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Decomposition and insect succession of clothed and unclothed carcasses in Western Australia

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ABSTRACT

The effect of clothing on carcass decomposition and patterns of insect succession onto remains were investigated in two separate years during autumn in Western Australia. The progression of decomposition differed between clothed and unclothed carcasses in both years of the study. The presence of clothing markedly prolonged the wet decay stage in both years with larval feeding occurring across the moist skin surface underneath clothing, as well as within and under the carcasses. Ambient temperatures were higher in the second year of the study and corresponded to marginally faster rates of decay throughout decomposition. Within years, insect arrival and oviposition were largely consistent between clothed and unclothed carcasses with a few notable exceptions. The green blow fly, *Lucilia sericata* Meigen (Diptera: Calliphoridae) oviposited one day earlier on clothed than unclothed carcasses in both years of the study. The black carrion fly, *Australophyra rostrata* Robineau-Desvoidy, (Diptera: Muscidae) colonised clothed carcasses in two distinct waves of succession but only one wave of ovipoistion was observed on unclothed carcasses in either year. Correspondingly, clothed carcasses supported larval feeding by *A. rostrata* for a longer duration than unclothed carcasses. Finally, dipteran larval masses were more widely distributed across the carcass surface and were present for a longer period of time on clothed carcasses than on unclothed carcasses in both years. Forensically relevant data detailing the seasonal pattern of insect succession onto clothed and unclothed decomposing remains in Western Australia are reported.

1. Introduction

The establishment of a post-mortem interval (PMI) of victims of unexplained death is a vital step in many forensic investigations [1,2]. Knowledge of the biology, behaviour and distribution of insect species found in association with decomposing remains has proven invaluable to investigators as a tool in helping establish PMI and/or indicating post-mortem movement of the body [3–5]. Decomposing remains represent a temporary, changing habitat, offering both food and shelter resources to numerous arthropod species. The activity of the insect species that utilise this resource gradually alters the state of the carcass, such that different species are attracted to, and colonise remains at different time periods and stages of decomposition [6,7]. The timing of insect colonisation, development and eventual departure from decomposing remains is a predictable and orderly process for a given set of conditions and is closely linked to the progression of carcass decomposition [5,7,8]. Entomological estimates of PMI are typically based on known patterns of insect succession and the developmental age of immature insects collected from the body [4]. As such, understanding the factors that affect decomposition and the associated arrival and departure of insects colonising remains is key to the accuracy of entomological estimates of time since death [9].

Many abiotic and biotic factors influence the rate of decomposition and insect succession onto remains including geographic location [9–11], climatic conditions [12,13], season [14,15], habitat [16–18], the physical state of the remains [19] and the decomposition environment [20–23]. Therefore, entomological estimates of PMI require baseline reference data detailing the expected pattern of insect succession onto decomposing remains for a given set of parameters. Problems arise when the research conditions under which succession data are collected do not match the specifics of the investigated death scene. Given the wide range of death scene scenarios encountered by forensic investigators there is a clear dissociation between the available succession data and the applicability of these data to forensic casework.

One of the main factors contributing to variation in the pattern of insect succession onto remains is the degree of insect access to the body [24]. When a body decomposes in an enclosed environment or is wrapped in some way, carcass attendance by individual insect species may be delayed or prevented, altering the timing and expected pattern of insect succession [21,23,25]. The

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rate of decomposition can also be affected by a reduction in insect numbers due to the slower removal of total biomass through larval feeding [24].

A common death scenario is the decomposition of clothed human remains, yet the influence of clothing on decomposition has received limited attention and is mainly focused on soil burial as opposed to surface decomposition [26,27]. The data that are available are geographically specific and often inconsistent. Reports indicate that the presence of wrapping or clothing can have different effects on decomposition rate, either slowing or accelerating decomposition. Clothing can act as a barrier to colonising insects and thus delay insect succession and slow decomposition [26]. For instance, Goff [21] reported that wrapping a body in layers of blankets can cause a delay of up to several days in blow fly invasion of a corpse by reducing access to the body. Conversely, clothing can also accelerate the decay process by slowing down postmortem body cooling and providing a favourable micro-environment for insect development [9]. Clothing can offer protection from ambient conditions (wind, direct sunlight, and rain) and predators [24]. The micro-environment beneath clothing can be warmer and more humid than ambient conditions of exposed carcasses, resulting in greater insect diversity, abundance and feeding activity and consequently increasing the rate of decomposition [9,24,28].

Insect succession patterns associated with clothed carcasses can also change as a consequence of the altered carcass state. Carcasses can remain moist beneath clothing for longer periods than exposed carcasses and as such may be attractive to certain insect species that prefer wet environments [28,29]. Further, the fluid retention properties of most garments can also increase larval abundance and thus decomposition rate as clothing soaked in decomposition fluid can increase ovipositonal opportunities for blow flies [26]. Conversely, a recent work by Kelly et al. [29] in central South Africa reported no difference in insect succession patterns or the timing of blow fly oviposition between clothed and unclothed carcasses during warmer seasons (autumn and summer). Clothing and wrapping did, however, influence the rate of decomposition and biomass loss resulting in a prolonged period of advanced decay and reduced biomass loss [29].

Although there is the potential for variation in insect succession patterns on clothed and unclothed decomposing remains, at present, there are no available reference data for Australia detailing the affect of clothing on decomposition and insect succession. As the species that colonise decomposing remains and their behaviour can be geographically specific, data for the Australasian region are needed to address this gap in current knowledge. In particular, there is a paucity of data detailing the succession patterns of synanthropic flies associated with clothed carcasses. As such, this study aimed to investigate the effect of clothing on carcass decomposition and the linked succession of calliphorid flies during autumn in Western Australia. The decomposition and succession data associated with clothed and unclothed pig carcasses are compared.

2. Materials and methods

2.1. Study site

A study of pig (*Sus scrofa* Linneaus) decomposition was conducted at a wildlife reserve situated 23 km south of Perth, Western Australia (32° 10′S, 115° 50′E). The site encompassed 253 ha of coastal bushland, consisting of predominately jarrah (*Eucalyptus marginate* Donn ex Smith), marri (*Corymbia calophylla* Lindley), paperbark (*Melaleuca* spp.) and grass trees (*Xanthorrhoea* spp.).

The study was conducted during autumn and was repeated in two separate years, 2001 and 2003. Trials commenced on the 5th April 2001 and the 13th March 2003. The date of death was designated as day 0 and each trial ran for 98 days. Daily records of ambient temperature at the study site were recorded throughout the study using a Datataker DT50 data logger (Hinco Instruments, Canning Vale, WA, Australia). Records of ambient temperature, rainfall and humidity were also obtained from the closest Australian Bureau of Meteorology weather station to the study site (approximately 7 km; 32° 10′S, 115° 88′E).

2.2. Animal model

Ten freshly killed, 40–45 kg domestic pig carcasses (*S. scrofa*) were used as models for human decomposition. The domestic pig is the internationally preferred animal model for human decomposition [30]. Five carcasses were used in each year. At the start of each trial, pigs were sacrificed by captive head bolt. Following death, the head wound was immediately closed using a silicon sealant so that the wound did not present a focus for insect activity. Three carcasses were clothed and two were left unclothed per trial. Clothed carcasses were dressed in light-weight, loose cotton T-shirts and shorts with elastic waist bands. The two unclothed carcasses acted as controls. Carcasses were placed directly on the soil surface on their side, head facing east, legs facing north, in a partially shaded site, approximately 10 m apart. An abdominal probe inserted into the centre of the abdomen of each carcass, post-mortem, recorded changes in internal temperature of the cadaver via a connection to a Tinytag Plus® data logger (Hastings Data Loggers, Port Macquarie, NSW, Australia). All data loggers were programmed to record the minimum and maximum temperature at 30 min intervals. Pigs were protected from large animal

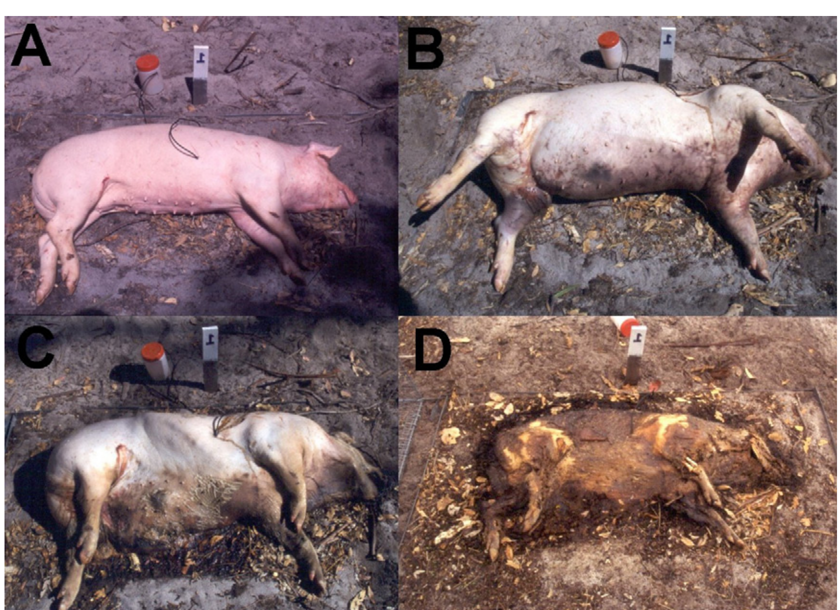

Fig. 1. Four defined stages of pig decomposition observed during the study: fresh (A), bloat (B), wet (C) and dry (D).