UPDATE ON SEA STAR WASTING DISEASE AND OTHER MARINE INVERTEBRATE DISEASES

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DISEASE IN THE MARINE ENVIRONMENT

Understanding and managing diseases in the marine environment has some distinct differences compared to terrestrial ecosystems. Specifically, marine ecosystems have a greater diversity of host phyla, they have higher microbial diversity, monoclonal organisms are more common, there are more classes of organisms that are involved in parasitic relationships, and the marine realm includes groups (potential hosts) like coral that have no terrestrial counterpart. Consequently, disease transmission dynamics and spread rates may be higher in marine systems when compared to terrestrial systems, and hosts in the ocean are predominantly invertebrates with short-lived, localized immunity dynamics.[1]

DISEASE IN MARINE INVERTEBRATES

Compared to marine mammals, marine birds, and marine fish of economic importance, we understand very little about diseases of marine invertebrates. Despite the fact that marine invertebrates represent the ocean's highest species diversity, other than coral diseases and diseases of harvested species or species that have other economic value, few marine invertebrate diseases have been identified or studied. The challenges or reasons behind this include limited access to identify epizootics (e.g. on a daily basis there are more people walking, hiking or bird watching than scuba dive), challenges accessing samples to study identified outbreaks, and limited funding. Several marine invertebrate disease outbreaks will be highlighted to identify these challenges and options for navigating these difficulties.

SEA STAR WASTING DISEASE

In the fall of 2013, divers from the Vancouver Aquarium reported an outbreak of wasting disease in several sea star species in Howe Sound, British Columbia (Canada). Affected sea stars show early signs of loss of turgor, which progresses to epidermal lesions, ruptures of the body wall, and loss of arms with ultimate carcass disintegration and death. Reports of this wasting syndrome spread and the disease has caused the mass mortality of over 20 star species from Alaska to Southern California. Relatively quickly after the onset of the outbreak, scientists using viral metagenomic investigations and experimental inoculation revealed a novel sea star-associated densovirus (SSaDV) as the most likely candidate virus associated with the disease.[2] With almost 29 different sea star species occurring within the region of the outbreak, it has been challenging to determine which species are most affected. One study, relying heavily on data collected by recreational scuba divers prior to and after the outbreak, showed that some species were so decimated by the outbreak that endangered species listing might be warranted, while populations of other species seemed to actually expand after the outbreak, presumably from a decrease in predation pressure or increase in prey availability.[3] Investigations also have show disease progression in one intertidal star species is exacerbated with elevated water and air temperatures.[4] Additional factors that may be involved in epizootic progression, including factors like innate host resistance, are still being investigated. Even as quickly as several years after this outbreak began, there have been dramatic increases in red (*Mesocentrotus franciscanus*) and green (*Strongylocentrotus droebachiensis*) urchin populations, causing concern that these increased numbers of grazers could potentially overgraze canopy-forming kelp.

OTHER NOTABLE MARINE INVERTEBRATE EPIZOOTICS

In some marine systems, invertebrates can be keystone species and their removal through disease epizootics can cause ecosystem-wide ramifications. One example is the near extirpation of a top predator, the intertidal sea star *Heliaster kubiniji* from Gulf of California, due to a devastating epizootic. This resulted in the expansion of a rock snail competitor, Morula ferruginosa and ecosystem-level changes. An infectious agent was likely responsible for the mass mortality of the black sea urchin, *Diadema antillarum* over an estimated an estimated 3.5 million square kilometers of Caribbean reefs with subsequent macroalgal cover of corals. Additionally, on the Atlantic coast of North America, an amoeba causes episodic mortality events in green sea urchins, which are important grazers.

CONCLUSION

Diseases in marine invertebrates are understudied but have the potential to have severe effects on marine ecosystem worldwide, especially when disease targets keystone species. Furthermore, climate change is going to warm waters, raise sea levels, and impact calcium secreting organisms through ocean acidification. Combined, these will likely increase the spread of hosts, pathogens and disease and rapidly change a system that currently is not even well understood. Using recreational scuba divers to collect data now via rigorous citizen-science programs that collect data on invertebrates (like that run by the REEF Environmental Education Foundation)[5,6] will help us identify epizootics early and hopefully enable us to better mitigate their impacts.

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