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Exploring the pathology of an epidermal disease affecting a circum-Antarctic sea star

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Over the past decade, unusual mortality outbreaks have decimated echinoderm populations over broad geographic regions, raising awareness globally of the importance of investigating such events. Echinoderms are key components of marine benthos for top-down and bottom-up regulations of plants and animals; population declines of these individuals can have significant ecosystem-wide effects. Here we describe the first case study of an outbreak affecting Antarctic echinoderms and consisting of an ulcerative epidermal disease affecting ~10% of the population of the keystone asteroid predator *Odontaster validus* at Deception Island, Antarctica. This event was first detected in the Austral summer 2012–2013, coinciding with unprecedented high seawater temperatures and increased seismicity. Histological analyses revealed epidermal ulceration, inflammation, and necrosis in diseased animals. Bacterial and fungal alpha diversity was consistently lower and of different composition in lesioned versus unaffected tissues (32.87% and 16.94% shared bacterial and fungal operational taxonomic units OTUs respectively). The microbiome of healthy stars was more consistent across individuals than in diseased specimens suggesting microbial dysbiosis, especially in the lesion fronts. Because these microbes were not associated with tissue damage at the microscopic level, their contribution to the development of epidermal lesions remains unclear. Our study reveals that disease events are reaching echinoderms as far as the polar regions thereby highlighting the need to develop a greater understanding of the microbiology and physiology of marine diseases and ecosystems health, especially in the era of global warming.

Emerging diseases in marine invertebrates seem to be increasing in prevalence, complexity, and sometimes virulence, concomitant with global climate change[1–5]. In addition to their direct impact on affected species, epizootics in marine invertebrates can have important ecological ramifications. For example, a mass die off of sea urchins in the Caribbean led to profound ecosystem shifts manifested by overgrowth of algae and subsequent secular declines in hermatypic corals[6]. The impact of marine diseases, especially in isolated regions, is difficult to investigate because of limited opportunities for long-term observations, especially if the immediate effects are sublethal or can be confounded by other ecological interactions (e.g., competition, predation)[5]. In other cases, epizootics occur too rapidly to be investigated or are not investigated at all[7,8]. Conceptually, diseases are the outcomes of susceptible hosts interacting with causative agents and the environment[9]. Some infectious diseases are polymicrobial, requiring the cooperation of several pathogens such as in black band disease in corals that involves primary sulfate-oxidizing cyanobacteria *Roseofilum reptotaenium* and secondary sulfate-reducing *Desulfovibrio* bacteria[10]. Confirming causation in marine invertebrate diseases can be challenging because of limited knowledge of host physiology and anatomy and difficulty in laboratory manipulation of agents associated with disease. For instance, many marine microbes cannot be cultured[3]. Against these backdrops, integrating multiple diagnostic methods

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