

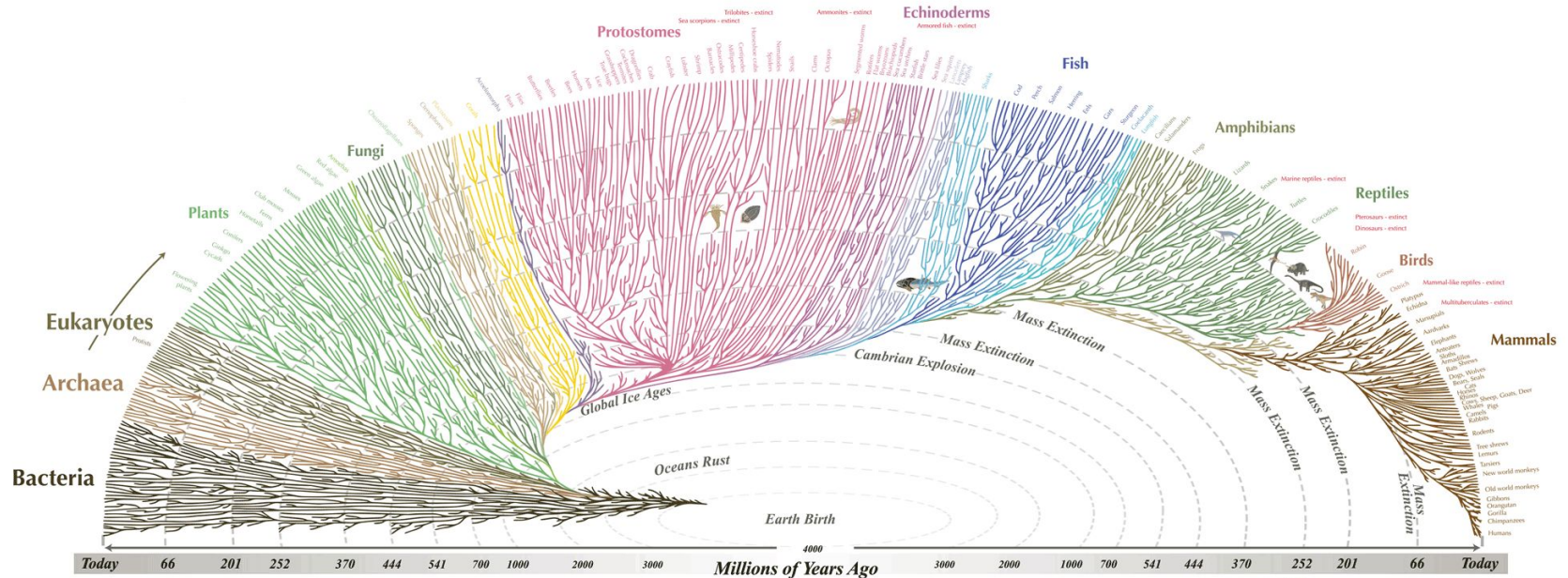
# ***Viruses across the Tree of Life***

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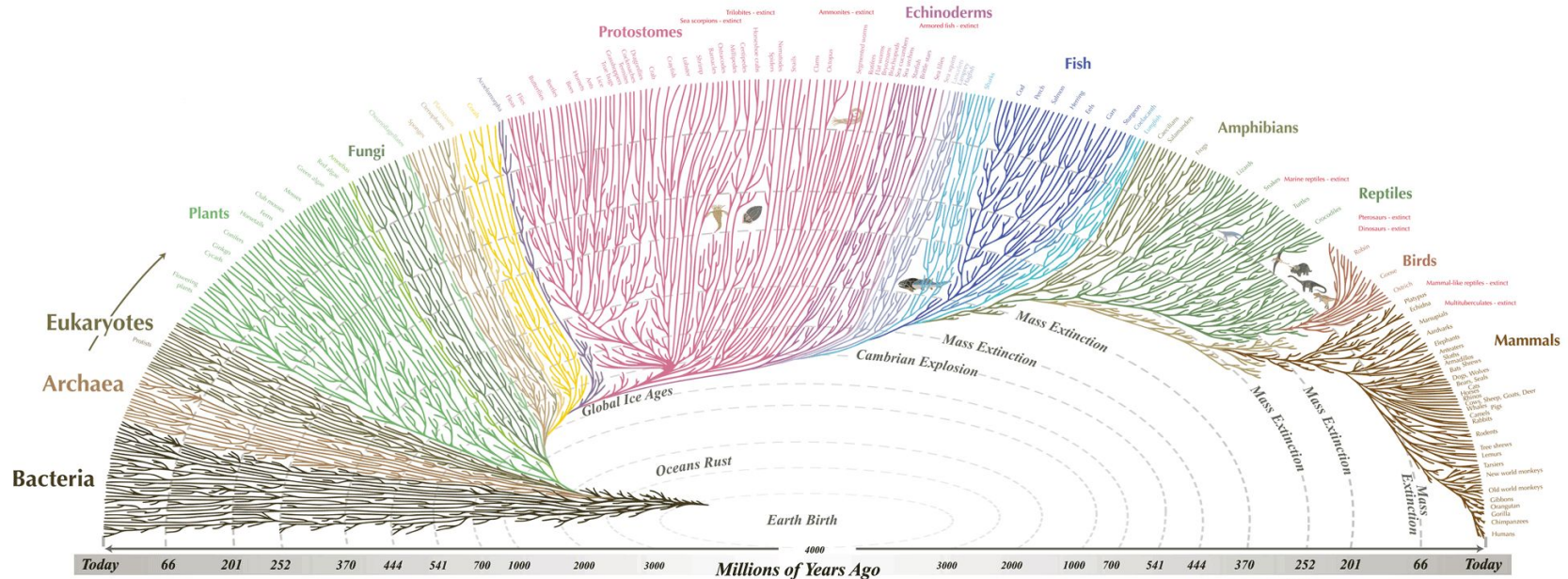
# The Tree of Life



All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: **Dinosaurs - extinct**

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# The Tree of Life Parasites



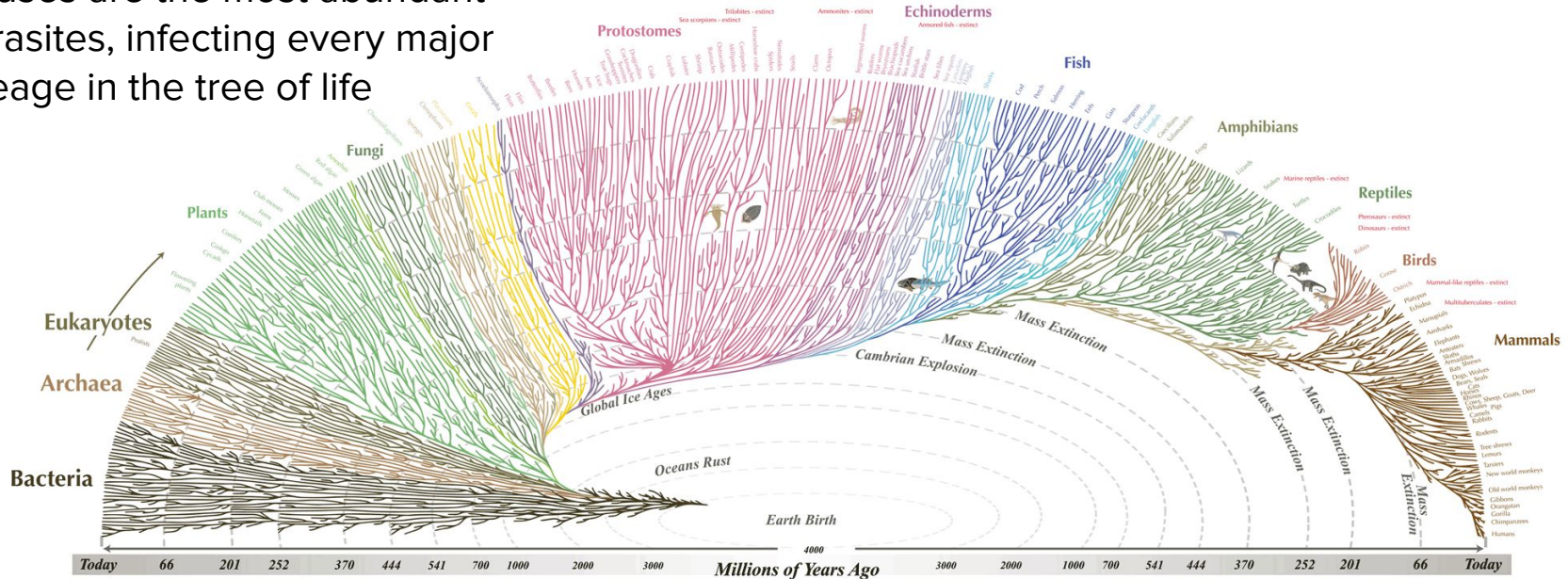
All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct



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# The Tree of ~~Life~~ Parasites

Viruses are the most abundant parasites, infecting every major lineage in the tree of life



All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: **Dinosaurs - extinct**

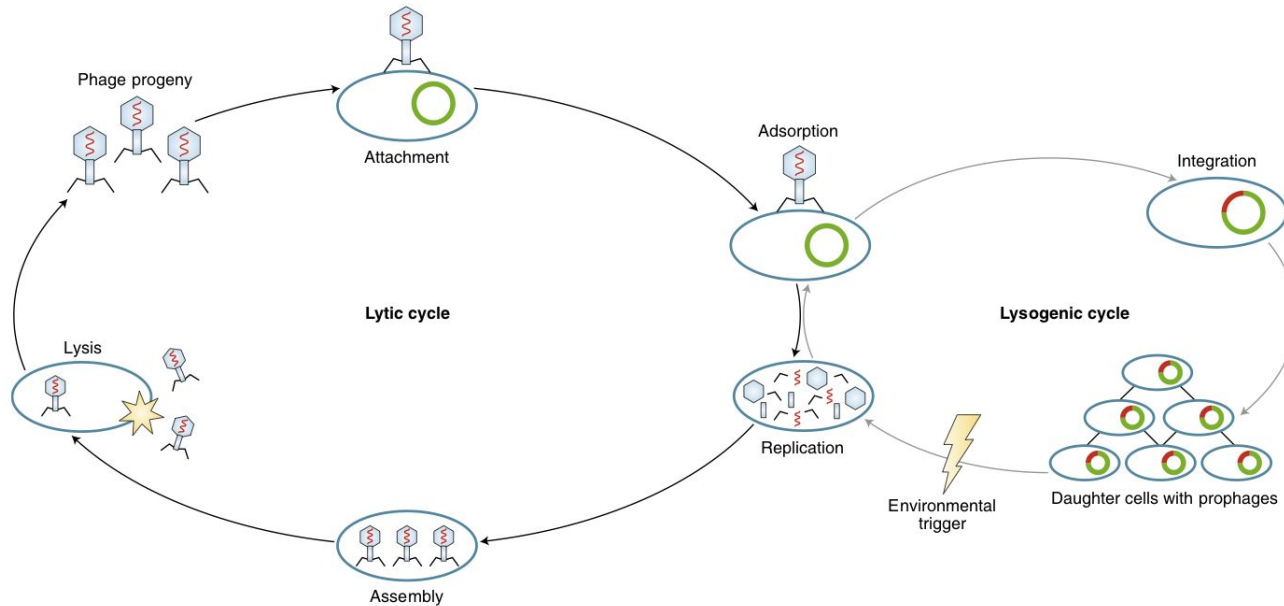
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# Viruses of bacteria



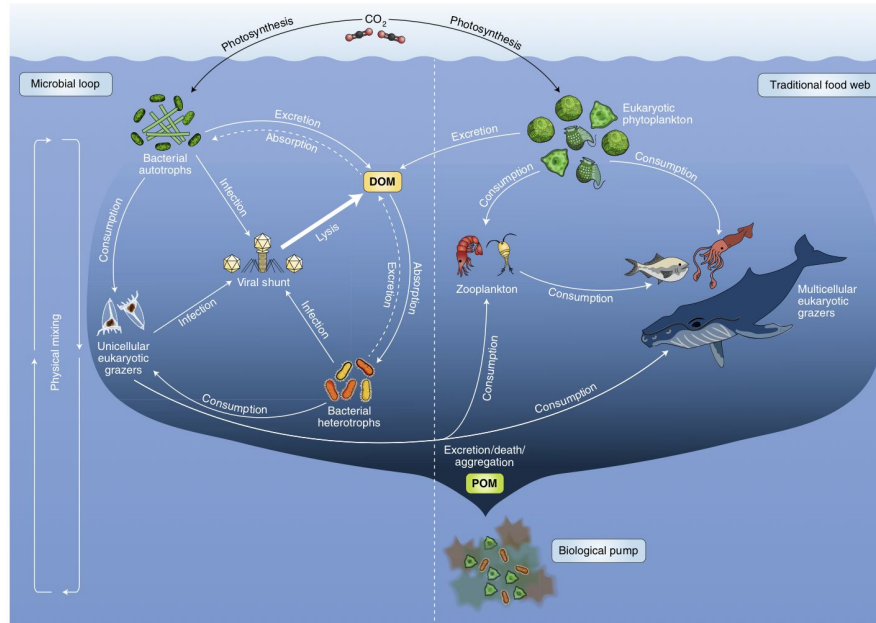
# Bacteriophages

Most viruses are bacteriophages that infect and kill bacteria.

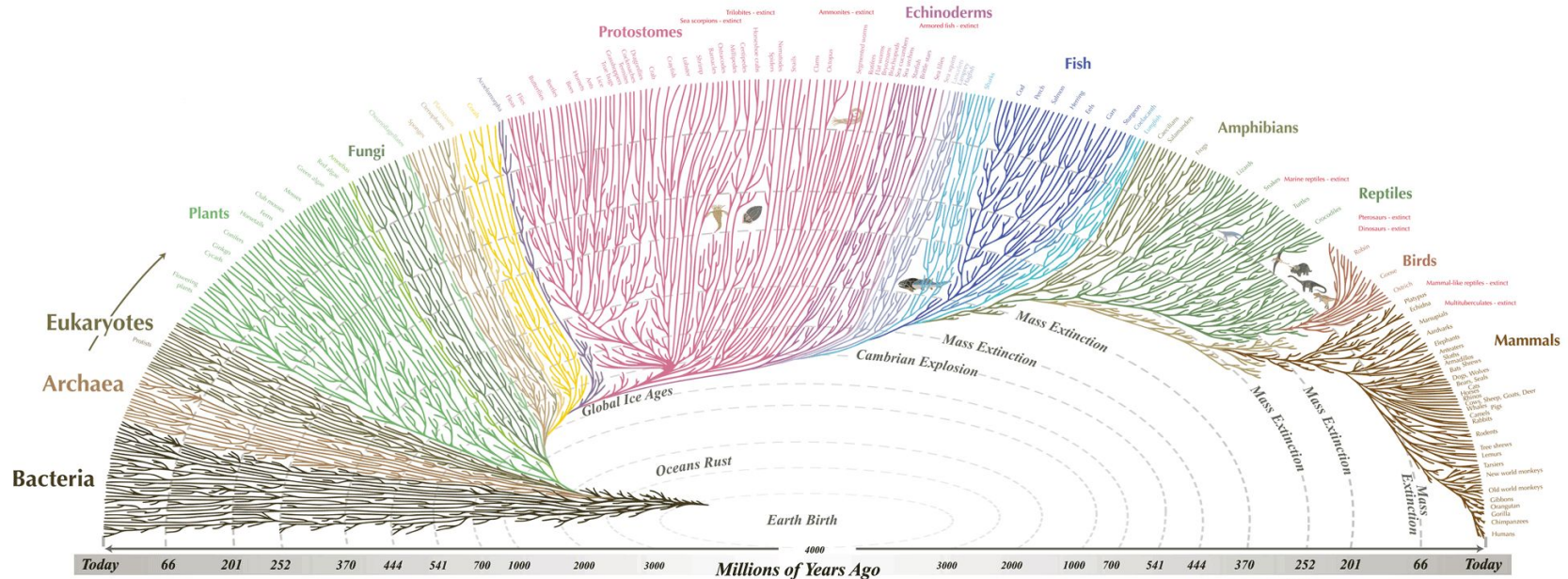


# Bacteriophages

Viruses act as a “shunt” that recycles dissolved carbon at the surface of the ocean.



# The Tree of Life



All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct



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# Viruses of plants

# Tulip breaking viruses

Dutch *tulip mania* in the 1630's came to an abrupt end partially due tulip breaking viruses that caused beautiful color patterns but also a loss of fitness.



*Tulip Planting in Spring* (Pieter Bruegel, the Younger)



*Flowers in a Glass Vase* (Jan van den Hecke)



*Tulip breaking virus* (Lesnaw and Ghabrial, 2000)

# Tomato spotted wilt virus

TSWV is a big problem for NC agriculture because it infects common crops like tomato, pepper and peanut.



# TSWV experimental adaptation studies

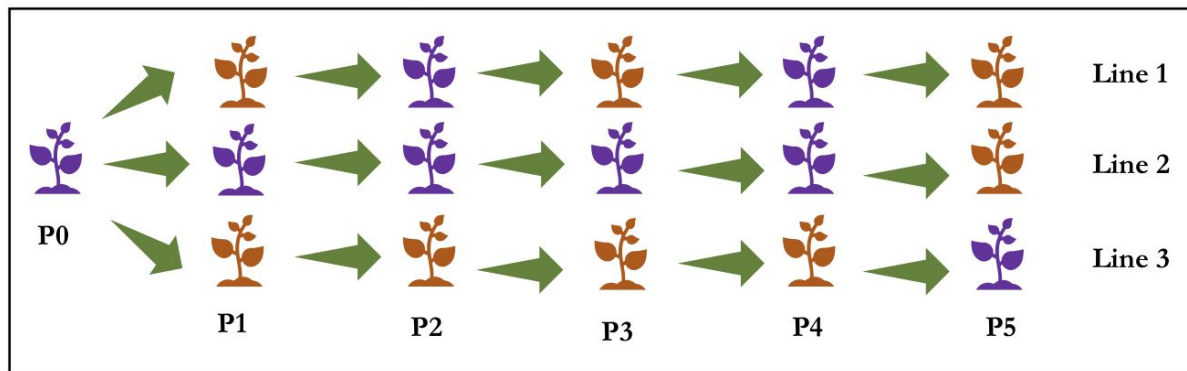
We passage TSWV between different plant host species to understand how the virus is able to adapt to new hosts.



Casey Ruark-Seward



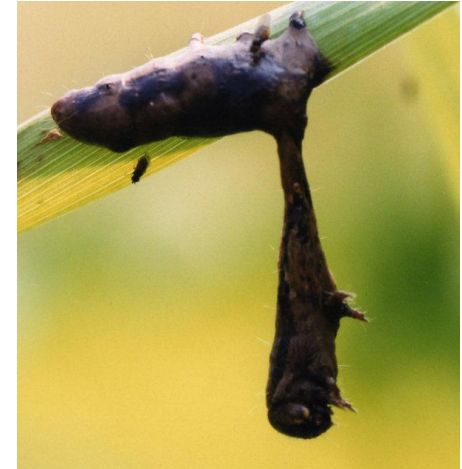
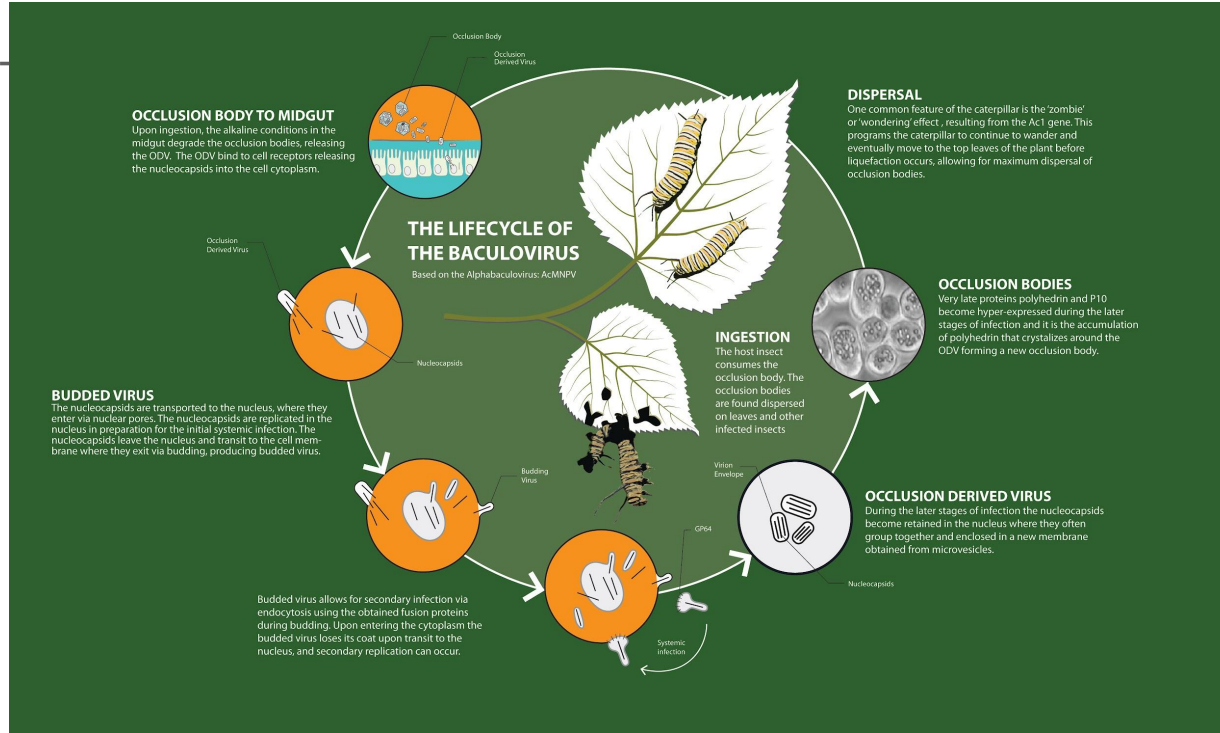
## 1. Plant Host Alternation Experiment



# Viruses of insects



# Baculoviruses



# Insects as virus vectors

Insects play an important role in moving or vectoring viruses between different host species

Many plant viruses are spread by aphids, whiteflies or thrips

Blood-feeding insects like mosquitoes spread important human viruses like Dengue and West Nile Virus.

Insects therefore play an important role in moving viruses through the tree of life.

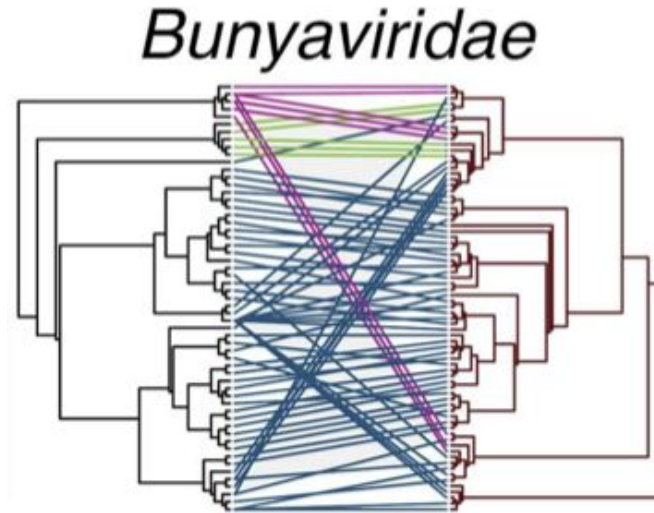
**Viruses move easily  
through the tree of life**

# Host vs. viral phylogenetic trees

By comparing host and viral phylogenies, we can see how viruses have moved across the tree of life.

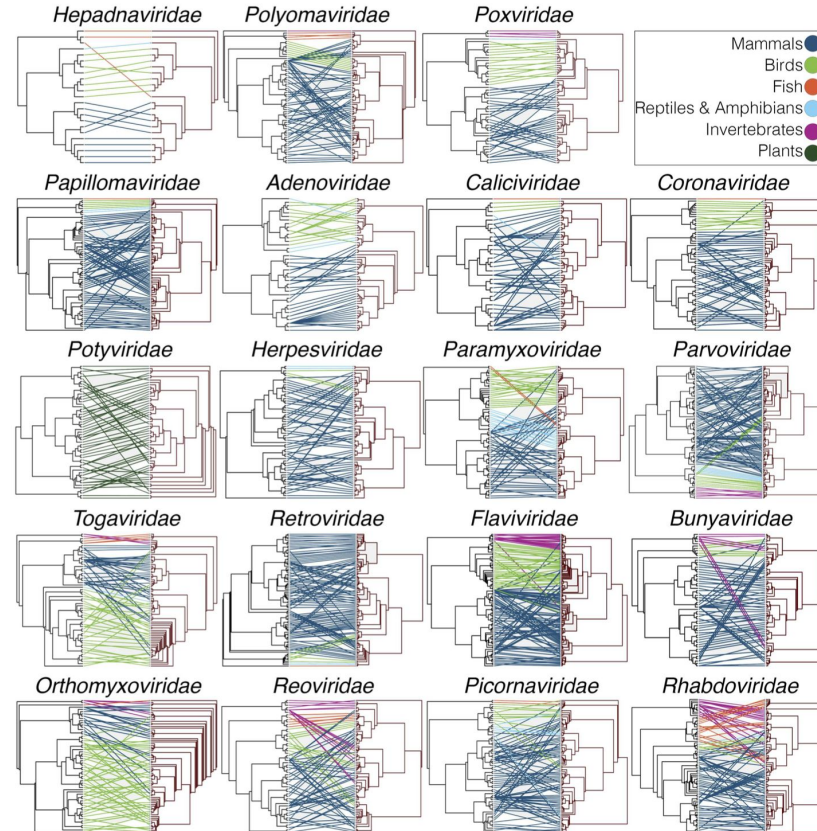


Hosts



Viruses

# Host vs. viral phylogenies





# **The origins and emergence of SARS-CoV-2**

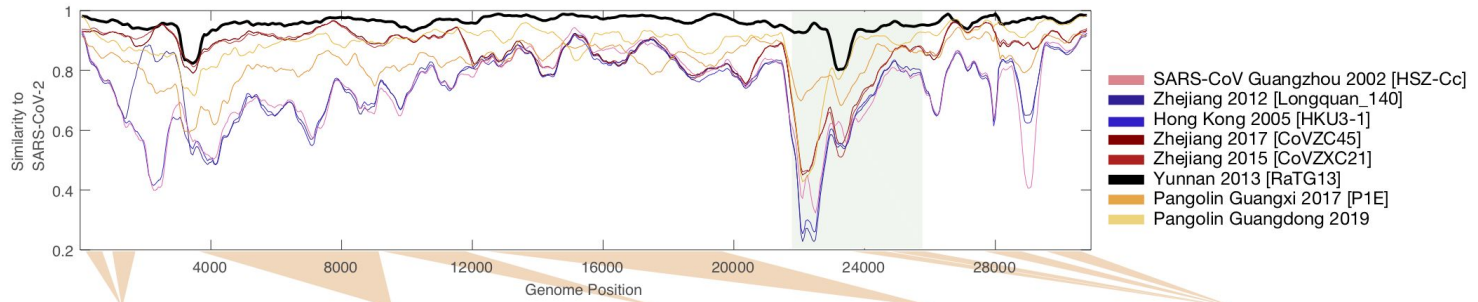
# The perfect epidemic storm

- Highly transmissible
- Stealthy
- Virulent



# The origins of SARS-CoV-2

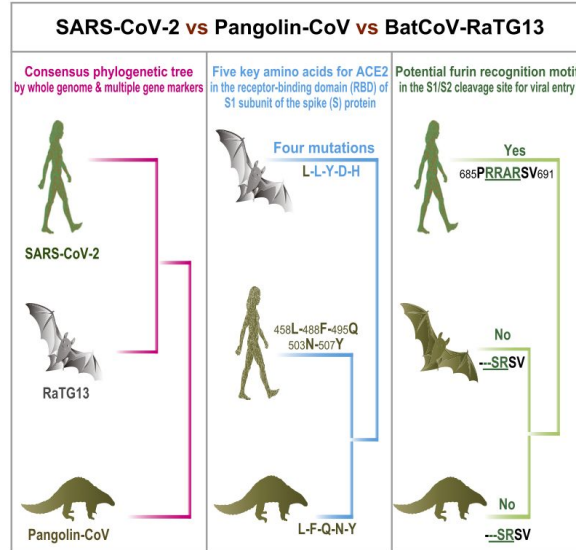
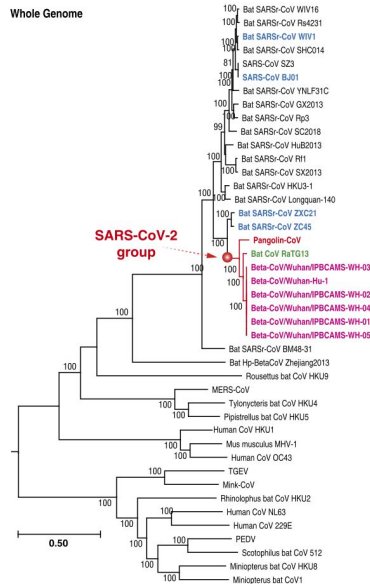
Sequence similarity suggests that the virus originated in bats but origins of the spike domain that binds to human cell receptors is unclear.



Boni et al. (bioRxiv, 2020)

# The origins of SARS-CoV-2

All available evidence suggests that SARS-CoV-2 originated in bats although it is possible pangolins may have served as an *intermediate host*.



Zhang et al. (Current Biology, 2020)

# The perfect epidemic storm

- Highly transmissible
- Stealthy
- Virulent

# But not completely unexpected

- Large reservoirs of similar viruses in bats/wildlife
  - Host jumps occur frequently
-



# Summary and conclusions

Viruses are everywhere and occur across all branches of the tree of life.

Viruses also move across the tree of life, often jumping between distantly related hosts.

While Covid-19 may represent the perfect epidemic storm, SARS-CoV-2 is certainly not unique and other viruses will continue to enter the human population.