Adaptation of human enterovirus to warm environments leads to resistance against chlorine disinfection

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Sunlight, temperature, and microbial grazing are among the environmental factors promoting the inactivation of viral pathogens in surface waters. Globally, these factors vary across time and space. The persistence of viral pathogens, and ultimately their ecology and dispersion, hinges on their ability to withstand the environmental conditions encountered. To understand how virus populations evolve under changing environmental conditions, we experimentally adapted echovirus 11 (E11) to four climate regimes. Specifically, we incubated E11 in lake water at 10 and 30 řC and in the presence and absence of sunlight. Temperature was the main driver of adaptation, resulting in an increased thermotolerance of the 30 řC adapted populations, whereas the 10 řC adapted strains were rapidly inactivated at higher temperatures. This finding is consistent with a source-sink model in which strains emerging in warm climates can persist in temperate regions, but not vice versa. A microbial risk assessment revealed that the enhanced thermotolerance increases the length of time in which there is an elevated probability of illness associated with swimming in contaminated water. Notably, 30 řC-adapted viruses also exhibited an increased tolerance toward disinfection by free chlorine. Viruses adapting to warm environments may thus become harder to eliminate by common disinfection strategies.
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