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A comparative study of the decomposition of pig carcasses in a methyl methacrylate box and open air conditions

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ABSTRACT

Analysis of the process of decomposition is essential in establishing the postmortem interval. However, despite the fact that insects are important players in body decomposition, their exact function within the decay process is still unclear. There is also limited knowledge as to how the decomposition process occurs in the absence of insects. In the present study, we compared the decomposition of a pig carcass in open air with that of one placed in a methyl methacrylate box to prevent insect contact. The pig carcass in the methyl methacrylate box was in the fresh stage for 1 day, the bloated stage from 2 d to 11 d, and underwent deflated decay from 12 d. In contrast, the pig carcass in open air went through the fresh, bloated, active decay and post-decay stages; and 22.3 h (0.93 d), 62.47 h (2.60 d), 123.63 h (5.15 d) and 246.5 h (10.27 d) following the start of the experiment respectively, prior to entering the skeletonization stage. A large amount of soft tissue were remained on the pig carcass in the methyl methacrylate box on 26 d, while only scattered bones remained on the pig carcass in open air. The results indicate that insects greatly accelerate the decomposition process.

1. Introduction

Putrefaction is a transformative and destructive phenomenon that is caused by the combined action of anaerobic bacteria from the corpse and aerobic bacteria in the environment.[1] Carcass decomposition is a complex process influenced by many biotic and abiotic factors, including autolysis of individual cells by internal chemical breakdown, tissue autolysis from liberated enzymes, and further tissue breakdown from external processes introduced by intestinal/environmental bacteria and arthropods. Decomposition is a continuous process, beginning at the time of death and ending when the body has been reduced to a skeleton. Understanding the process of corpse decomposition is essential to estimating postmortem interval in a death case.

Necrophagous invertebrates are responsible for the majority of vertebrate carcass decomposition,[2–4] composing part of the "necrobiome".[5] The necrobiome consists of microbes (e.g., bacteria, fungi, and protists), insects, and vertebrate consumers that utilize carrion as a resource for feeding, breeding, and as a habitat. While there is abundant research on various types of insects and their role in the decomposition process as it relates to determination of the postmortem interval (PMI), studies that evaluate the decomposition process in the absence of insects are rare.

In the present study, a pig carcass was placed in an enclosed container to artificially protect the carcass from arthropods (mainly insects). The putrefactive changes were observed and compared with the decomposition of the pig carcass that was placed in open-air conditions, providing information about the relationship between arthropods and the putrefaction and decomposition of carcass.

2. Materials and methods

This study was conducted in 2006 in the Panyu Forensic Autopsy Center (22°45′ N, 113°14′ E) of Guangzhou, South China. All animal studies were approved by the Institutional Animal Care and Use Committee (IACUC) and carried out under the policies of Soochow University. The study site was located on a hill having shrubs and a ground cover of weeds. The pigs each weighing about 35 kg to be hogtied were transported into experiment place. The operations personnel with face mask poured about 30–50 ml ether to the folded thick towel and covered the mouth and nose of the pigs about 2–3 min using that towel until the pigs were fainted. Then the operations personnel used a hammer to hit the parietal-

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occipital brain regions to kill pigs. One pig (Pig A, PA) was placed in a 120 × 90 × 100 cm^3 methyl methacrylate box. The upper part of the left and right walls of the box was made of nylon mesh (60 mesh gauze), and the remaining surfaces were made of methyl methacrylate, with a sliding cover on the top. The other pig (Pig B, PB) was placed in open air and covered wire mesh (130 × 85 × 85 cm^3) to prevent dogs or other animals from accessing the carcass. The wire mesh cover had 5 cm openings on all surfaces except the bottom.

The two experiment sites were 50 m away. Both sites were in the shade to prevent exposure to direct sunlight. The species of vegetation, terrain features and shaded conditions were almost identical at the two sites. The carcasses were observed and photographed, and data was recorded twice a day. When inspecting PA, the surrounding insects were driven away before opening the sliding cover for observation and photography. Any insects entering the box during inspection were caught and killed. The insects on PB were collected with a net or beaker and returned to the laboratory for identification and storage. The temperature and relative humidity at the experiment sites was measured by an electronic thermohygrometer (ZDR-20, Hangzhou Zeda instruments Co. Ltd., China).

3. Results

3.1. Meteorological data

The average daily temperature during the experiment was 29.69 °C, and the relative humidity was 82.27% (Fig. 1).

3.2. Decomposition process of carcasses

The decomposition process of the two carcasses was markedly different; PA decomposed slowly and PB decomposed quickly (Fig. 2). Three stages, i.e., fresh stage, bloated stage, and the deflated decay stage could be identified from the decomposition of PA, and the durations were 0–1 d, 2–11 d, 12- 26 d respectively. There was still a large amount of soft tissues remaining on the carcass on 26d. A series of postmortem morphological changes including livor mortis, rigor mortis, algor mortis and greenish discoloration were observed in the decomposition process. Tissue liquefaction was observed on 3d, and lasted until the next stage. The carcass did not undergo obvious changes after the deflated decay stage, and the putrefactive liquids were significantly decreased.

PB underwent five discernable stages of decomposition, i.e., fresh, bloated, active decay, post-decay and skeletonization, occurring 22.3 h (0.93 d), 62.47 h (2.60 d), 123.63 h (5.15 d) and 246.5 h(10.27 d) hours (days) from the start of the experiment, respectively. There were no soft tissue present and only bones remaining on the carcass on 26d. The same postmortem morphological changes occurring on PA were also observed in the early phases of decomposition of PB. Large numbers of maggots could be observed throughout the body on third day.

3.3. Activity and succession of major arthropod species on the carcasses

There was no insect activity on PA. The adult flies laid a large amount of eggs through the nylon mesh (Fig. 3), which were cleared manually. Insect activities on PB obeyed the basic rule of forensic entomology, their succession pattern can be seen in Supplementary Material 1.

4. Discussion

The differences in the decomposition process of carcasses in enclosed and open-air conditions are mainly due to the presence or absence of insects. In the absence of arthropods, the decomposition of carrion was significantly delayed, which is consistent with previous studies.[6,7] Many abiotic, biotic and experimental factors can affect the rate of decomposition and insect succession on remains, including geographic location,[8,9] climatic conditions,[10,11] season,[12,13] habitat[14,15] and experimental design. Factors that also contribute to differences in decomposition rate include the cause of death or the treatment of the body after death, such as hanging,[16] burial,[6,17] burning,[18,19] wrapping or clothing.[20,21] Understanding the decomposition and insect succession models under these conditions is critical for accurate estimation of PMI.

The microbial community is another important factor influencing the decomposition of vertebrate corpses.[25,26] In this study, the handling of PA excluded insects and part of the microbial community, including microbes that are in the soil associated with decomposition and those that are carried by insects. However, the microbes on the skin, abdominal cavity and in the air still exist and are therefore an important source of potential decomposers. It is undeniable that microbial decomposition was inhibited in PA to some extent, however, we conclude that the presence or absence of insects is the crucial factor influencing the rate of decomposition in this study.

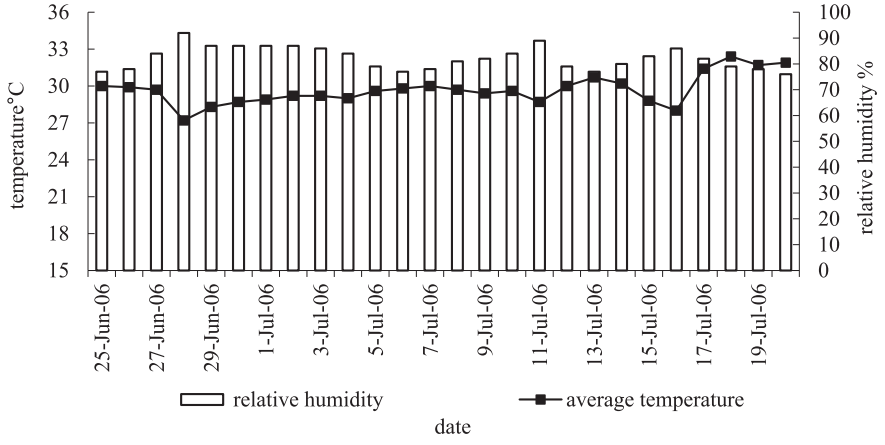

Fig. 1. Average daily temperature and relative humidity during the experimental period (June 25th, 2006 to July 20th, 2006).