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Biogeography of Pathogens and Hosts: Tracking Prokaryotic and Eukaryotic Disease Agents

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Abstract

Biogeography—the study of the spatial distribution of organisms—has traditionally focused on plants and animals. However, pathogens, both prokaryotic (bacteria and archaea) and eukaryotic (fungi, protozoa, helminths), also exhibit distinct biogeographic patterns that are shaped by host availability, environmental conditions, and human activity. Understanding the biogeography of disease agents and their hosts is essential for predicting outbreaks, managing public health, and conserving biodiversity.

***Keywords:** Ethnic group comparison; Fidelity level; Decoctions and infusions; Botanical formulations*

Introduction

Pathogen biogeography refers to the spatial and temporal distribution of infectious agents across ecosystems. It encompasses: Host-pathogen interactions: Where and how pathogens infect hosts, Environmental reservoirs: Non-host habitats that support pathogen survival, Dispersal mechanisms: How pathogens move across landscapes, Evolutionary dynamics: How geographic isolation shapes pathogen diversity. This field integrates ecology, epidemiology, genomics, and climate science to track disease emergence and spread [1].

For example, Vibrio species thrive in warm coastal waters and are expanding poleward due to ocean warming. Similarly, Borrelia species, which cause Lyme disease, are spreading into higher latitudes as tick vectors expand their range. Prokaryotic pathogens, such as Mycobacterium tuberculosis, Vibrio cholerae, and Borrelia burgdorferi, are responsible for some of the most widespread

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infectious diseases [2].

Eukaryotic pathogens include fungi (Candida, Cryptococcus), protozoa (Plasmodium, Trypanosoma), and helminths (Schistosoma, Ascaris). For instance, Plasmodium falciparum, the agent of malaria, is restricted to tropical regions where Anopheles mosquitoes thrive. Climate change is expanding mosquito habitats, increasing malaria risk in previously unaffected areas [3].

The emergence of zoonotic diseases like Ebola, SARS, and COVID-19 highlights the importance of host-pathogen biogeography. Wildlife trade and habitat encroachment increase contact between humans and novel pathogens. The biogeography of these reservoirs and vectors is influenced by climate, land use, and ecological interactions. For example, tick-borne diseases are increasing in temperate regions due to warmer winters and changing host populations [4].

A recent global study mapped the biogeography of ATGs—genes that encode toxins used by microbes to compete with others. These genes were found to have habitat-specific distributions, with some clusters shared across multiple environments due to the adaptability of ATG-carrying species. This highlights the ecological importance of microbial competition and its role in shaping pathogen communities [5].

Conclusion

The biogeography of pathogens and hosts is a dynamic and interdisciplinary field that bridges ecology, medicine, and environmental science. As climate change, globalization, and land-use transformation accelerate, tracking the spatial patterns of prokaryotic and eukaryotic disease agents becomes increasingly urgent. By integrating genomic, ecological, and geographic data, researchers can better predict and mitigate the impacts of infectious diseases on global health and biodiversity.

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