

UNIVERSITI TEKNOLOGI MARA

**NECROBIOME, SOIL CHEMISTRY
PROFILES, AND BONE DENSITY
ASSOCIATED WITH PENGUIN
(*PYGOSCELIS PAPUA* AND
PYGOSCELIS ANTARCTICUS)
CARCASSES UNDER ANTARCTICA
CLIMATE**

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ABSTRACT

Carrion acts as a nutrient pulse to the ecosystem. The carrion decomposition process involves breaking down organic materials through the activities of invertebrates, vertebrates, and microbes. Eventually, the nutrients from the decomposition process will be incorporated into the soil and contribute to the soil fertility. However, carrion decomposition research in Antarctica is still unexplored. Therefore, this study is the first to explore the carrion decomposition process under Antarctica's climates. This investigation aimed to document the necrobiome, soil chemistry profiles, bone density, and the correlation of the necrobiome and soil chemistry with the penguin species, stage of decomposition, and soil sampling location. Soil samples were collected from around and beneath penguin carrion at a penguin rookery Antarctic Specially Protected Areas 171 (ASPA 171) near King Sejong Station, Barton Peninsula, King George Island, Antarctica. Soil bacterial and fungal identification was conducted using Illumina MiSeq sequencing of the 16S rRNA and internal transcribed spacer (ITS) genes. The process of Sanger sequencing recognized arthropods, while nematodes were determined using morphological identification. Dry combustion methods were employed to detect soil nitrogen and sulphur for the analysis of soil chemistry profiles. Additionally, ammonia, nitrate, and phosphate levels were measured using a spectrophotometer through colourimetric analysis. Furthermore, the study also determined total carbon, pH, electrical conductivity, soil moisture, and soil porosity. Bone mineral density (BMD) and bone mineral content (BMC) was measured using a DEXA scanner. This study shows a low diversity of the necrobiome (arthropods, nematodes, bacteria and fungi), and no significant differences were found in the soil chemistry profiles of different decomposition stages around and beneath the penguin carrion. BMD and BMC between fresh and dry decomposition stages also shows no significant changes suggesting that the inhospitable conditions of Antarctica do not accelerate bone degradation. Meanwhile, correlation analysis shows variability between the necrobiome and soil chemistry with the penguin species, stage of decomposition, and soil sampling location, indicating that carrion presence influencing the chemical composition of the surrounding environment. This research serves as the first study to document the carrion decomposition process in Antarctica and offers insights into nutrient dynamics and bone preservation in extreme environments, with potential applications in ecology, microbiology, and governance. Thus, it offers important opportunities to advance both basic and applied perspectives of carrion ecology in Antarctica.

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CHAPTER 1

INTRODUCTION

1.1 Study Background

Carrion decomposition is a key component of ecosystem function and the recycling of energy and nutrients by organisms and their environment. Necromass takes a wide range of shapes, sizes, and qualities (Carter et al., 2007; Swift et al., 1979) which forms the basis of many food webs and is therefore important for ecosystem function (Gessner et al., 2010). The focal point for interactions and behaviors among decomposer species in complex communities also influences the ecosystems across different time and space scales (Yang et al., 2010).

The necrobiome refers to a group of both prokaryotic and eukaryotic species that are involved in the breakdown of organic matter, such as animal carrion and human corpses (Benbow et al., 2013). The necrobiome community consists of two groups of microbial populations: the thanatomicrobiome (Can et al., 2014; Hauther et al., 2015; Hyde et al., 2013, 2015) and the epinecrotic microbial community (Benbow et al., 2015; Dickson et al., 2011; Javan et al., 2016; Metcalf et al., 2016; Pechal et al., 2014; Pechal et al., 2013). Invertebrates such as Calliphoridae and Sarcophagidae are the first and most dominant, Diptera that colonise and decompose vertebrate remains (Mondor et al., 2012), followed by carrion beetles (Coleoptera: Silphidae), rove beetles (Coleoptera: Staphylinidae), hister beetles (Coleoptera: Histeridae), and dermestid beetles (Coleoptera: Dermestidae) (Mondor et al., 2012). Meanwhile, the nematode of Rhabditidae, *Oscheius tipulae*, dominates the necrobiome community during the advanced decay stages of decomposition (Benninger et al., 2008; Carter & Tibbett, 2008). Microorganisms, such as bacteria and fungi, have a significant impact on the movement of energy and matter within the environment. Bacteria found in soil and derived from deceased organisms and their immediate surroundings play a crucial role in breaking down animal remains into organic substances and necessary nutrients. Decomposers are highly efficient in consuming and converting deceased organic material, thus playing a crucial role in the structure and function of ecological systems (Benbow et al., 2019). Consequently, the ongoing investigation of the necrobiome community remains a significant focus in the decomposition process.