

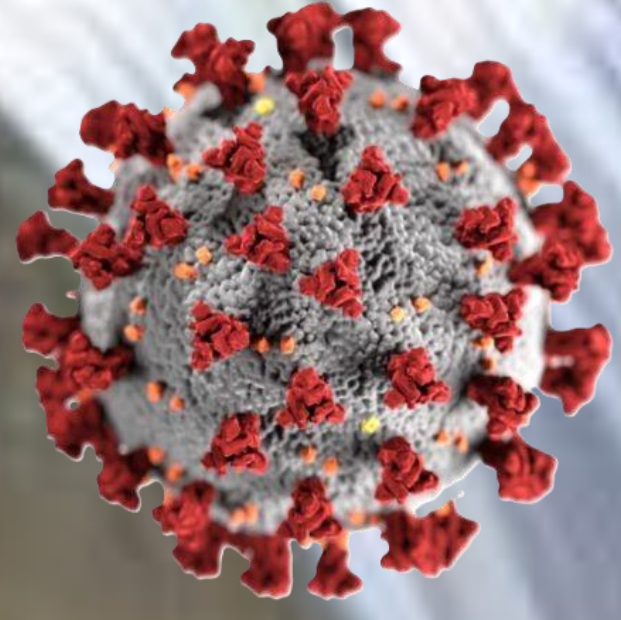
Wastewater genomics as a tool for SARS-CoV-2 surveillance and ecosystem health assessment under global change

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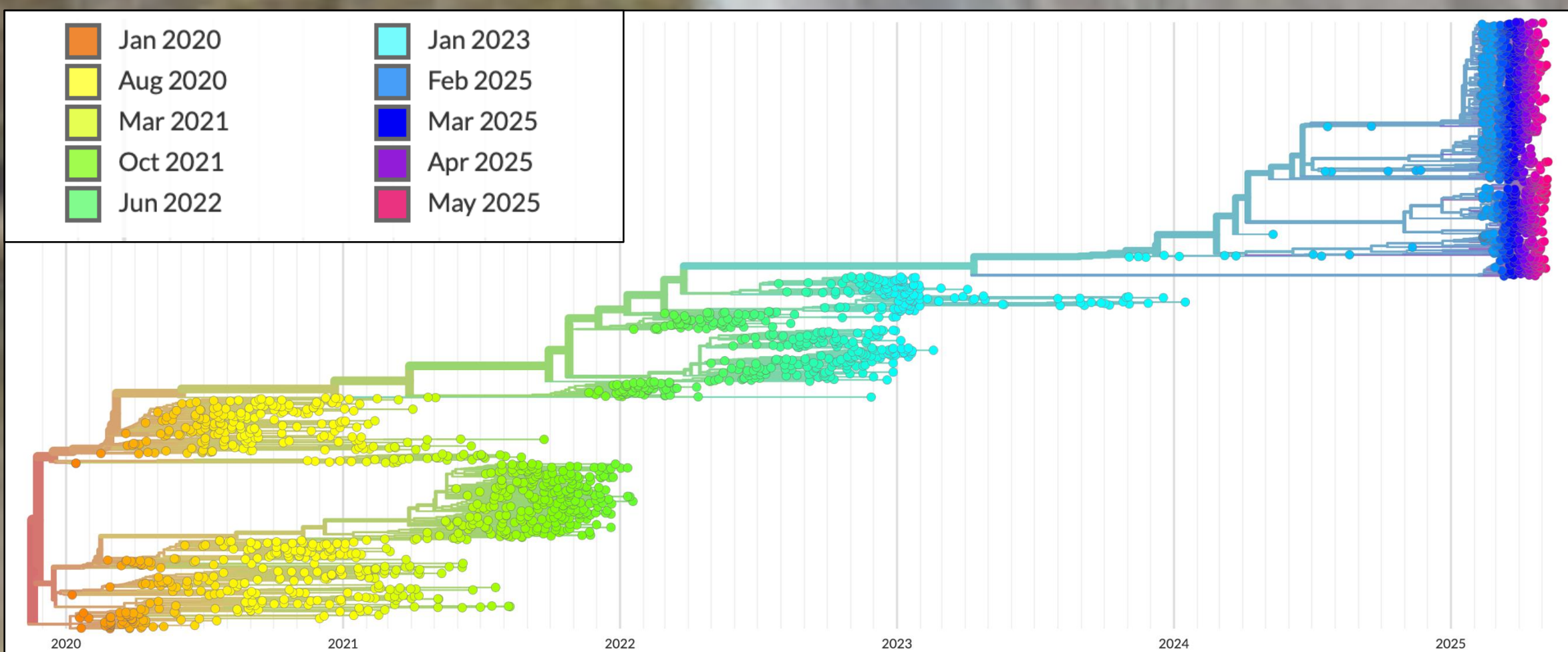
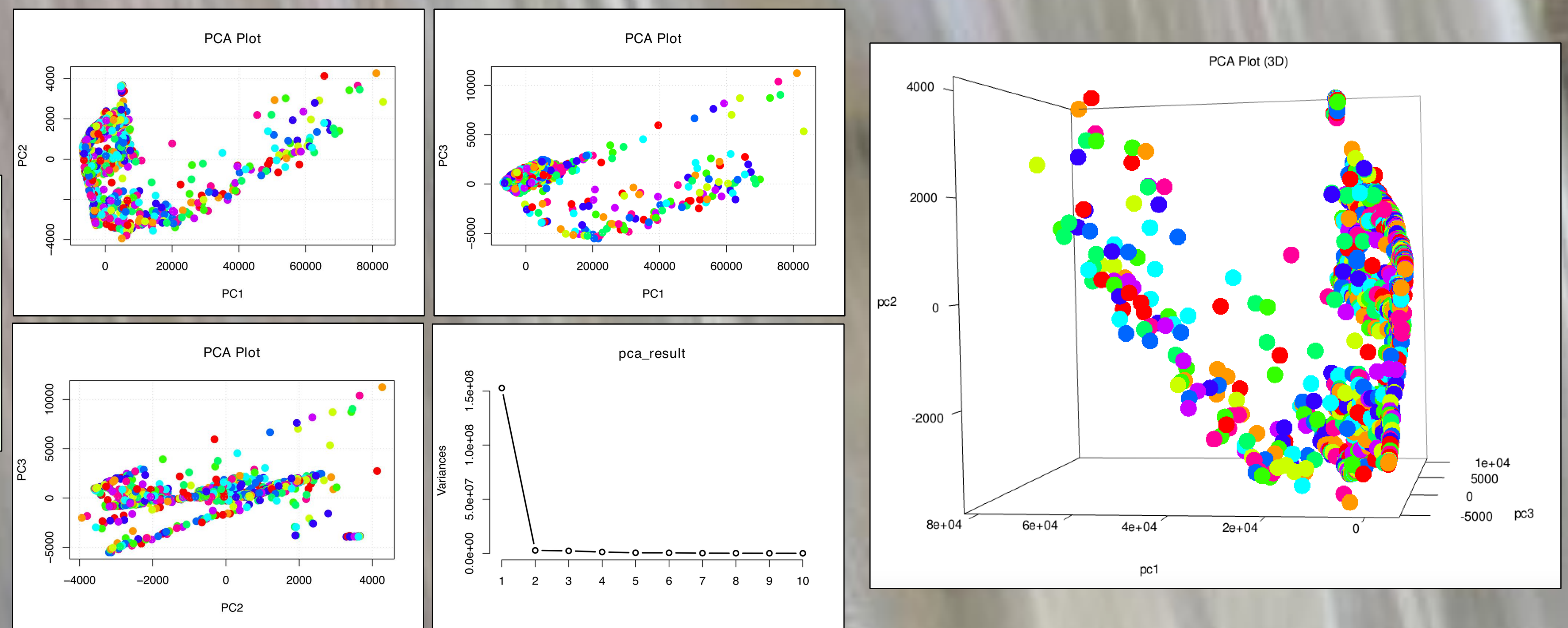
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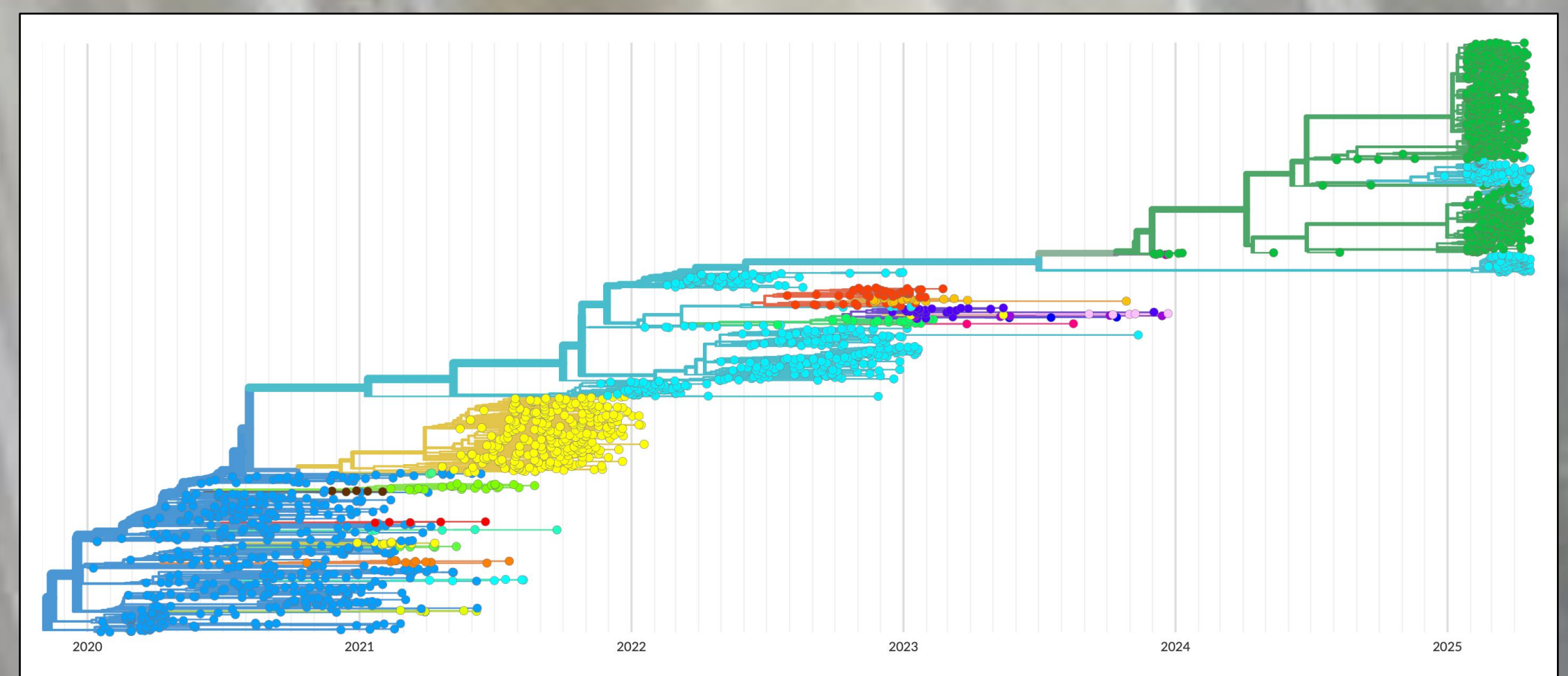


Wastewater and environmental water analysis is increasingly proving to be a non-invasive and effective method for monitoring. Bioinformatic analysis of genomic data enables early tracking of pathogens in populations and environments, often before the onset of clinical cases. This approach also provides valuable insights into the health status of aquatic ecosystems, serving as a proxy indicator of environmental integrity. In this context, the SARS-CoV-2 virus represents a particularly useful marker. Its excretion via both respiratory and gastrointestinal routes—including by asymptomatic and pre-symptomatic individuals—can serve as a valuable indicator.

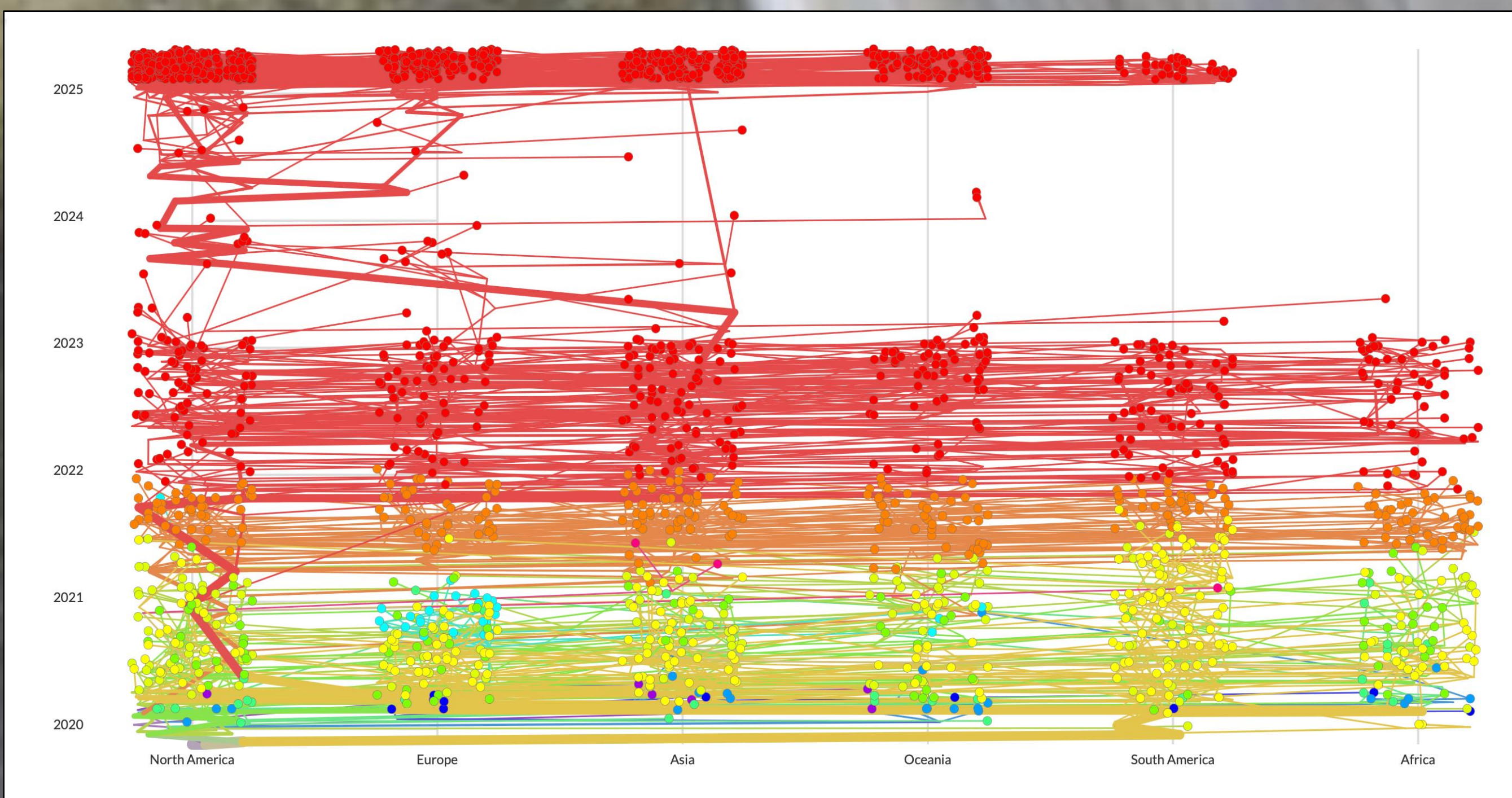
The PCA analysis of wastewater samples does not show any structuring based on geographic factors. The observed structuring is exclusively attributable to genetic variability, which groups evolutionary lineages based on common genetic mutations.



The phylogenetic tree constructed from wastewater samples reveals clustering based on sampling dates.



The phylogenetic tree constructed from human samples reveals clustering based on genetic factors.



The Scatter Plot generated by combining samples from wastewater and human isolates shows structuring based on sampling year and variant.

These results indicate that the distribution patterns of different SARS-CoV-2 variants found in wastewater are comparable to those observed in human samples. In both cases, no strict geographic or temporal structuring was detected, and clusters formed based on genetic similarities and mutations.

Wastewater surveillance is a multifunctional tool that serves as a sentinel for both environmental well-being and the health of aquatic animals. For this reason, continuous monitoring of aquatic ecosystems through genomic analysis is crucial, as pathogens present in wastewater can affect aquatic organisms, leading to disease and mortality. Moreover, since the microorganisms found in wastewater samples reflect those circulating among humans, wastewater analysis can also provide useful insights into human health.