meat surface and pungent smell is felt along with small flies.  | Internal rotting and pungent smell is increased.  | The outer layer of meat piece is cooked at a small extent due to warn weather and good conductance of aluminium. | Only 1 worm is seen over the surface of meat and pungent smell is increases and small flies are also seen on meat piece but are less than that in open area. | 2 – 3 worms are seen over the surface of meat and pungent smell increases and small flies are also seen on meat piece but are less than that in open area. | Rate of internal rotting increases with pungent smell but process is slower as compared to that in open area. | Due to close and dark room there will be no cooking of meat piece in aluminium foil but rotting and foul smell increases.              |
| 48 hour, 8 am | 20°C        | The Larval stage of Insect is visible and foul smell increases and small flies are seen as it is.               | The Larval stage of Insect is visible and foul smell increases and some parts of bones is seen as meat was consumed by some insects and small flies.                              | The carbon oils started to come out of the flesh due to internal rotting which results in a very bad pungent smell. | The cooking continues and pungent smell increases.   | Larval stage of Insect is seen and pungent smell is increases and small flies are also seen on meat piece but are less than that in open area.               | Larval stage of Insect is seen and pungent smell increases and small flies are also seen on meat piece but are less than that in open area.                | Rotting rate and pungent smell of meat piece increases.   | Internal rotting of meat piece continues and color of meat piece shed off due to its reaction with aluminium and foul smell increases. |

| Time          | Temperature | Open Area   |  |   |  | Closed Area  |  |  |  |
|---------------|-------------|---|--|---|--|--|--|--|--|
|               |             | Container A   | Container B  | Container C   | Container D  | Container A'   | Container B'   | Container C'   | Container D'   |
| 60 hour, 8 pm | 22°C        | The dark layer over the surface of meat is clearly visible along with pupae of Insect and increased foul smell and small flies are seen as it is. | Pupae stage of Insect are now seen over the surface of meat along with increment in foul smell and small flies.                    | The meat piece is mushy from outer surface and the coming out of oil level increases along with increment in pungent smell. | Small amount of oil came out of meat piece and is dark in color than meat piece of container C.                                    | Due to cold weather in dark room the surface is only rotten and pupae is seen on meat piece and small flies are also seen on meat piece but are less than that in open area.   | Pupae is seen on the meat piece as well as in soil and pungent smell increases and small flies are also seen on meat piece but are less than that in open area.  | Carbon oils came out of the meat piece and rate of rotting and pungent smell increases.  | Carbon oils in lighter color than that of in open area container D and of closed area container C' came out of meat piece with increased foul smell.                   |
| 72 hour, 8 am | 19°C        | Finally the life cycle of insect is completed and again insect is seen on meat piece and small flies are also visible..                           | Finally the life cycle of Insect is completed and again Insect is seen on meat along with increased pungent smell and small flies. | The meat is completely rotten and whole oil came out of meat piece and the pungent smell is completely worst.               | The meat piece is finally cooked at an small extent only from outer layer and pungent smell increases and outer layer became hard. | Finally the life cycle of insect is completed and again insect is seen on meat piece but the process was slow as compared to that in open area and less insects were there than that of container A and small flies are also seen on meat piece but are less than that in open area. | Finally the life cycle of Insect is completed and again Insect is seen on meat along with increased pungent smell and the smell felt in closed room is more pungent than in open area and small flies are also seen on meat piece but are less than that in open area. | The meat is completely mushy due to internal rotting and the pungent smell is increased and was very bad and oil came out of meat piece is less than that of oil in container C placed in open area. | The meat piece is finally rotten along with increment in bad pungent smell and coming out of oil of lighter color in less quantity than that of in container D and C'. |

A. Photographs of experiment at Mandsaur (place – I)

1) Open area





| Time          | Temperature | Open Area   |  |   |  | Closed Area  |   |   |  |
|---------------|-------------|---|--|---|--|--|---|---|--|
|               |             | Container A   | Container B  | Container C   | Container D  | Container A'   | Container B'  | Container C'  | Container D'   |
| 6 hour, 2 pm  | 24°C        | Flies started feeding over the meat.  | Flies started to eat the meat.   | No changes are seen on meat piece.  | No changes are seen on meat piece.   | Flies are seen late on meat piece and less in number as compared to container A.             | Flies are seen late on meat piece and less in number as compared to container B but more than container A'. | No changes are seen on meat piece.  | No changes are seen on meat piece.   |
| 12 hour, 8 pm | 16°C        | Ants are seen on meat pieces and around the meat.   | Ants are now seen on the surface of meat as well as in soil.   | Internal rotting of meat piece started.   | No changes are seen on meat piece.   | Ants are seen on the meat and around the meat piece.   | Ants are seen on the meat and around the meat piece are less than that in open area and container A'.       | No changes are seen on meat piece.  | No changes are seen on meat piece.   |
| 24 hour, 8 am | 14°C        | The eggs changes into larva with pungent smell along with very small flies over and on meat piece.              | Eggs of insects are seen on the meat surface and in soil and are more in numbers than container A                                    | Internal rotting is increased and pungent smell is also felt.   | Foul smell and internal rotting of meat piece started.   | Eggs are seen on the meat piece and pungent smell is felt.                                   | Eggs are seen on the meat piece and pungent smell is felt.  | Internal rotting started and pungent smell is felt.   | Foul smell and internal rotting of meat started.   |
| 36 hour, 8 pm | 17°C        | Mites are seen over meat and pungent smell increases.   | Mites are seen over meat surface and pungent smell is felt.  | Internal rotting and pungent smell is increased.  | The outer layer of meat piece is cooked at a small extent due to warm weather and good conductance of aluminium. | Mites are seen over the surface of meat and pungent smell is increases.                      | Mites are seen over the surface of meat and pungent smell increases.  | Rate of internal rotting increases with pungent smell but process is slower as compared to that in open area. | Due to close and dark room there will be no cooking of meat piece in aluminium foil but rotting and foul smell increases.                            |
| 48 hour, 8 am | 12°C        | The Larval stage of Insect is visible and foul smell increases.   | The Larval stage of Insect is visible and foul smell increases and some parts of bones is seen as meat was consumed by some insects. | The carbon oils started to come out of the flesh due to internal rotting which results in a very bad pungent smell.         | The cooking continues and pungent smell increases.   | Larval stage of Insect is seen and pungent smell is increases.                               | Larval stage of Insect is seen and pungent smell increases.   | Rotting rate and pungent smell of meat piece increases.   | Internal rotting of meat piece continues and color of meat piece shed off due to its reaction with aluminium and foul smell increases.               |
| 60 hour, 8 pm | 18°C        | The dark layer over the surface of meat is clearly visible along with pupae of Insect and increased foul smell. | Pupae stage of Insect are now seen over the surface of meat along with increment in foul smell.                                      | The meat piece is mushy from outer surface and the coming out of oil level increases along with increment in pungent smell. | Small amount of oil came out of meat piece and is dark in color than meat piece of container C.                  | Due to cold weather in dark room the surface is only rotten and pupae is seen on meat piece. | Pupae is seen on the meat piece as well as in soil and pungent smell increases.                             | Carbon oils came out of the meat piece and rate of rotting and pungent smell increases.                       | Carbon oils in lighter color than that of in open area container D and of closed area container C' came out of meat piece with increased foul smell. |

| Time          | Temperature | Open Area  |   |   |  | Closed Area   |   |  |  |
|---------------|-------------|--|---|---|--|---|---|--|--|
|               |             | Container A  | Container B   | Container C   | Container D  | Container A'  | Container B'  | Container C'   | Container D'   |
| 72 hour, 8 am | 14°C        | Finally the life cycle of insect is completed and again insect is seen on meat piece along with increase in pungent smell. | Finally, the life cycle of Insect is completed and again Insect is seen on meat along with increased pungent smell. | The meat is completely rotten and whole oil came out of meat piece and the pungent smell is completely worst. | The meat piece is finally cooked at an small extent only from outer layer and pungent smell increases and outer layer became hard. | Finally, the life cycle of insect is completed and again insect is seen on meat piece but the process was slow as compared to that in open area and less insects were there than that of container A. | Finally, the life cycle of Insect is completed and again Insect is seen on meat along with increased pungent smell and the smell felt in closed room is more pungent than in open area. | The meat is completely mushy due to internal rotting and the pungent smell is increased and was very bad and oil came out of meat piece is less than that of oil in container C placed in open area. | The meat piece is finally rotten along with increment in bad pungent smell and coming out of oil of lighter color in less quantity than that of in container D and C'. |

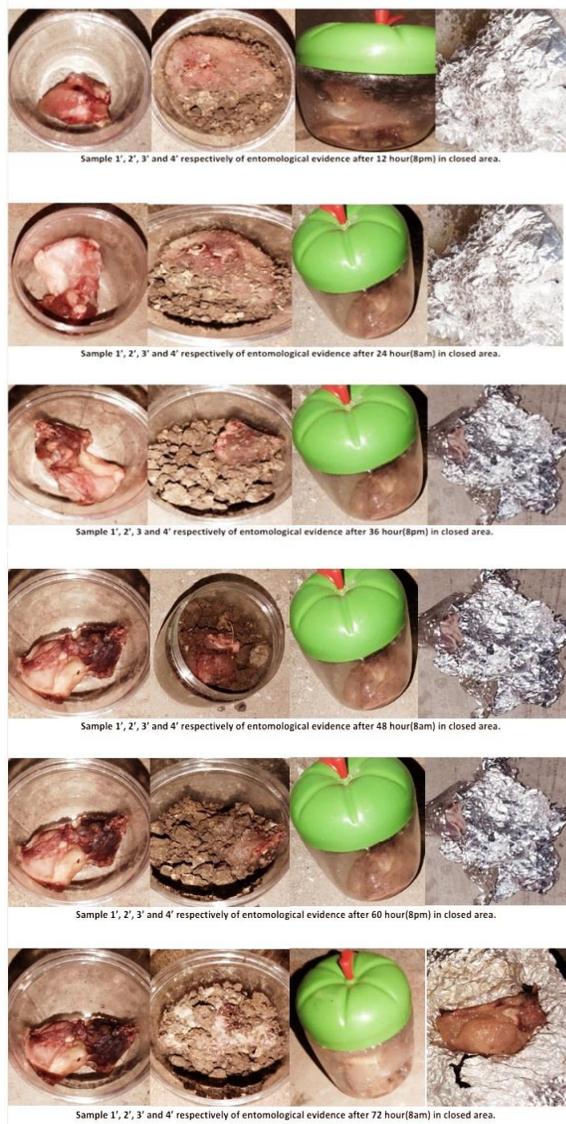
**B. Photographs of experiment at Indore (place – II)**

**1) Open area**



**2) Closed area**





### 3. Result of the Experiment

#### A. Table 1 - At place I – Mandasaur

##### 1) Open area

1. In the container A, on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and than at last worms were seen at 36th hour. The eggs were seen after 24th hour and the Larval stage was seen at 48th hour and pupae was seen at 60th hour and at last again at 72nd hour at different temperatures along with foul smell we had seen insects and due to warm and cold climatic conditions of day and night simultaneously the outer layer of meat becomes dark and less number of insects were seen on that container and some small flies are visible on the surface of meat and flying over the meat piece.
2. In the container B, on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and than at last worms were seen at 36th hour. The eggs were seen after 24th hour and the Larval stage was seen at 48th hour and pupae was seen at 60th hour and

at last again at 72nd hour at different temperatures along wit foul smell, we had seen insects and more number of insects were found on this container as compared to container A because due to presence of soil the proper habitat of Insect is present in that container and also a small portion of meat was also eaten up by the insects and a large part of bone which was covered by the layer of meat at initial level was visible and small flies are also seen on the surface of meat piece, around the meat and in the soil and flies are more in number as compared to that of container A.

3. In the container C, the meat was rotten and foul smell is felt and due to its packing, the insects were not entered in that container and as nothing is exchanged in container and environment so internal rotting of meat piece is seen in that container.
4. In the container D, the meat was rotten along with foul smell and due to heat in day and good conductivity of aluminium foil, the meat piece was cooked up to some extent after 72nd hour.

The photographs of each and every meat piece with proper dimensions at different time intervals along with the difference in temperature was noted in the observation table as specified in the above table 1.

##### 2) Closed area

1. In the container A', on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and then at last worms were seen at 36th hour. The eggs were seen after 24th hour and the Larval stage was seen at 48th hour and pupae was seen at 60th hour and at last again at 72nd hour at different temperatures along with foul smell we had seen insects and less number of insects were seen on that container than in open area and small flies are also seem on the meat piece and over the meat piece but are less in number than that of open area.
2. In the container B', on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and than at last worms were seen at 36th hour. The eggs were seen after 24th hour and the Larval stage was seen at 48th hour and pupae was seen at 60th hour and at last again at 72nd hour at different temperatures along with foul smell, we had seen insects and more number of insects were found on this container as compared to container A' because due to presence of soil the proper habitat of Insect is present in that container but insects were less than that in open area and small flies are also seen on the meat piece, in the soil and over the meat piece are more in number than that of container A' but less in number than that in open area.
3. In the container C', the meat was rotten and foul smell is felt and due to its packing, the insects were not entered in that container and as nothing is exchanged in container and environment so internal rotting of meat piece is seen in that container and was less than that in open area.

4. In the container D', the meat was rotten and foul smell was felt but in closed room the meat was not cooked as it was cool as compared to open area.

The photographs of each and every meat piece with proper dimensions at different time intervals along with the difference in temperature was noted in the observation table as specified in the above table 1.

#### B. Table 2 - At Place II – Indore

##### 1) Open area

1. In the container 1, on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and at last mites were seen at 36th hour but worms were not seen. The eggs were seen after 24th hour and the Larval stage was seen at 48th hour and pupae was seen at 60th hour and at last again at 72nd hour at different temperatures along with foul smell we had seen insects and due to cold climatic conditions the layer of meat became hard as compared to that of container A and less number of insects were seen on that container.
2. In the container 2, on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and then at last mites were seen at 36th hour. The eggs were seen after 12th hour and the Larval stage was seen at 24th hour and pupae was seen after 48th hour and at last again at 72nd hour at different temperatures along with foul smell, we had seen insects and more number of insects were found on this container as compared to container 1 because due to presence of soil the proper habitat of Insect is present in that container and also a small portion of meat was also eaten up by the insects and a part of bone covered by the meat at initial level was visible.
3. In the container 3, the meat was rotten and foul smell is felt and due to its packing, the insects were not entered in that container and as nothing is exchanged in container and environment so internal rotting of meat piece is seen in that container.
4. In the container 4, the meat was rotten along with foul smell and due to cold climate and less warm environment and good conductivity of aluminium foil, the meat piece was less cooked than that of container D and the meat piece was hard from outside and rotten from inside after 72nd hour.

The photographs of each and every meat piece with proper dimensions at different time intervals along with the difference in temperature was noted in the observation table as specified in the above table 2.

##### 2) Closed area

1. In the container 1', on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and at last mites were seen at 36th hour but worms were not seen. The eggs were seen after 24th hour and the Larval stage was seen at 48th hour and pupae was seen at 60th hour and at last again at 72nd hour at different temperatures along with foul smell we had

seen insects and due to cold climatic conditions the layer of meat became hard as compared to that of container A' and less number of insects were seen on that container than that of container 1 as container 1' is placed in closed area.

2. In the container 2', on the meat piece first of all house flies were came first at 6th hour and then the ants at 12th hour and then at last mites were seen at 36th hour. The eggs were seen after 12th hour and the Larval stage was seen at 24th hour and pupae was seen after 48th hour and at last again at 72nd hour at different temperatures along with foul smell, we had seen insects and more number of insects were found on this container as compared to container 1' because due to presence of soil the proper habitat of Insect is present in that container and also a small portion of meat was also eaten up by the insects and a part of bone covered by the meat at initial level was visible but there were less insects in closed area as compared to open area.
3. In the container 3', the meat was rotten and foul smell is felt and due to its packing, the insects were not entered in that container and as nothing is exchanged in container and environment so internal rotting of meat piece is seen in that container.
4. In the container 4', the meat was rotten along with foul smell and due to cold climate and less warm environment and good conductivity of aluminium foil, the meat piece was less cooked than that of container D' and the meat piece was hard from outside and rotten from inside after 72nd hour.

The photographs of each and every meat piece with proper dimensions at different time intervals along with the difference in temperature was noted in the observation table as specified in the above table 2.

#### C. Hybrid result of Table 1 and Table 2

##### 1) Similarities

1. The universal rules of forensic entomology are not changed at both the places even though there were changes in environmental conditions.
2. Insect took the correct time of 72 hours to complete its first life cycle on to the entomological evidence at both places.
3. Insects came in the standard sequence on to the entomological evidence as per rules of entomology that first flies attack on dead organisms and then ants afterwards mites and worms and at last beetles. This sequence is correctly matched with the situation at both the places.
4. Insects have approached to only those evidences which are placed open in both open and closed area but the sealed or packed dead organism is out of reach of insects at both places.

##### 2) Differences

1. The different types of insects were seen at both the places like at place I worms were seen and at place II mites were seen on entomological evidence and small

flies are only visible at place I.

2. Even though to complete first life cycle that insect took 72 hours but due to environmental changes their time span of visibility of different stages of life cycle of insects was thoroughly changed with changes on dead body.
3. Environmental effects and difference in temperature have changed the experimental observation at both the places with difference in changes on dead body, insect approaching dead body and changes in amount of insects found at Place I and Place II along with differences in open and closed area of Place I as well as in open and closed area of Place II.
4. The distance between two places of experiment was 250 km due to which each and every conditions related to environment of dead body, habitat of insects and difference in temperatures is observed along with different observations in all the cases of Place I and Place II and in open and closed areas of that places and also within the evidences placed in open areas and as well as in closed areas of both the places.

#### 4. Conclusion

This experimental study helps us to prove that as the places of scene of crime changes, the environment, habitat and

climatic conditions of places get changed along with change in presence of different types of insects along with the presence of specific type of Insect at specific place and each and every insect have a different life cycles and due to changes in environment also the life cycle of arthropods changes and thus we can conclude that a small amount of single change in distance, environment and climatic condition of scene of crime the life cycle of Insect changes and specific area have an abundance of adequate type of Insect as per location of scene of crime but the universal principles of forensic entomology never changes such as duration of life cycle of each and every arthropod and forensic importance of insects in entomological cases in forensic entomology.

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