



A joint venture between The University of Melbourne and The Royal Melbourne Hospital

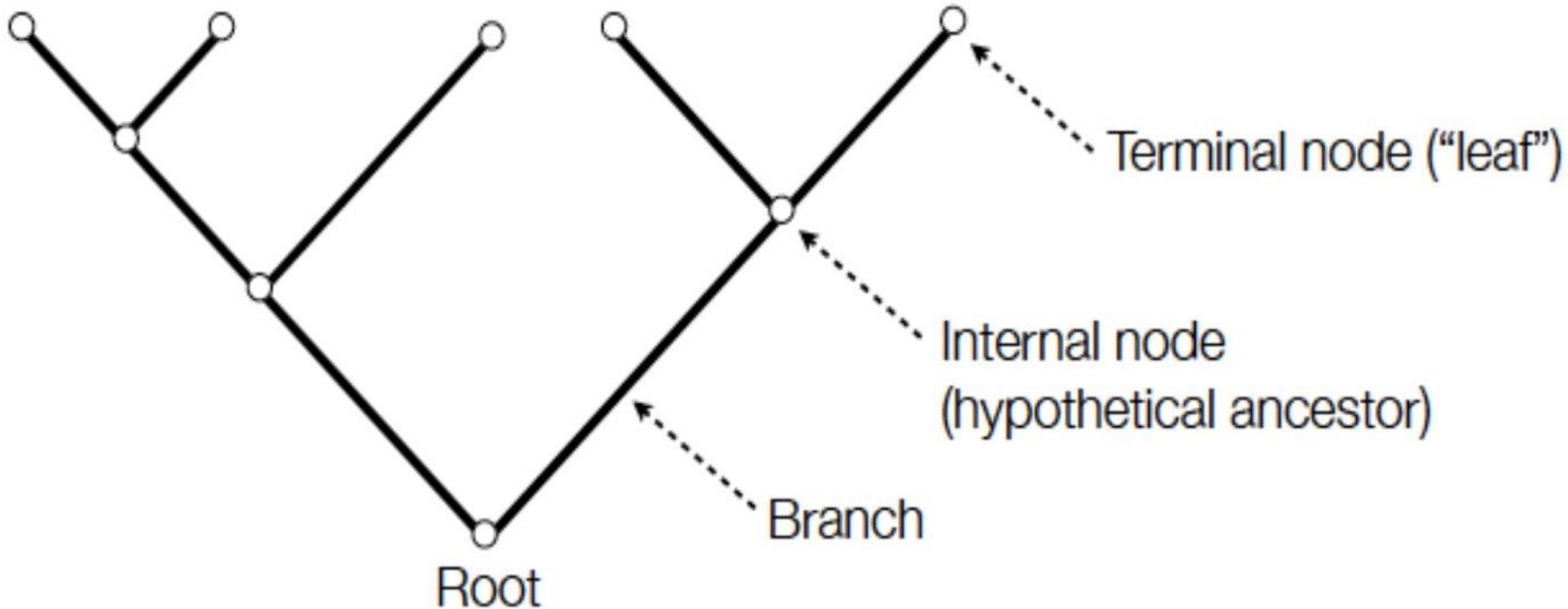
Introduction to Nextstrain

Wytamma Wirth
(@wytamma)

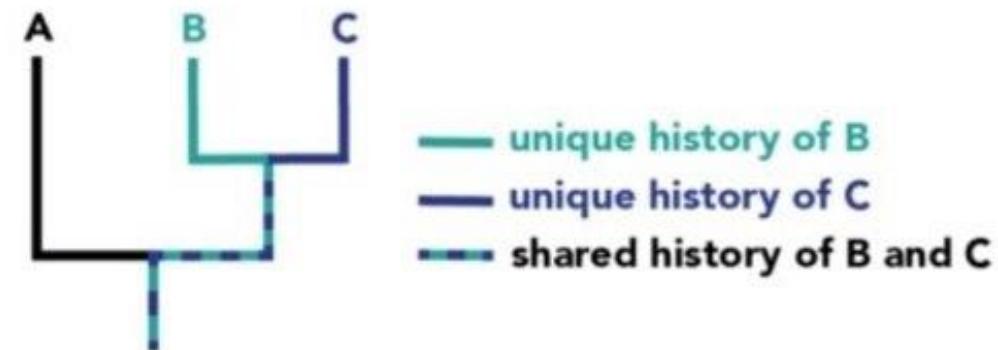
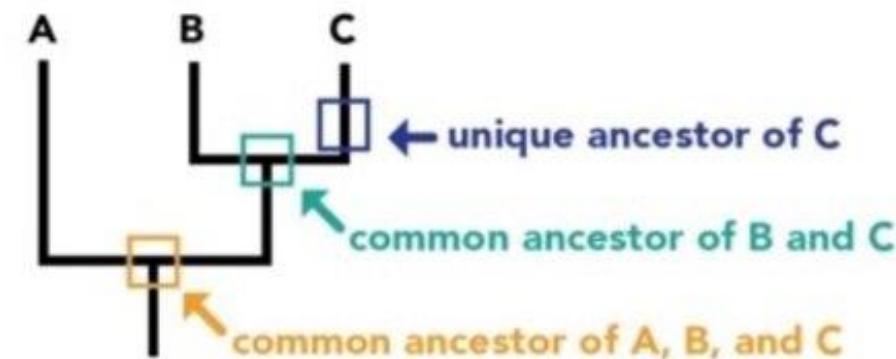
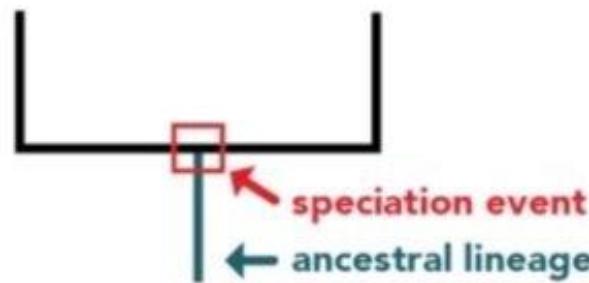
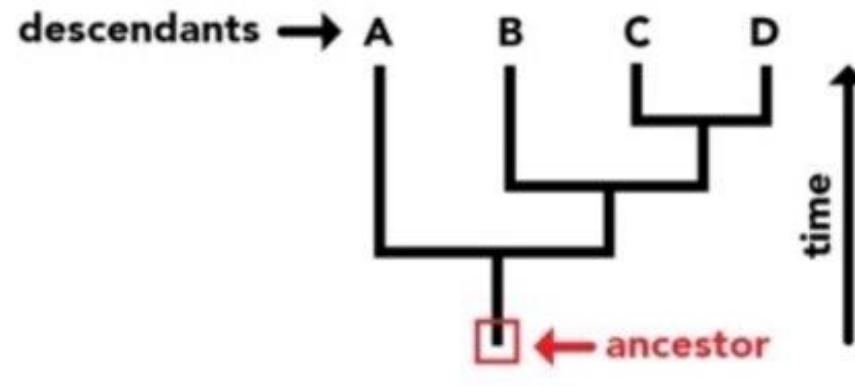
Objectives

- Refresher on Phylogenies
- Learn about Nextstrain ecosystem and Nextstrain builds
- Learn to interact, use and extract information from Nextstrain
- Visualise phylogenetic trees with metadata

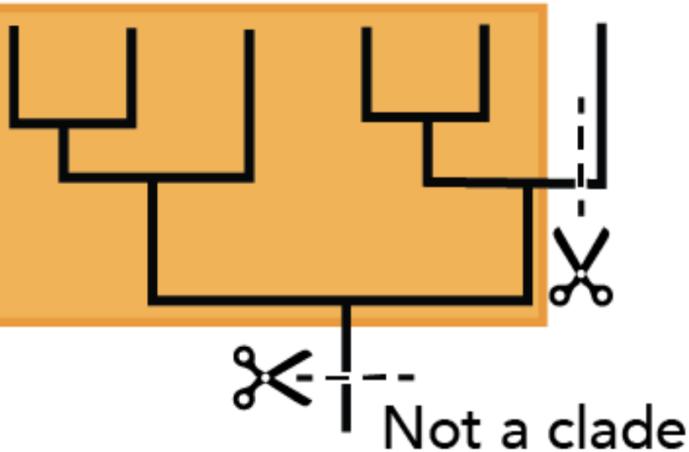
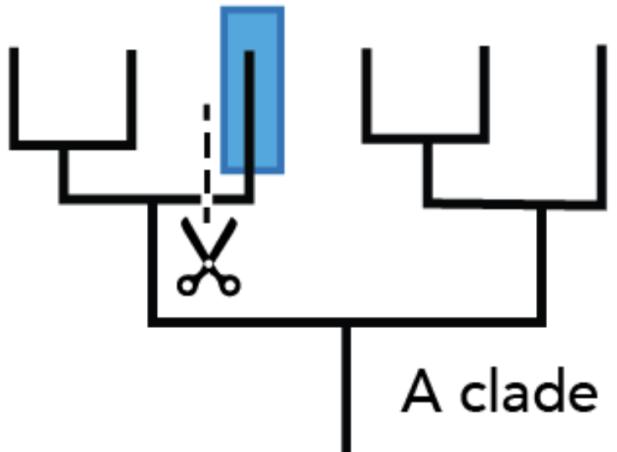
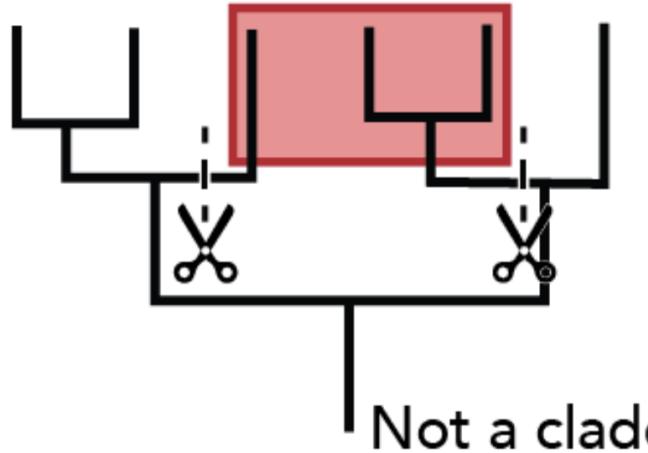
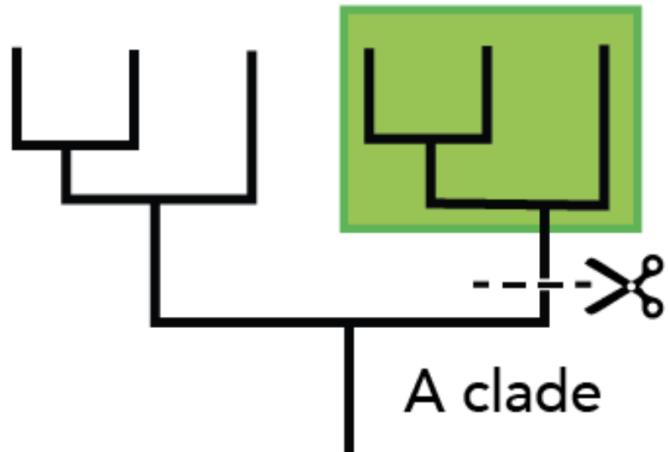
Phylogenetic Trees - Terminology



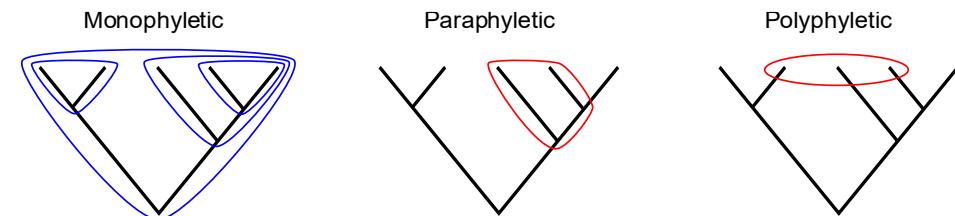
Reading Phylogenetic trees



What is a Clade/lineage?



- Monophyletic group - All and only the descendants of a common ancestor (including that ancestor).
- Paraphyletic group - Does not include all of the descendants of the common ancestor.
- Polyphyletic group - Does not include the common ancestor.



What is Nextstrain?



Nextstrain is a project to harness the scientific and public health potential of pathogen genome data. Our goal is to aid epidemiological understanding of pathogen spread and evolution and improve outbreak response.

Pathogen surveillance

Our website, nextstrain.org, provides real-time snapshots of evolving pathogen populations such as [SARS-CoV-2](#), [influenza](#), and [Ebola](#). We use interactive visualizations to enable exploration of curated datasets and analyses which are continually updated when new genomes are available. This offers a powerful pathogen surveillance tool to virologists, epidemiologists, public health officials, and community scientists. In many cases old snapshots of these analyses are able to be easily accessed, see [viewing previous analyses](#) for more.

Open-source software

The software we write to power [all parts](#) of Nextstrain—bioinformatics, visualizations, analysis pipelines, data management, and more—is entirely [open-source](#) and [available to the public](#). We aim to empower the wider genomic epidemiology and public health communities to tweak our analyses, create new ones, and communicate what we do.



Nextstrain

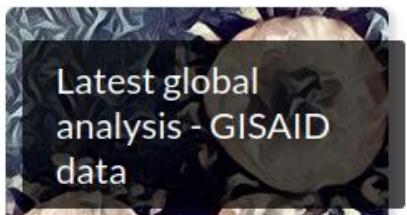
Real-time tracking of pathogen evolution

Nextstrain is an open-source project to harness the scientific and public health potential of pathogen genome data. We provide a continually-updated view of publicly available data alongside powerful analytic and visualization tools for use by the community. Our goal is to aid epidemiological understanding and improve outbreak response. If you have any questions, or simply want to say hi, please give us a shout at hello@nextstrain.org.

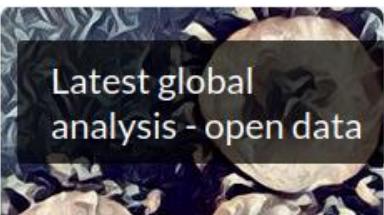
[READ MORE](#)

SARS-CoV-2 (COVID-19)

We are incorporating SARS-CoV-2 genomes as soon as they are shared and providing analyses and situation reports. In addition we have developed a number of resources and tools, and are facilitating independent groups to run their own analyses.



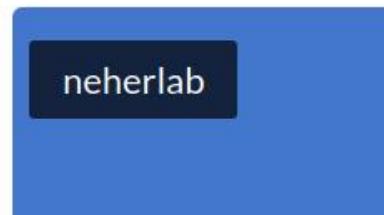
Latest global analysis - GISAID data



Latest global analysis - open data

Nextstrain Groups

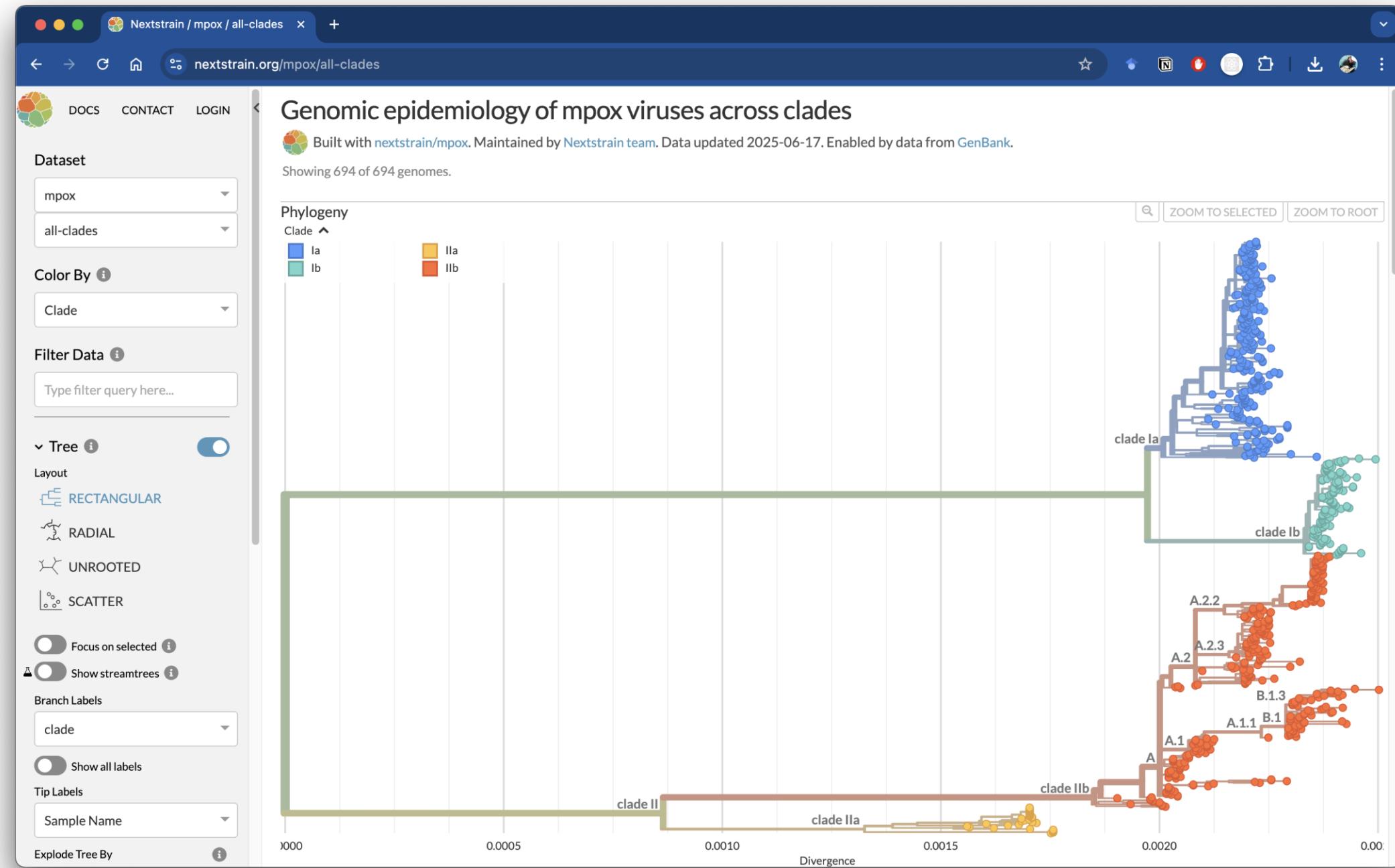
We want to enable research labs, public health entities and others to share their datasets and narratives through Nextstrain with complete control of their data and audience.

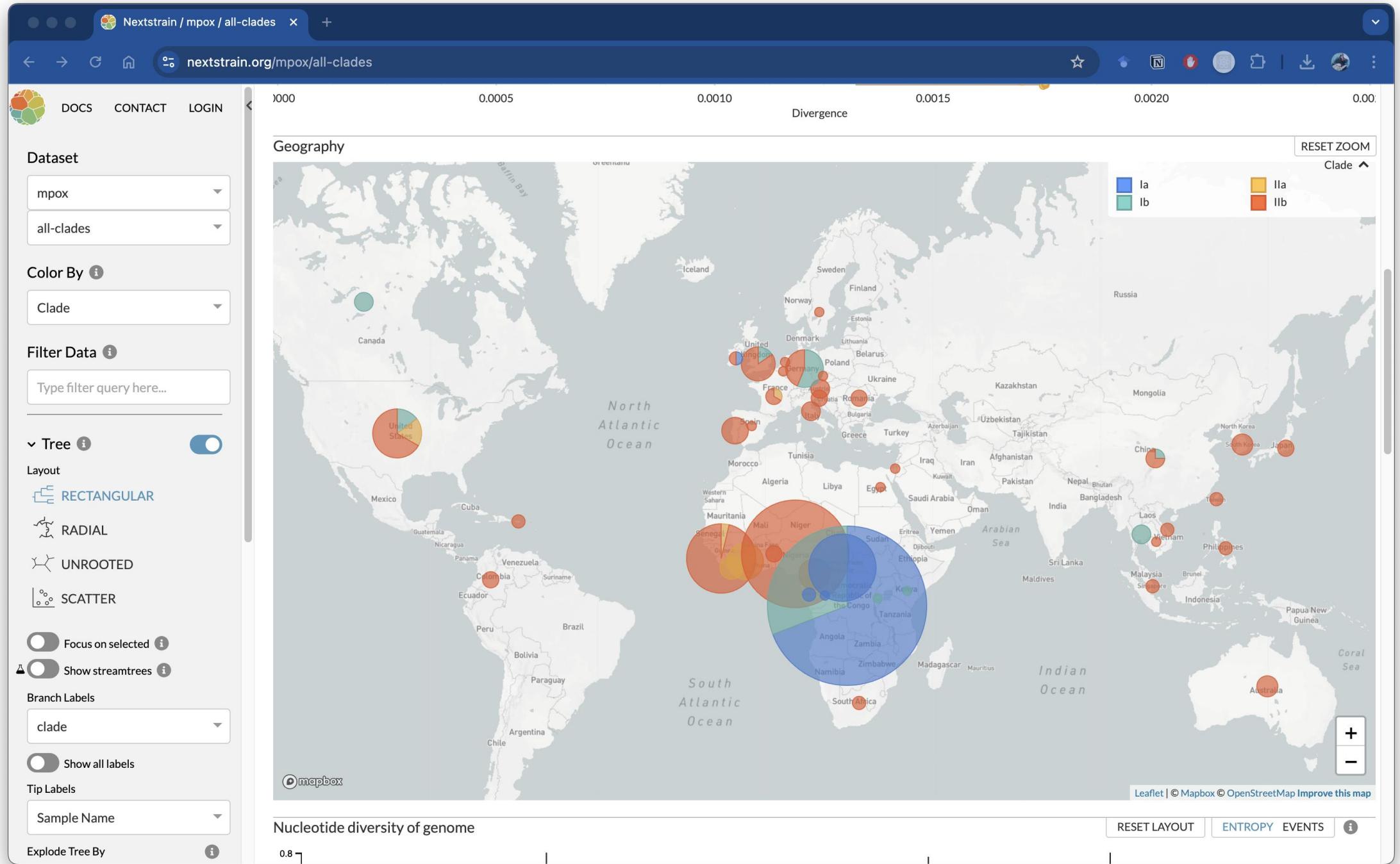


neherlab



spheres







DOCS HELP LOGIN <

ENTROPY EVENTS AA NT

Dataset

flu
seasonal
h3n2
ha
2y

Date Range

2013-11-11

2023-05-12

▶ PLAY

↻ RESET

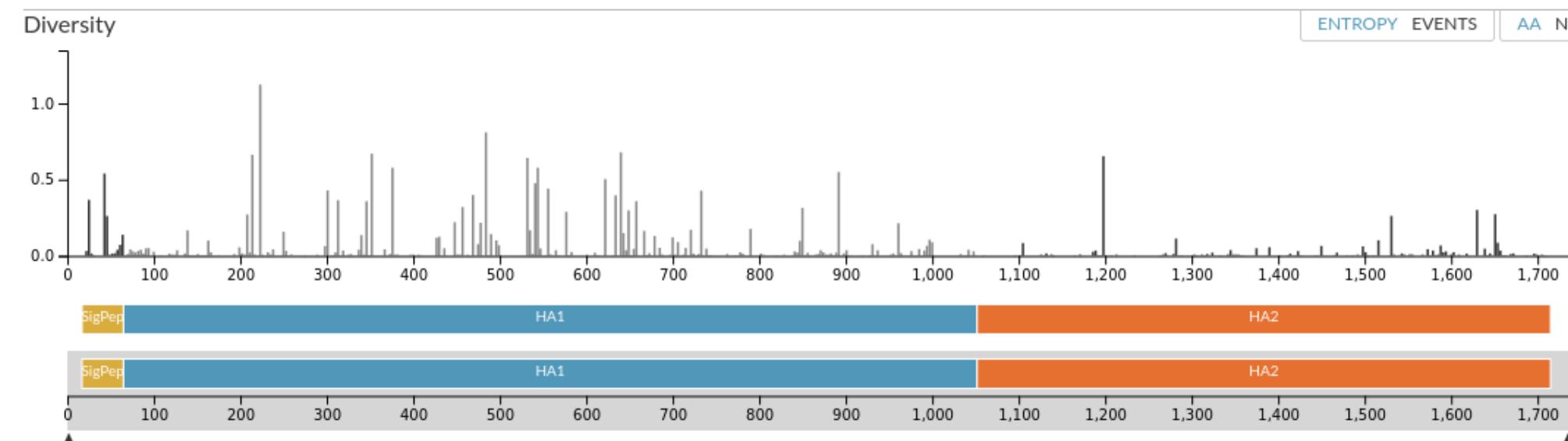
Color By

Clade

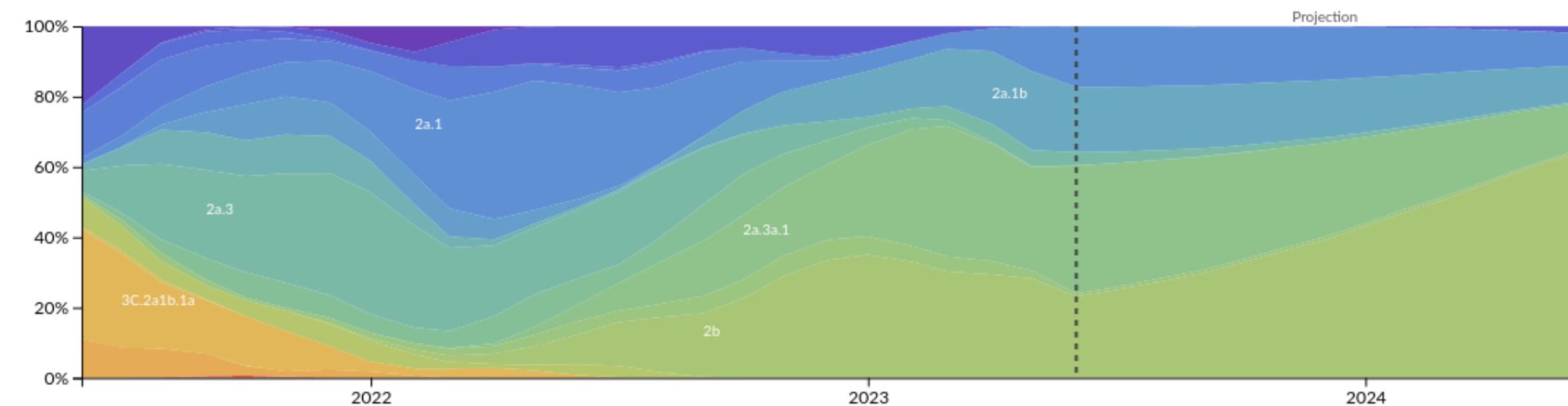
Filter Data

Type filter query here...

Tree Options



Frequencies (colored by Clade)



<https://docs.nextstrain.org/en/latest/learn/augur-to-auspice.html#auspice-component-diversity-panel-entropy-event-toggle>



DOCS HELP LOGIN <

Dataset

flu

seasonal

h3n2

h3n2

h1n1pdm

vic

yam

2013-11-11 2023-05-12

▶ PLAY ⏪ RESET

Color By

Clade

Filter Data

Type filter query here...

Tree Options

Layout

RECTANGULAR

RADIAL

UNROOTED

CLOCK

Real-time tracking of influenza A/H3N2 evolution

Built with [nextstrain/seasonal-flu](#). Maintained by [Jover Lee](#), [Richard Neher](#) and [Trevor Bedford](#). Enabled by data from [GISAID](#).

Showing 1949 of 1949 genomes sampled between Sep 2015 and May 2023.

Phylogeny

Clade ^

- 1
- 2b
- 1a
- 2c
- 1a.1
- 3C.2a1
- 2
- 3C.2a1a
- 2a
- 3C.2a1b.1
- 2a.1
- 3C.2a1b.1a
- 2a.1a
- 3C.2a1b.1b
- 2a.1b
- 3C.2a1b.2
- 2a.2
- 3C.2a1b.2a
- 2a.3
- 3C.2a1b.2b
- 2a.3a
- 3C.2a2
- 2a.3a.1
- 3C.3
- 2a.3b



DOCS HELP LOGIN <

Dataset

flu

seasonal

h1n1pdm

ha

ha

na

2012-05-19 2023-05-25

▶ PLAY ⏪ RESET

Color By

Clade

Filter Data

Type filter query here...

Tree Options

Layout

RECTANGULAR

RADIAL

UNROOTED

CLOCK

Real-time tracking of influenza A/H1N1pdm evolution



Built with [nextstrain/seasonal-flu](#). Maintained by [Jover Lee](#), [Richard Neher](#) and [Trevor Bedford](#). Enabled by data from [GISAID](#).

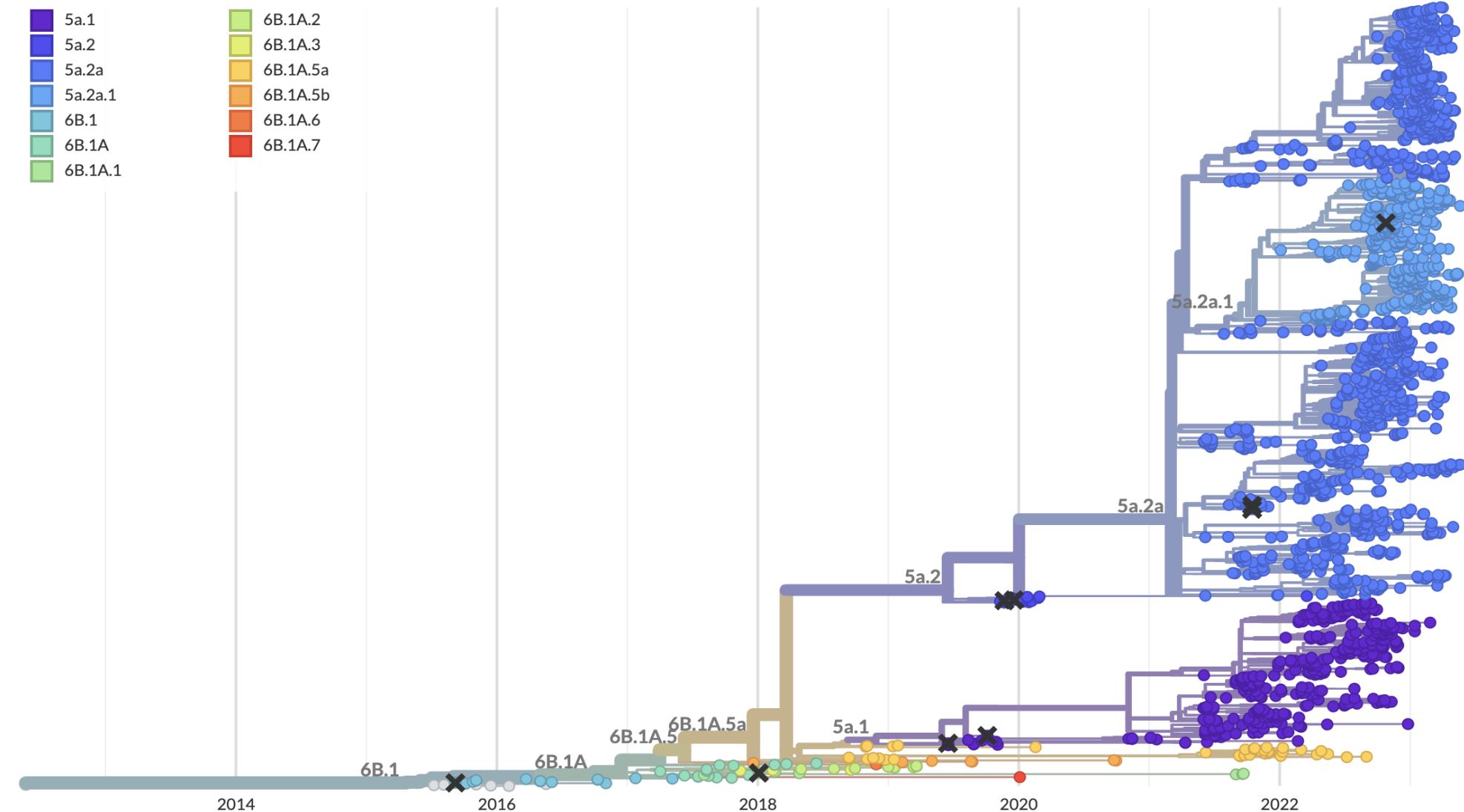
Showing 2027 of 2027 genomes sampled between Jul 2015 and May 2023.

Phylogeny

Clade ▲

- 5a.1
- 5a.2
- 5a.2a
- 5a.2a.1
- 6B.1
- 6B.1A
- 6B.1A.1
- 6B.1A.2
- 6B.1A.3
- 6B.1A.5a
- 6B.1A.5b
- 6B.1A.6
- 6B.1A.7

ZOOM TO SELECTED RESET LAYOUT



flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19 2023-05-25

PLAY

RESET

Color By

Clade

Filter Data

australia

Country → Australia

Division → South Australia

Division → Western Australia

sample → A/SouthAustralia/315/2022

sample → A/SouthAustralia/163/2022

SCATTER

Branch Length

TIME

DIVERGENCE

Real-time tracking of influenza A/H1N1pdm evolution



Built with [nextstrain/seasonal-flu](#). Maintained by [Jover Lee](#), [Richard Neher](#) and [Trevor Bedford](#). Enabled by data from [GISAID](#).

Showing 2027 of 2027 genomes sampled between Jul 2015 and May 2023.



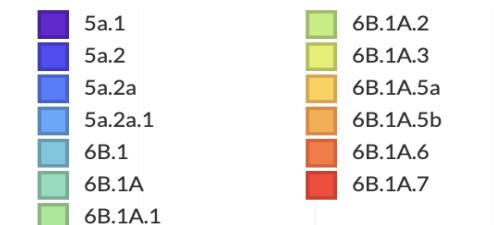
ZOOM TO SELECTED

RESET LAYOUT

Phylogeny

Clade ▾

5a.1	6B.1A.2
5a.2	6B.1A.3
5a.2a	6B.1A.5a
5a.2a.1	6B.1A.5b
6B.1	6B.1A.6
6B.1A	6B.1A.7
6B.1A.1	



Color By

Clade

Filter Data

australia

Country → Australia

Division → South Australia

Division → Western Australia

sample → A/SouthAustralia/315/2022

sample → A/SouthAustralia/163/2022

SCATTER

Branch Length

TIME

DIVERGENCE



flu

seasonal

h1n1pdm

ha

2y

Date Range

 2012-05-19 2023-05-25

PLAY

RESET

Color By

Clade

Filter Data

Type filter query here...

Currently selected filter categories:

1 x Country

Tree Options

Layout

RECTANGULAR

RADIAL

UNROOTED

CLOCK

SCATTER

Real-time tracking of influenza A/H1N1pdm evolution



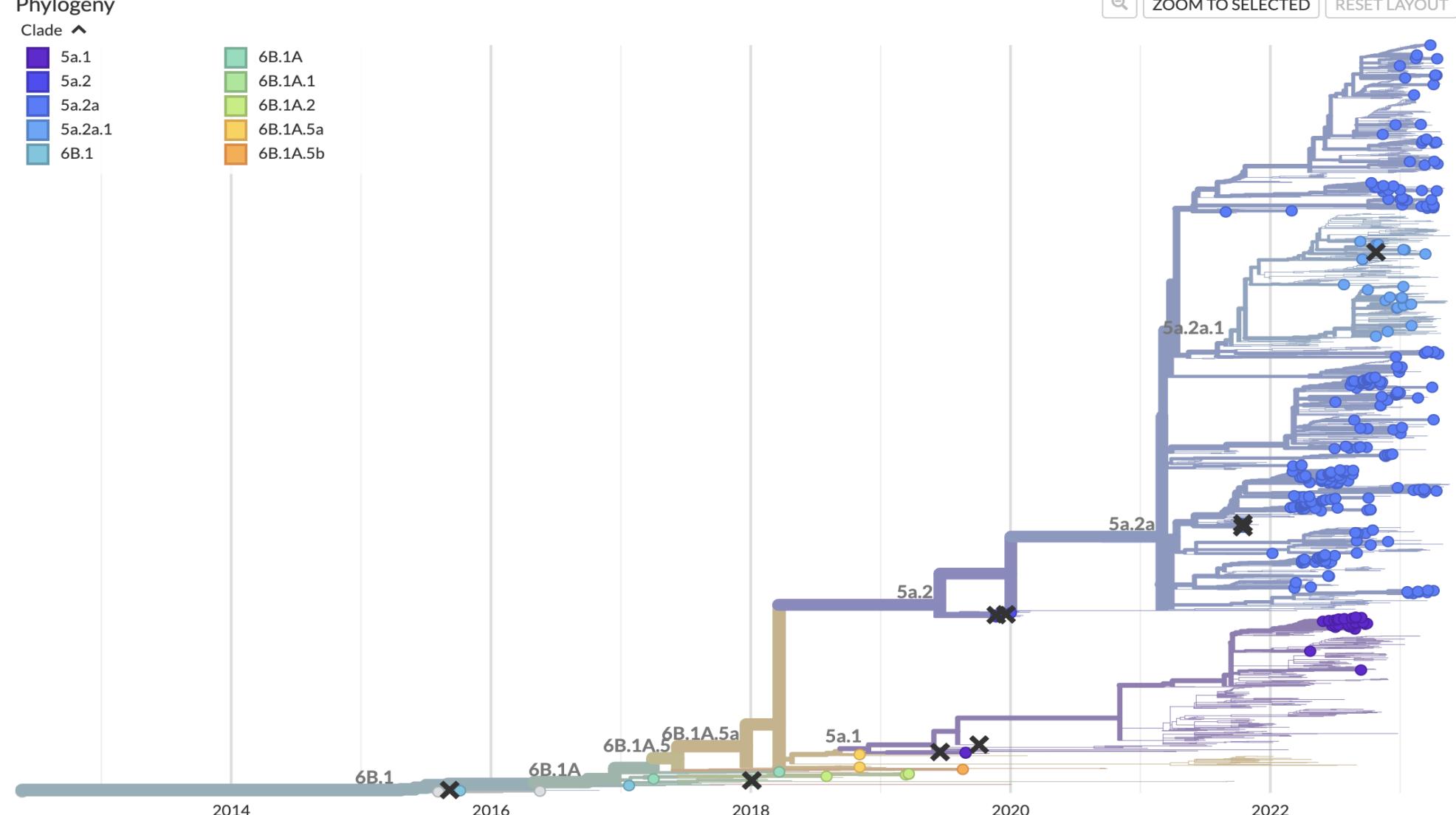
Built with [nextstrain/seasonal-flu](#). Maintained by [Jover Lee](#), [Richard Neher](#) and [Trevor Bedford](#). Enabled by data from [GISAID](#).

Showing 329 of 2027 genomes sampled between Aug 2015 and Apr 2023. Filtered to [Australia \(329\)](#) .

Phylogeny

Clade ^

- | | |
|---------|----------|
| 5a.1 | 6B.1A |
| 5a.2 | 6B.1A.1 |
| 5a.2a | 6B.1A.2 |
| 5a.2a.1 | 6B.1A.5a |
| 6B.1 | 6B.1A.5b |



flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19 2023-05-25

PLAY

RESET

Color By

Clade

Filter Data

Type filter query here...

Year/month → 2023-01

Year/month → 2023-02

Year/month → 2023-03

Year/month → 2023-04

Year/month → 2023-05

genotype HA1 104Q

genotype HA1 104R

genotype HA1 105L

genotype HA1 105M

Real-time tracking of influenza A/H1N1pdm evolution



Built with [nextstrain/seasonal-flu](#). Maintained by [Jover Lee](#), [Richard Neher](#) and [Trevor Bedford](#). Enabled by data from [GISAID](#).

Showing 329 of 2027 genomes sampled between Aug 2015 and Apr 2023. Filtered to [Australia \(329\)](#) .

Phylogeny

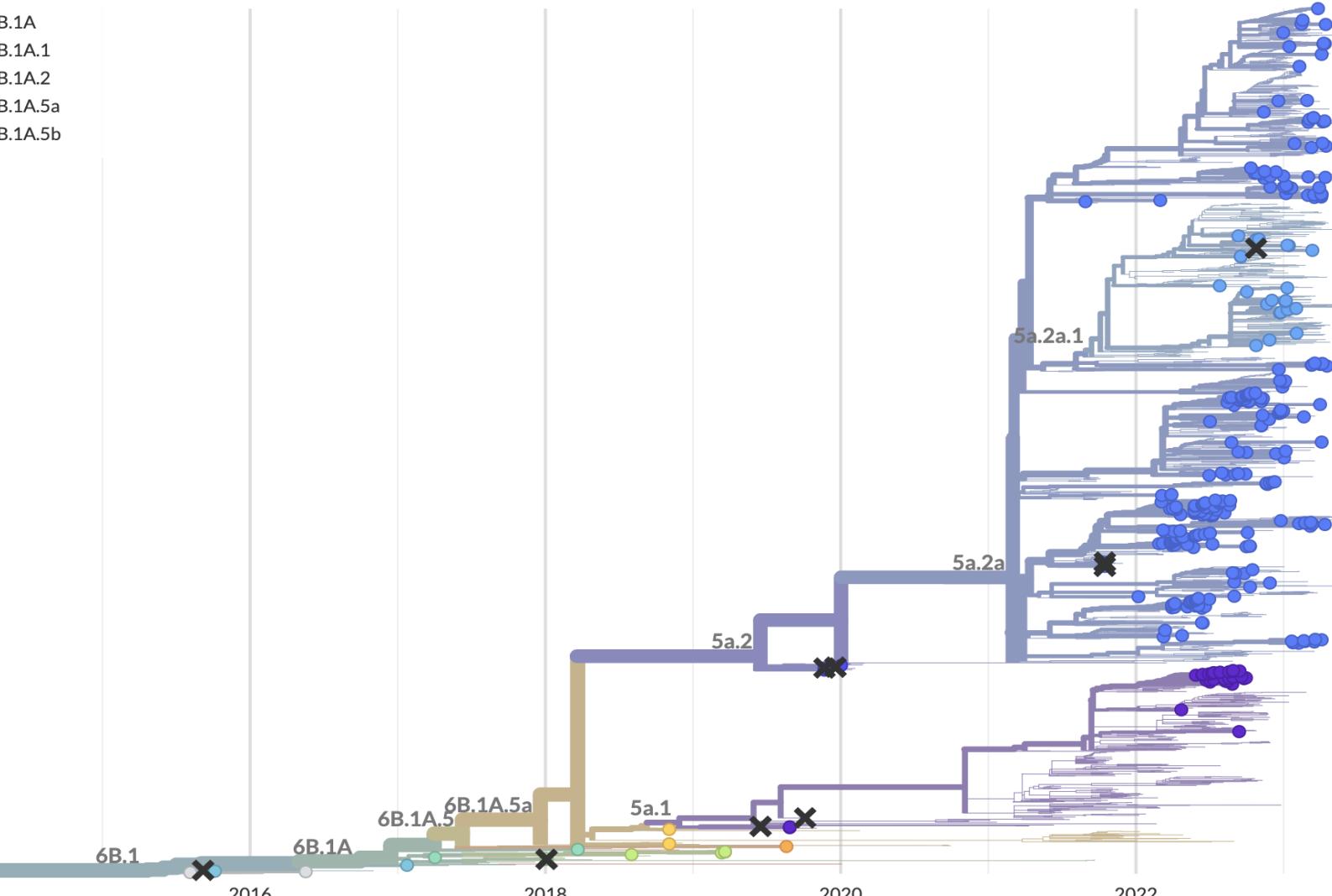
Clade ^

5a.1	6B.1A
5a.2	6B.1A.1
5a.2a	6B.1A.2
5a.2a.1	6B.1A.5a
6B.1	6B.1A.5b



ZOOM TO SELECTED

RESET LAYOUT



2014

2016

2018

2020

2022

flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19
2023-05-25

PLAY

RESET

Color By

Clade

Filter Data

Type filter query here...

Currently selected filter categories:

1 x Country

1 x Year/month

Tree Options

Layout

RECTANGULAR

RADIAL

UNROOTED

CLOCK

SCATTER

Real-time tracking of influenza A/H1N1pdm evolution



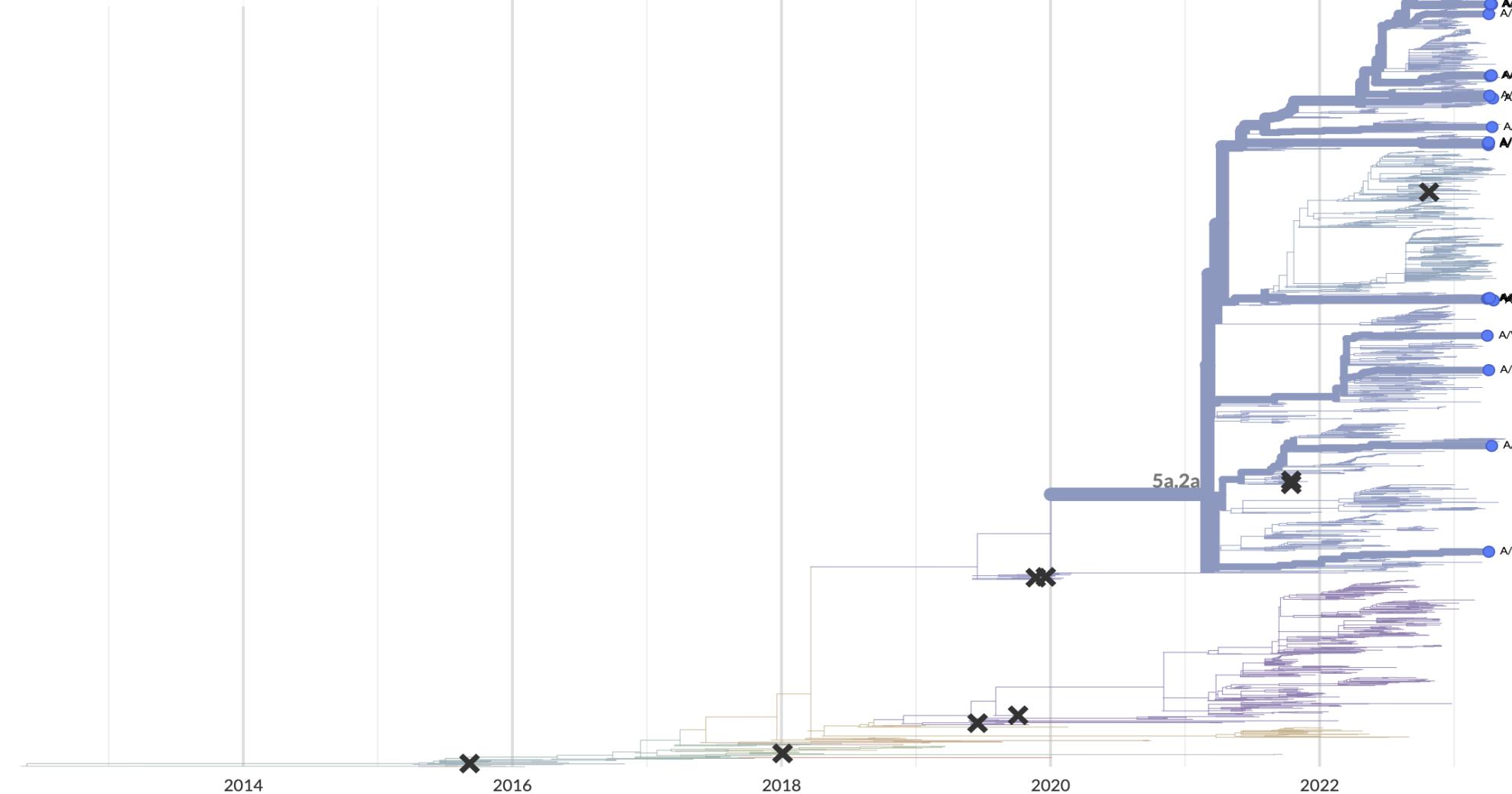
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Showing 23 of 2027 genomes sampled between Apr 2023 and Apr 2023. Filtered to [Australia \(329\)](#) [∩](#) [2023-04 \(82\)](#) .

Phylogeny

Clade ▲

5a.2a



ZOOM TO SELECTED

RESET LAYOUT

flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19
2023-05-25

PLAY

RESET

Color By

Clade

Filter Data

Type filter query here...

Currently selected filter categories:

1 x Country 1 x Year/month

Tree Options

Layout

RECTANGULAR RADIAL UNROOTED CLOCK SCATTER

Real-time tracking of influenza A/H1N1pdm evolution



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Showing 23 of 2027 genomes sampled between Apr 2023 and Apr 2023. Filtered to [Australia \(329\)](#) [n](#) [2023-04 \(82\)](#) .

Phylogeny

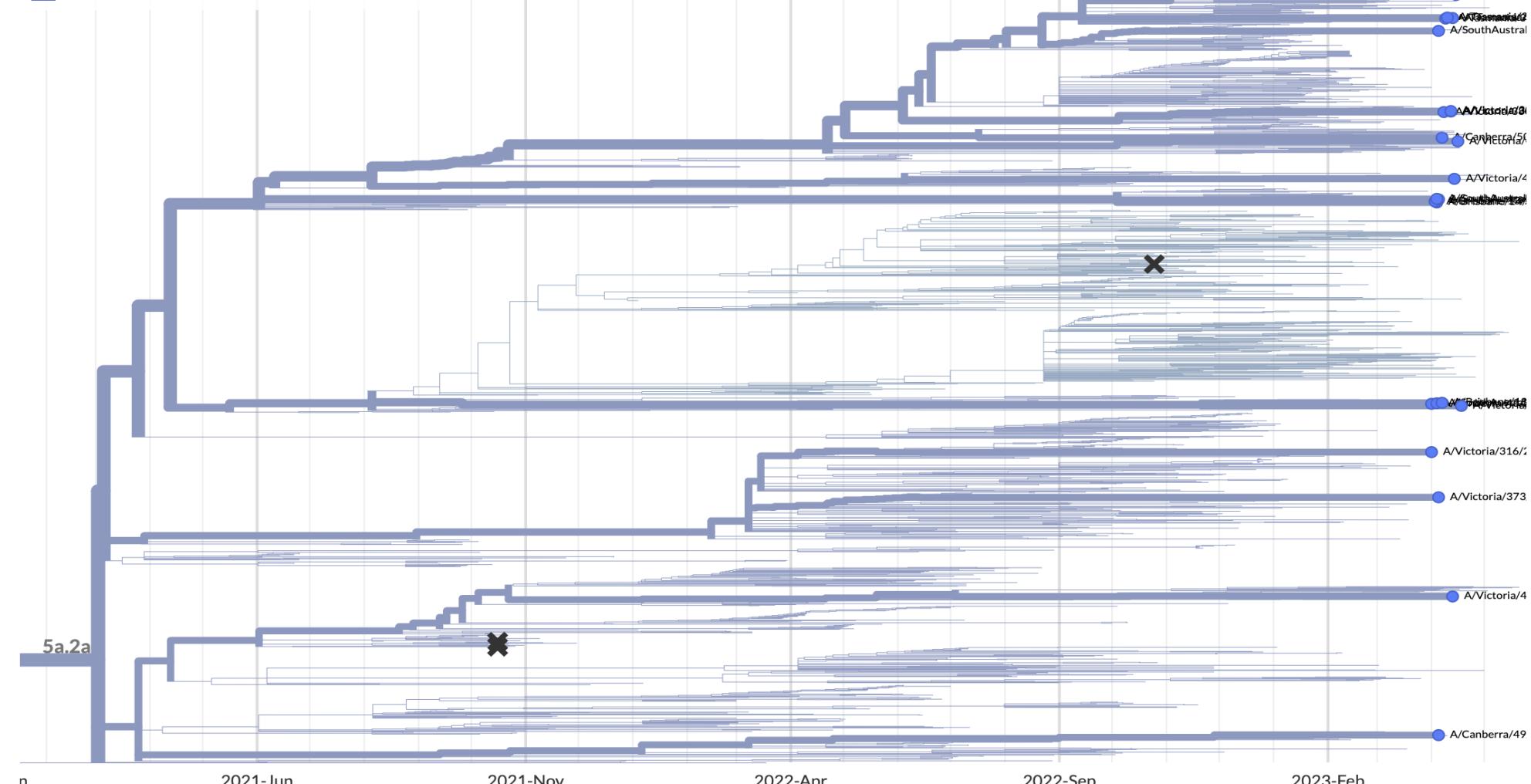
Clade ^

5a.2a



ZOOM TO SELECTED

RESET LAYOUT



flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19

2023-05-25

PLAY

RESET

Color By

Clade

Filter Data

Type filter query here...

Currently selected filter categories:

1 x Country

1 x Year/month

Tree Options

Layout

RECTANGULAR

RADIAL

UNROOTED

CLOCK

SCATTER

Real-time tracking of influenza A/H1N1pdm evolution



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Showing 23 of 2027 genomes sampled between Apr 2023 and Apr 2023. Filtered to [Australia \(329\)](#) n [2023-04 \(82\)](#) .

Phylogeny

Clade ^

5a.2a

mouse over on a branch – do not click!



ZOOM TO SELECTED

RESET LAYOUT

Number of descendants: 95

Homoplasic mutations: A992G

No amino acid mutations

Divergence: 0.0392

Inferred Date: 2022-09-14

Date Confidence Interval: (2022-09-04, 2022-10-01)

Clade: 5a.2a

Click to zoom into clade

Shift + Click to display more info

n

2021-Jun

2021-Nov

2022-Apr

2022-Sep

2023-Feb

A/Tasmania
A/Adelaide/2
A/SouthAustralia
A/WesternAustralia
A/Queensland/5
A/Victoria/4
A/Sydney/1
A/Victoria/316/
A/Victoria/373
A/Victoria/4
A/Canberra/49

flu

seasonal

h1n1pdm

ha

2y

Date Range

PLAY

RESET

Color By

Clade

Filter Data

Type filter query here...

Currently selected filter categories:

1 x Country

1 x Year/month

Tree Options

Layout

RECTANGULAR

RADIAL

UNROOTED

CLOCK

SCATTER

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Showing 23 of 2027 genomes sampled between Apr 2023 and Apr 2023. Filtered to [Australia \(329\)](#) [2023-04 \(82\)](#) .

Phylogeny

Clade

5a.2a

mouse over on a terminal node – do not click!

A/Tasmania/46/2023

Nucleotide changes: 71 + 2 reversions to root

Amino Acid changes: 27

Divergence: 0.0398

Date: 2023-04-15

Clade: 5a.2a

Click on tip to display more info

n

2021-Jun

2021-Nov

2022-Apr

2022-Sep

2023-Feb

ZOOM TO SELECTED

RESET LAYOUT

flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19

2023-05-25

PLAY

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Color By

Clade

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Type filter query here...

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Tree Options

Layout

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UNROOTED

CLOCK

SCATTER

Real-time tracking of influenza A/H1N1pdm evolution



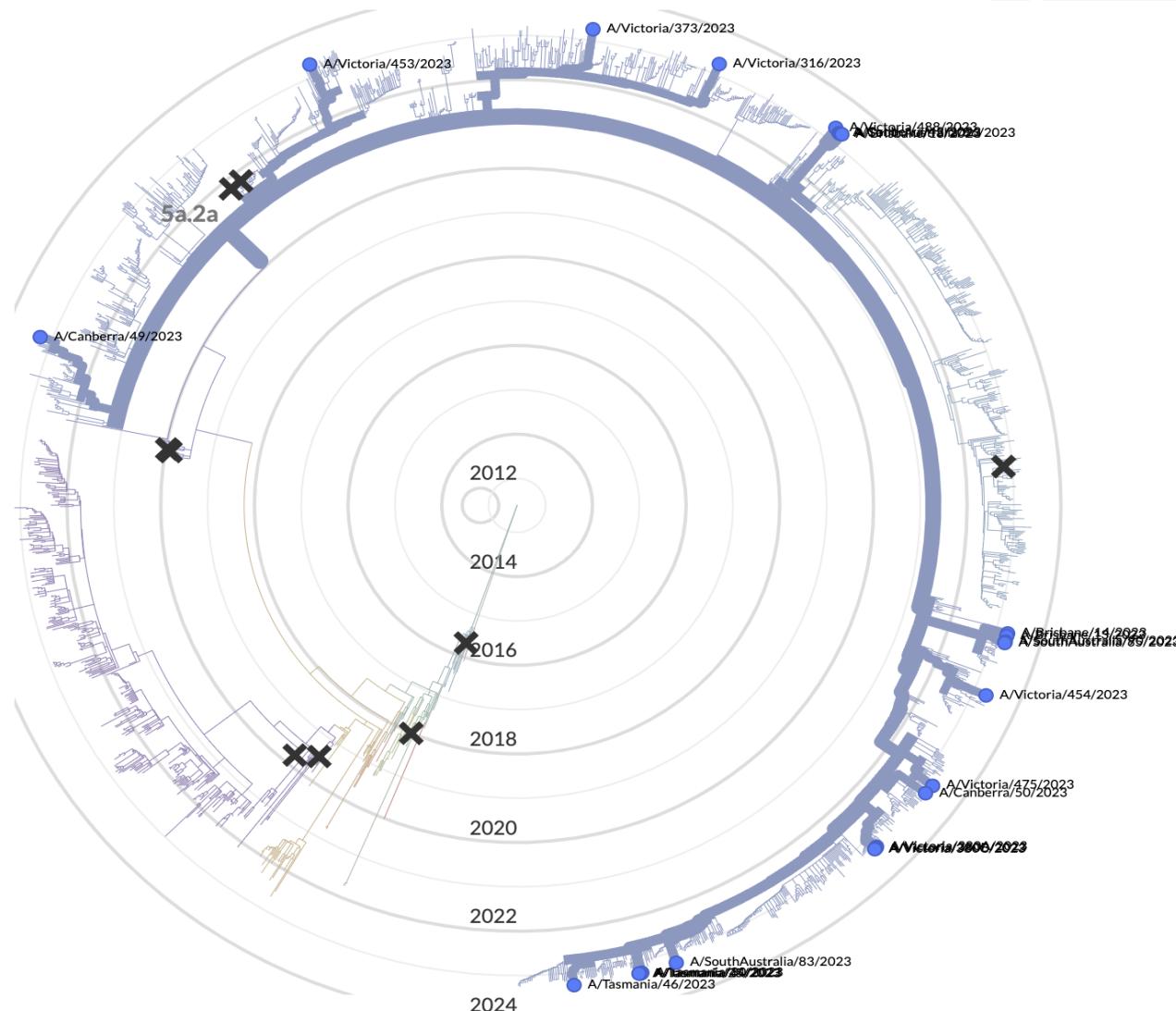
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Phylogeny

Clade ^

5a.2a



ZOOM TO SELECTED

RESET LAYOUT

flu

seasonal

h1n1pdm

ha

2y

Date Range

2012-05-19

2023-05-25

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1 x Country

1 x Year/month

Tree Options

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Real-time tracking of influenza A/H1N1pdm evolution



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Phylogeny

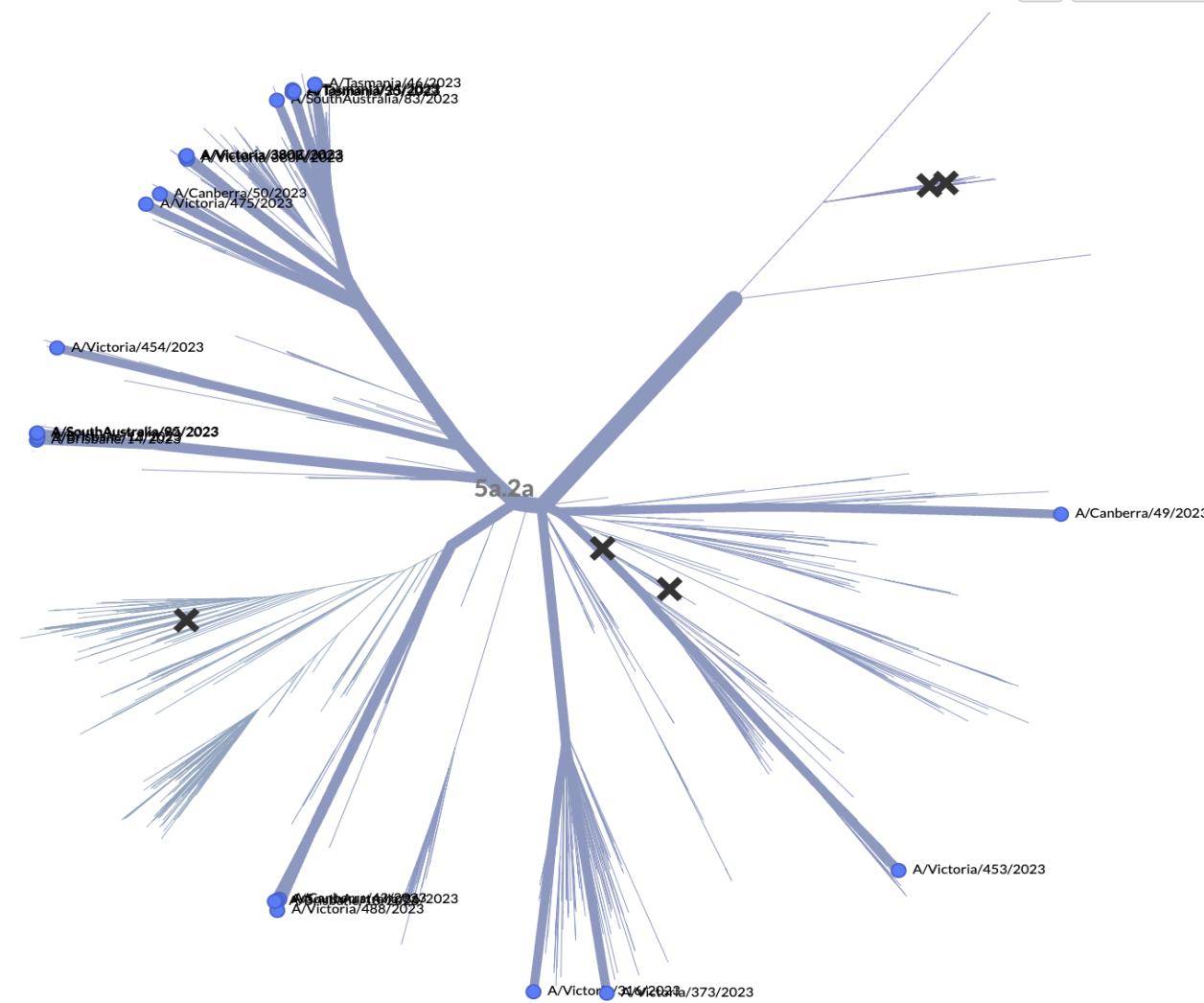
Clade

5a.2a



ZOOM TO SELECTED

RESET LAYOUT



flu

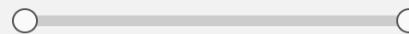
seasonal

h1n1pdm

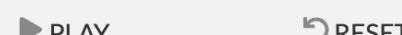
ha

2y

Date Range



2012-05-19

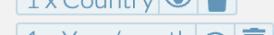


Color By

Filter Data



Currently selected filter categories:



Tree Options

Layout



Real-time tracking of influenza A/H1N1pdm evolution



Built with [nextstrain/seasonal-flu](#). Maintained by Jover Lee, Richard Neher and Trevor Bedford. Enabled by data from 

Showing 23 of 2027 genomes sampled between Apr 2023 and Apr 2023. Filtered to Australia (329) 2023-04 (82)

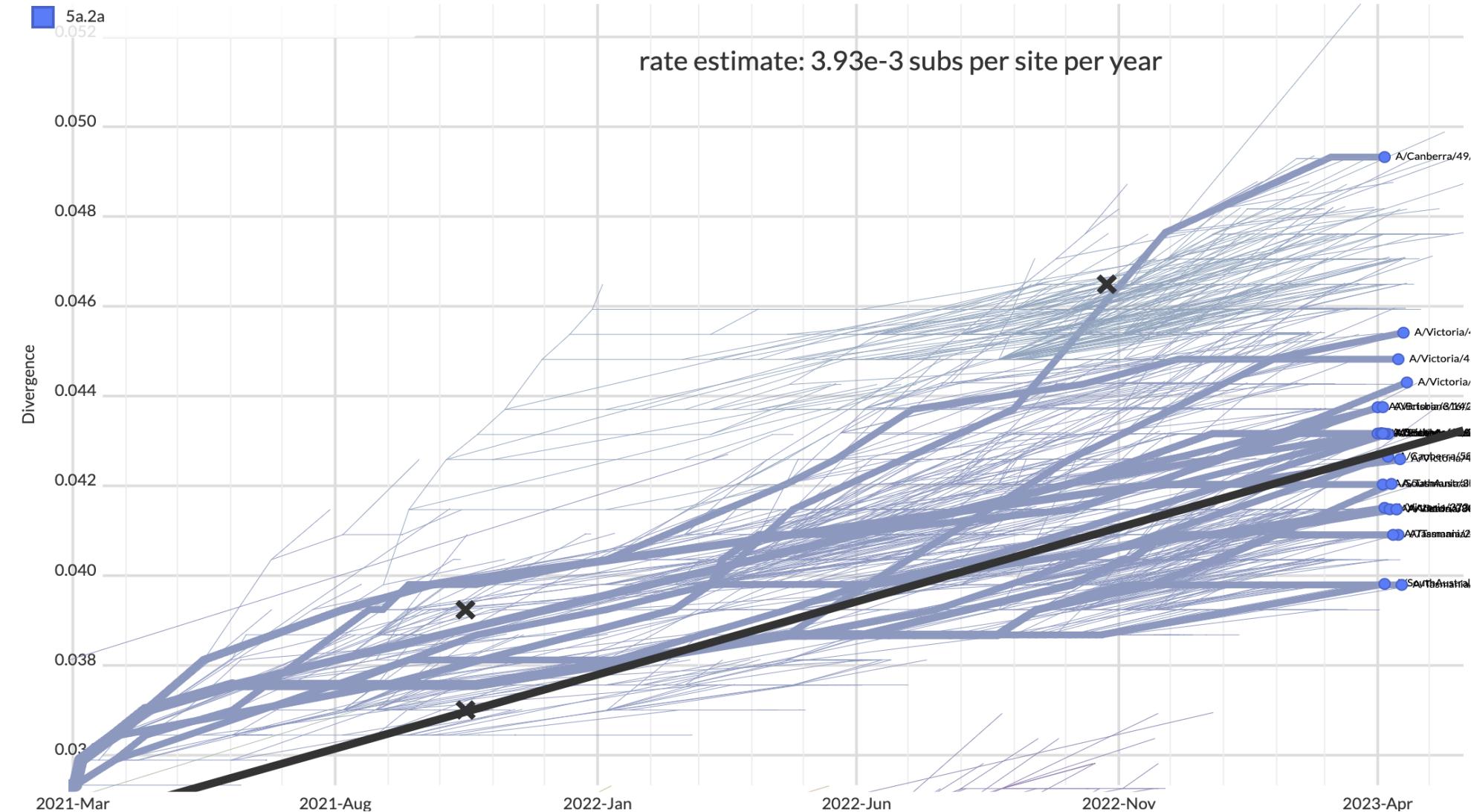
Phylogen

Clade ←



-0.05

rate estimate: 3.93e-3 subs per site per year



Demonstration of Nextstrain

- MPXV all-clades Tree:
 - <https://nextstrain.org/mpox/all-clades>
- Filtering:
 - By country
 - By serotype
- Change colors:
 - Date
 - Country
 - Region
- Interactively explore tree
- Save and export figures and data

Questions? + Resources

- Nextstrain – background on phylogenetics
 - <https://nextstrain.org/narratives/trees-background/>