

Phylogenetic reconstruction and outbreak investigation using IRIDA and SNVPhyl

Aaron Petkau
National Microbiology Laboratory
Public Health Agency of Canada
September 26, 2015

aaron.petkau@phac-aspc.gc.ca



<u>Integrated Rapid Infectious Disease Analysis informatics platform</u> supporting real-time infectious disease outbreak investigations

Genomics, Epidemiology, Clinical, Lab Data



Vision: Open source, standards compliant, enabling rich genomic epi analysis for public health agencies, plus supporting rapid, open genome data release, interacting with, complementing other resources









SNVPhyl

Single Nucleotide Variant PHYlogenomics



Reference Mapping Variant
Identification
& Filtering

 \rightarrow

Phylogeny Generation

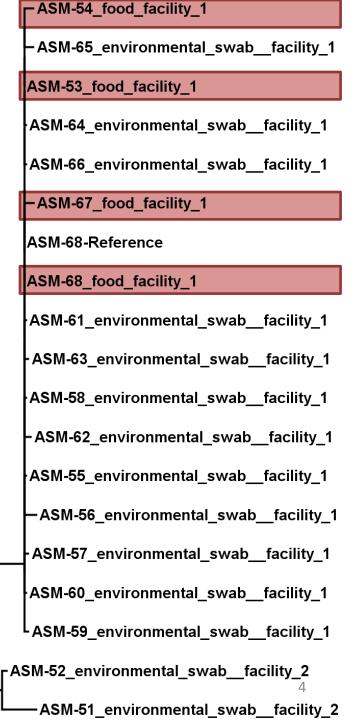
- Implemented in Galaxy
 - Web interface, API, provenance
- **Galaxy**

- QA/QC reports
- Re-labeling of tree

Listeria monocytogenes Methods:

- de novo assembled ASM_68
- Removed phage, repeats
- Matches defined using 0-4 SNVs, match; 5-20 SNVs, uncertain match

Food Product Isolates



Listeria monocytogenes Methods:

- de novo assembled ASM_68
- Removed phage, repeats
- Matches defined using 0-4 SNVs, match; 5-20 SNVs, uncertain match

10 SNVs

Food Product Isolates

~100 SNVs

- ASM-54 food facility 1 - ASM-65 environmental swab facility 1 ASM-53_food_facility_1 ASM-64 environmental swab facility 1 ASM-66_environmental_swab__facility_1 -ASM-67 food facility 1 ASM-68-Reference ASM-68 food facility 1 ASM-61_environmental_swab__facility_1 ·ASM-63_environmental_swab__facility_1 ASM-58 environmental swab facility 1 - ASM-62_environmental_swab__facility_1 ASM-55_environmental_swab__facility_1 ASM-56_environmental_swab__facility_1 ·ASM-57_environmental_swab__facility_1 ·ASM-60_environmental_swab__facility_1 - ASM-59_environmental_swab__facility_1 ASM-52_environmental_swab__facility_2 -ASM-51 environmental swab facility 2

Listeria monocytogenes Methods:

- Downloaded reads from NCBI
- Screened for candidates
- Re-ran SNVPhyl on potential matches

9 SNVs

Additional NCBI Isolates

~100 SNVs

ASM-53_food_facility_1 -SAMN02400164 SRR1027093 SAMN02582713_SRR1112204 ASM-64 environmental swab facility 1 ASM-54 food facility 1 ASM-57 environmental swab facility 1 - ASM-67_food_facility_1 SAMN02689015_SRR1193825 − ASM-56_environmental_swab__facility_1 ASM-68-Reference ASM-68_food_facility_1 ASM-55 environmental swab facility 1 — ASM-65_en√ironmental_swab__facility_1 ASM-62 environmental swab facility 1 SAMN02582710 SRR1112195 ASM-66_environmental_swab__facility_1 ASM-58_environmental_swab__facility_1 ASM-63_environmental_swab__facility_1 ASM-59 environmental swab facility 1 ASM-60 environmental swab facility 1 ASM-61_environmental_swab__facility_1 - ASM-51 environmental swab facility 2 - ASM-52_environmental_swab__facility_2 - SAMN03483404_SRR1975179

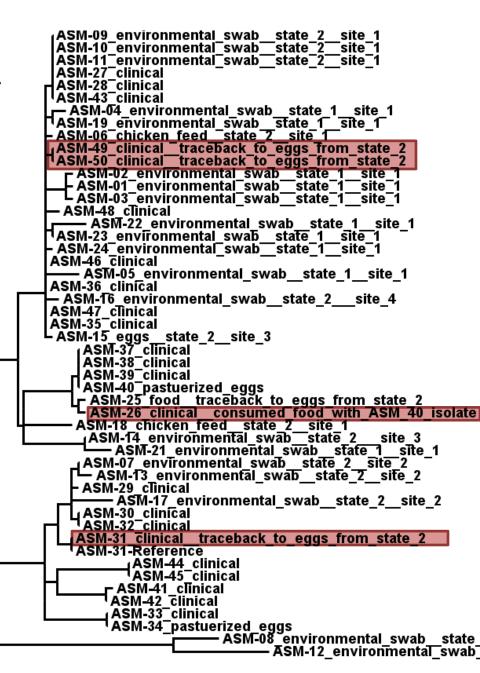
19 SNVs

Salmonella Enteritidis

Salmonella clinical

Methods:

- de novo assembled ASM_31
- Removed ASM_20
- Removed phage, repeats
- Removed 3 sites where ASM_31 (assembly) differs from reads



Salmonella Enteritidis

Salmonella clinical

Methods:

- de novo assembled ASM_31
- Removed ASM_20
- Removed phage, repeats

3 SNVs

10 SNVs

```
ASM-09_environmental_swab__state_2__site_1
ASM-10_environmental_swab__state_2__site_1
ASM-11_environmental_swab__state_2__site_1
 ASM-27<sup>-</sup>clinical
 ASM-28 clinical
 ASM-43 clinical
ASM-43 clinical
ASM-04 environmental swab state 1 site 1
ASM-19 environmental swab state 1 site 1
- ASM-06 chicken feed state 2 site 1
- ASM-49 clinical traceback to eggs from state 2
- ASM-50 clinical traceback to eggs from state 2
- ASM-02 environmental swab state 1 site 1
- ASM-01 environmental swab state 1 site 1
- ASM-03 environmental swab state 1 site 1
   ASM-48 clinical
 ASM-22 environmental swab state 1 site 1
ASM-23 environmental swab state 1 site 1
ASM-24 environmental swab state 1 site 1
ASM-46_clinical
       ASM-05 environmental swab state 1 site 1
ASM-36 clinical
— ASM-16_environmental_swab__state_2__site_4
ASM-47 clinical
ASM-35 clinical
 ASM-15_eggs__state_2__site_3
        ASM-37 clinical
        ASM-38 clinical
        ASM-39 clinical
      ASM-40 pastuerized eggs
- ASM-25 food traceback to eggs from state 2
         ASM-26 clinical consumed food with ASM 40 isolate
      ASM-18 chicken feed state 2 site 1
     ASM-14 environmental swab state 2 site 3
— ASM-21 environmental swab state 1 site 1
_ ASM-07 environmental swab state 2 site 2
_ ASM-13 environmental swab state 2 site 2
_ ASM-20 a finish
     – ASM-29 cTinical
              - ASM-17 environmental swab state 2 site 2
       ı ASM-30 clinical
      ASM-31 clinical traceback to eggs from state 2
     ASM-31-Reference
                  ∡ASM-44 clinical
                   ASM-45 clinical
              - ASM-41 clinical
              ASM-42 clinical
              ASM-33<sup>-</sup>clinical
              ASM-34 pastuerized_eggs
                                        ASM-08 environmental_swab__state
                                                   - ASM-12 environmentaT swab
```

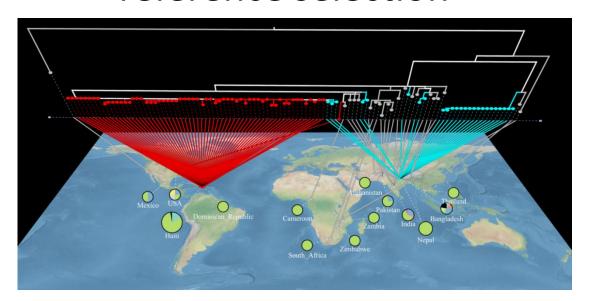
More Information



http://irida.ca, posters #7, #8

Current Interest:

mobile element detection, recombination detection, reference selection



Phylogeography: http://kiwi.cs.dal.ca/GenGIS



Acknowledgements

- NML Public Health Agency of Canada
 - Philip Mabon
 - Franklin Bristow
 - Thomas Matthews
 - Josh Adam
 - Jennifer Cabral
 - Cameron Sieffert
 - Natalie Knox
 - Chrystal Berry
 - Peter Kruczkiewicz
 - Eduardo Taboada
 - Aleisha Reimer
 - Morag Graham
 - Gary Van Domselaar
- CDC
 - Lee S. Katz

 BC Public Health Microbiology & Reference Laboratory

- Damion Dooley
- William Hsiao
- Simon Fraser University
 - Fiona Brinkman
 - Emma Griffiths
 - Geoff Winsor
 - Matthew R. Laird
 - Mélanie Courtot
- University of Lisbon
 - João André Carriço
- Dalhousie University
 - Alex Keddy
 - Robert G. Beiko
- IRIDA Team
- Galaxy Team

http://snvphyl.readthedocs.org/







