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The suitability of visual taphonomic methods for digital photographs: An experimental approach with pig carcasses in a tropical climate

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ABSTRACT

In the context of increased scrutiny of the methods in forensic sciences, it is essential to ensure that the approaches used in forensic taphonomy to measure decomposition and estimate the postmortem interval are underpinned by robust evidence-based data. Digital photographs are an important source of documentation in forensic taphonomic investigations but the suitability of the current approaches for photographs, rather than real-time remains, is poorly studied which can undermine accurate forensic conclusions. The present study aimed to investigate the suitability of 2D colour digital photographs for evaluating decomposition of exposed human analogues (*Sus scrofa domesticus*) in a tropical savanna environment (Hawaii), using two published scoring methods; Megyesi et al., 2005 and Keough et al., 2017. It was found that there were significant differences between the real-time and photograph decomposition scores when the Megyesi et al. method was used. However, the Keough et al. method applied to photographs reflected real-time decomposition more closely and thus appears more suitable to evaluate pig decomposition from 2D photographs. The findings indicate that the type of scoring method used has a significant impact on the ability to accurately evaluate the decomposition of exposed pig carcasses from photographs. It was further identified that photographic taphonomic analysis can reach high inter-observer reproducibility. These novel findings are of significant importance for the forensic sciences as they highlight the potential for high quality photograph coverage to provide useful complementary information for the forensic taphonomic investigation. New recommendations to develop robust transparent approaches adapted to photographs in forensic taphonomy are suggested based on these findings.

1. Introduction

Accurate postmortem analysis and interpretation of human remains is crucial to forensic death investigations. In many forensic cases, human remains are subject to decomposition associated with extensive postmortem changes. Reaching postmortem conclusions, including the cause and manner of death, postmortem interval (PMI), and identification of the deceased, rely on the accurate interpretation of these changes (biophysicochemical characteristics) both at the death/decomposition scene and in laboratory [1–4]. This field of research and application is forensic taphonomy [5–7].

A number of methods were developed to evaluate and measure decomposition, including carbon dioxide release [7,8], gravesoil chemistry [9–11], RNA degradation [12–14], and mass loss [15–18]. Another approach [19] relies upon the appearance of gross postmortem changes, including to the hard and soft tissues, that are visually assessed and allocated a number (a score). This approach, commonly referred to as Total Body Score (TBS), has been used widely by forensic taphonomists because it possesses all of the traits of an ideal technique; it is readily available, cost-effective, rapid, and simple [20]. However, the reliability of TBS is influenced by a wide range of variables, including those linked with the methodology and the experimental conditions, that may undermine the accuracy of the postmortem conclusions [21–23]. It is thus very important that forensic taphonomy relies on evidence-based interpretations underpinned by robust methods [24–28].

Abbreviations: ADD, Accumulated Degree Day; ANOVA, Analysis of Variance; BDS, Body Decomposition Score; CI, Confidence Interval; FDS, Face Decomposition Score; HSD, Honest Significant Difference; ICC, Intra-class Correlation Coefficient; LDS, Limbs Decomposition Score; PMI, Postmortem Interval; SD, Standard Deviation; SE, Standard Error; TBS, Total Body Score

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Fig. 1. Decomposition of pig (*Sus scrofa domesticus*) carcasses in Palolo Valley, Oahu, Hawaii placed on stainless steel metal mesh (63.5 mm × 63.5 mm) and PVC frame to facilitate mass loss measurements throughout the duration of the experiment in Winter/Spring (February – April) after five hours postmortem when no visible changes could be observed (Fresh stage) (a). Bloating was observed by 30 h postmortem (Early decomposition) (b), with *rigor mortis* and widespread postmortem colour changes observed by 54 h postmortem (Early decomposition) (c). The abdomen of the black pig carcass ruptured by 54 h postmortem (Early decomposition) (d) and all carcasses supported numerous fly larvae (Early/Active decomposition) (e), which were observed from 30 h to approximately 10 days postmortem (252 ADD). Little mass loss (~7%) and gross postmortem change was observed after 11 days postmortem (279 ADD) (Advanced decomposition) (f).

The method developed by Megyesi et al. [19] after Galloway et al. [29] is a well-established approach to visually evaluate decomposition of human remains in a forensic context [30]. Although the method was developed from photographs, it is often applied in forensic reconstructions and empirical research for in situ remains, including non-human materials such as pigs, rabbits, and mice [31–37]. To the authors' knowledge, the suitability of the Megyesi et al. [19] method for these materials and contexts has not been validated yet. To date, it appears that only the study by Keough et al. [30] investigated the suitability of the Megyesi et al. method for exposed in situ pig remains and found significant differences between human and porcine decomposition processes in the early postmortem periods. Most forensic taphonomy studies focus on providing new data from various environments but there is a paucity of studies on the suitability of the available scoring methods for certain forensic contexts, including when photographs of the remains are used [22,23].

Specifically, there is a lack of research to test the suitability of taphonomic photography-based approaches in an experimental manner. However, photographs of the death/decomposition scene and the corpse itself are a standard documentation in forensic investigations [38–41] and can be the only available source of information when the actual remains are not accessible [19,29,42–46]. Because of this discrepancy between the knowledge base available and the current practice, the suitability of digital photographs to evaluate decomposition in lieu of the original remains is unclear, which can be problematic for forensic death investigation as any misevaluation of postmortem changes and PMI can hamper accurate forensic conclusions, including the positive identification of the deceased. Establishing the baseline for scoring decomposition from photographs is thus critical.

To address this gap in the knowledge, an experimental study was conducted to evaluate the applicability of two published taphonomic methods in pig remains (*Sus scrofa domesticus*), used as proxy for human corpses, under the following conditions: (i) in real-time and (ii) using digital colour photographs scored by observers. The aim of this study was not to validate the methods but to provide a baseline for scoring decomposition of exposed remains by evaluating the repeatability of decomposition body scores according to materials (carcass and photograph) and methods.

To achieve this objective, decomposition body scores were generated by two groups of observers, one based in the United States of America (USA), the other in the United Kingdom (UK). To meet the objective of setting a baseline for forensic taphonomy, this study attempted to be as close to real forensic cases conditions as possible, in which persons in charge of evaluating the decomposition stage of human corpses at death/decomposition scene (e.g. first responders and death investigators) can come from different backgrounds with various levels of education and experience in collecting evidence from dead bodies [45,47,48].

This research addresses two complementary questions: (i) Are the Megyesi et al. [19] and Keough et al. [30] methods suitable to evaluate pig decomposition from 2D colour digital photographs in lieu of real-time remains?; and (ii) are the decomposition body scores generated from the photographs consistent and reproducible between the two groups of observers? The research hypotheses considered here were