

A Genomic Based Data-Driven Risk-Based Enterprise for Operational Decision

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CEO

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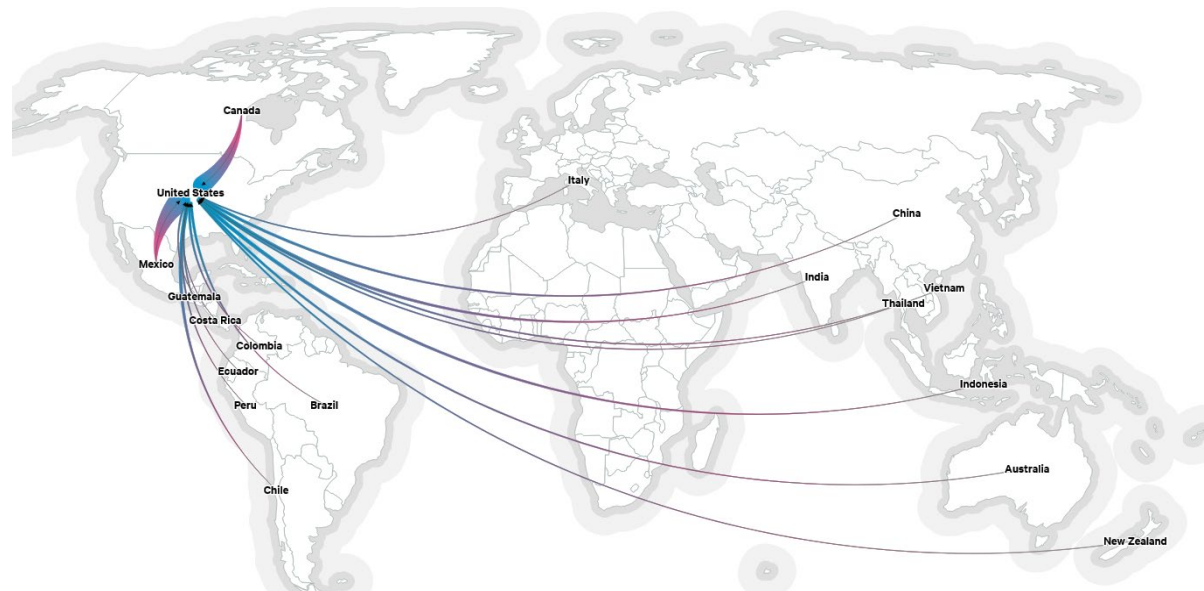
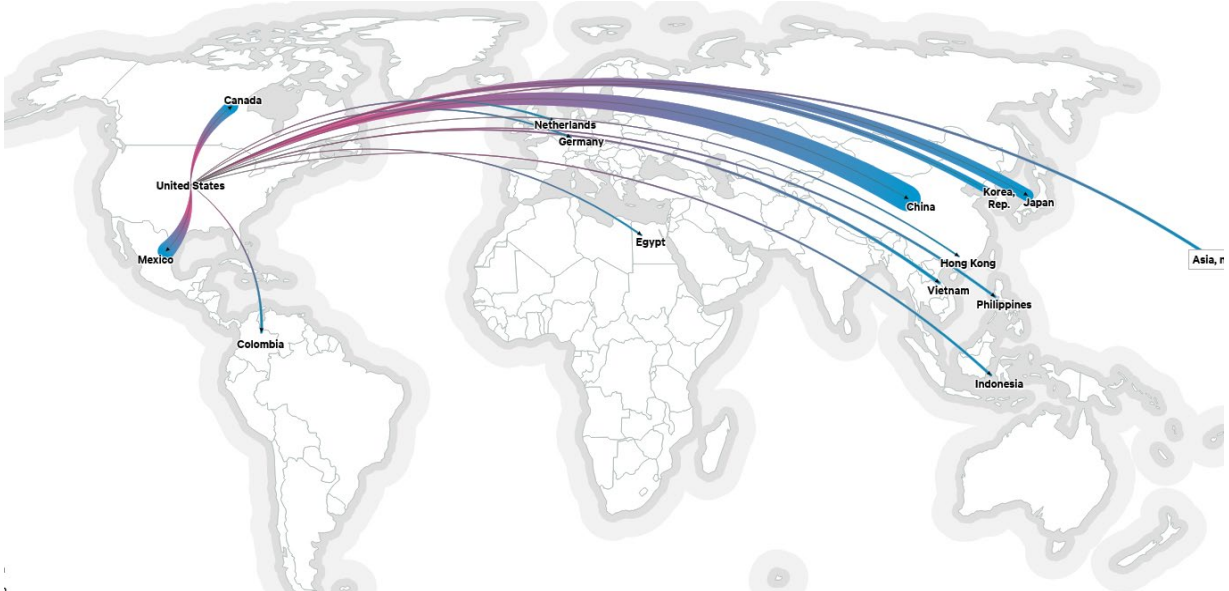


orion
Integrated Biosciences

Discover the Unknown

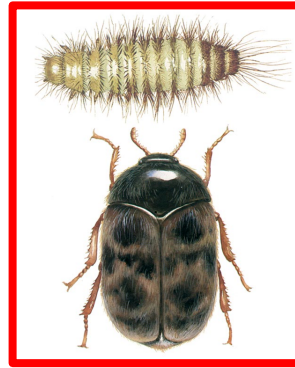
U.S. Agricultural and Food Supply Chain

AFS is one of the 16 critical infrastructure components with **National Security Implications**
FACs are imported from more than 134 countries: 90% of seafood, 40% of vegetables



Exports
\$131 B

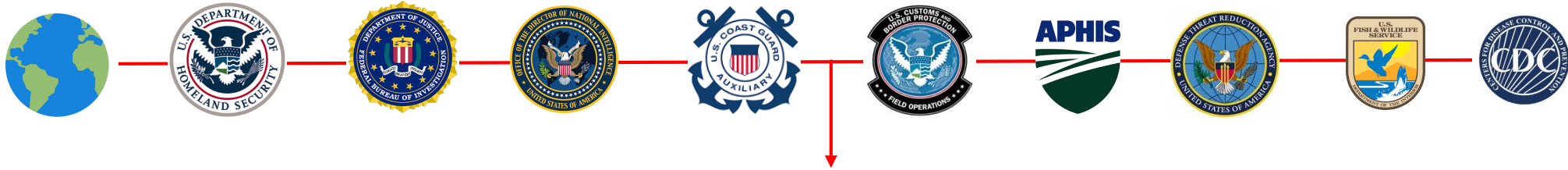
Value



Imports
\$151 B

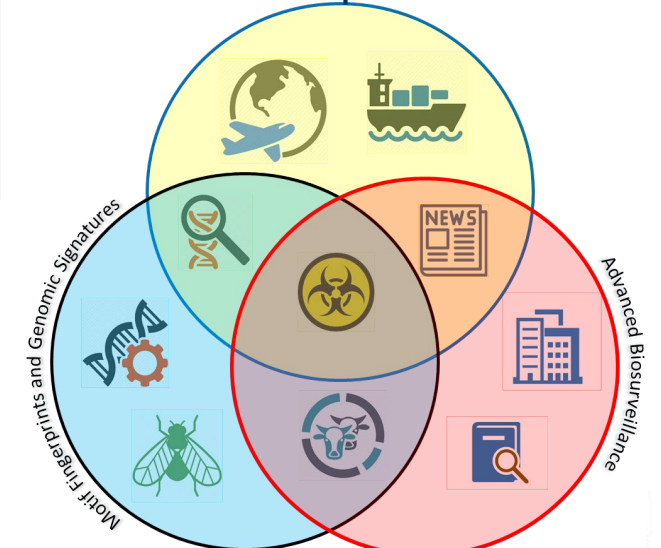
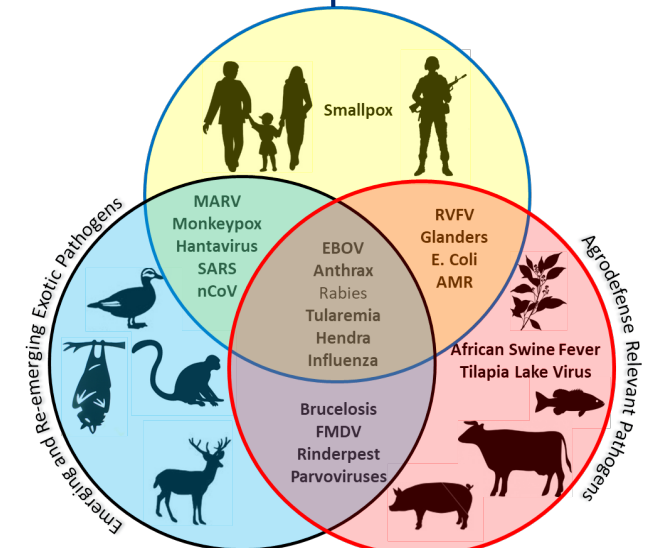
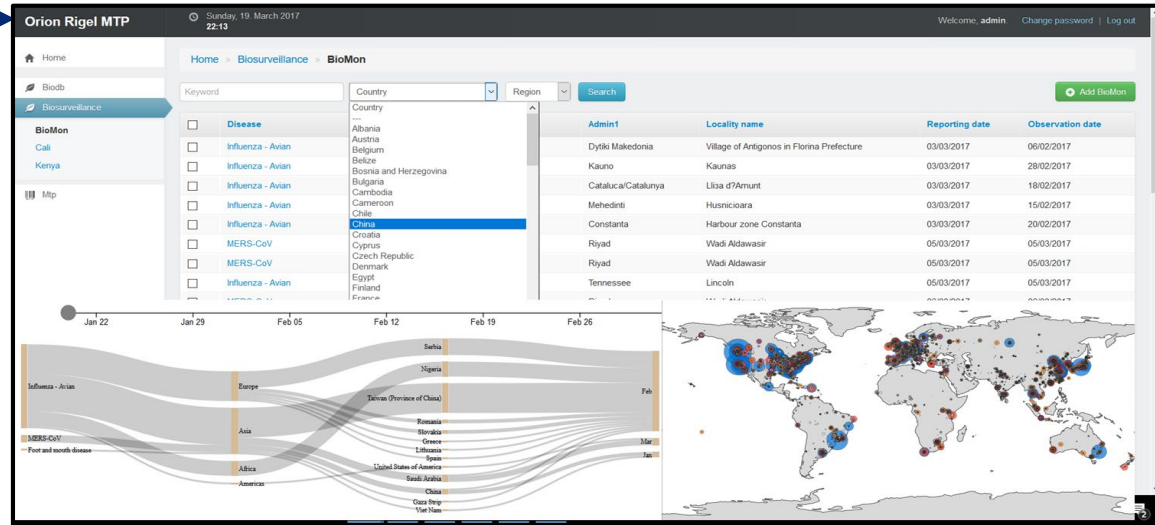


RIGEL Genomic Enterprise for Global Situational Awareness

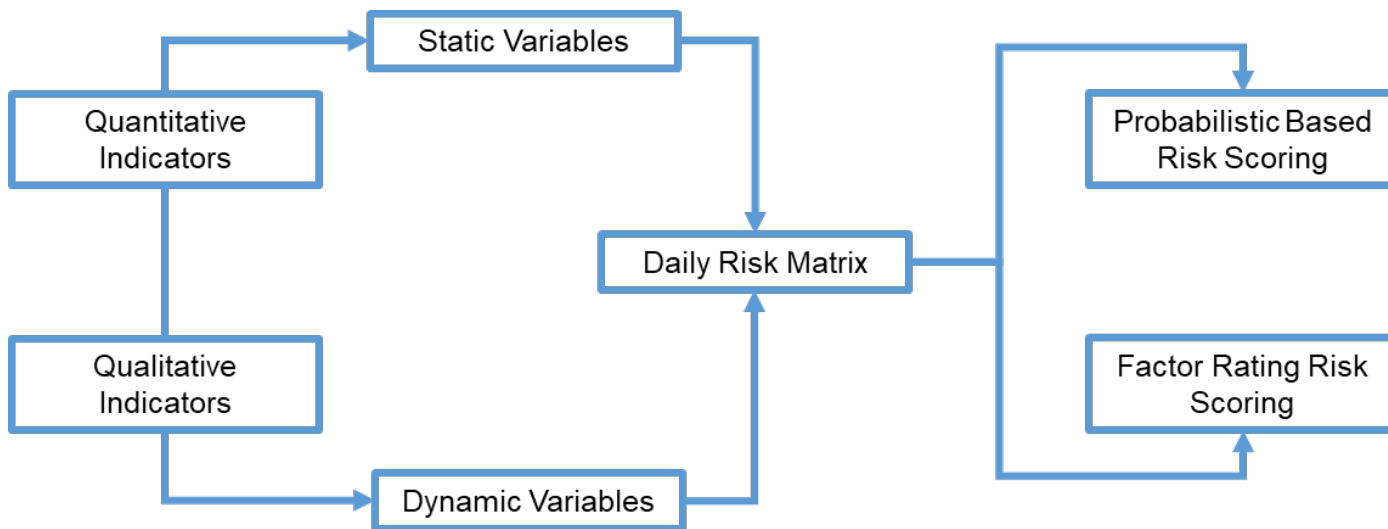
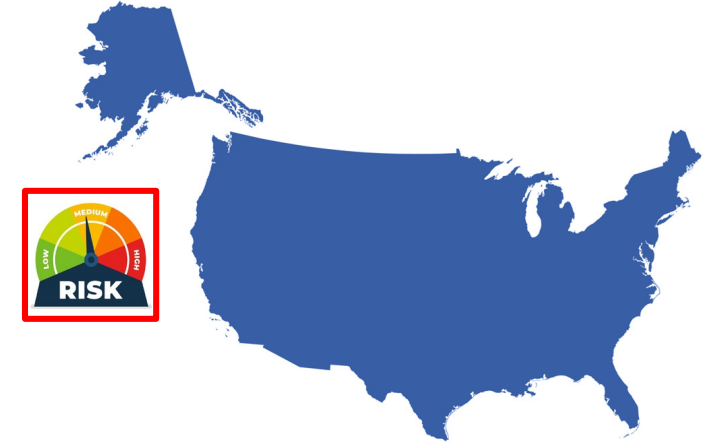
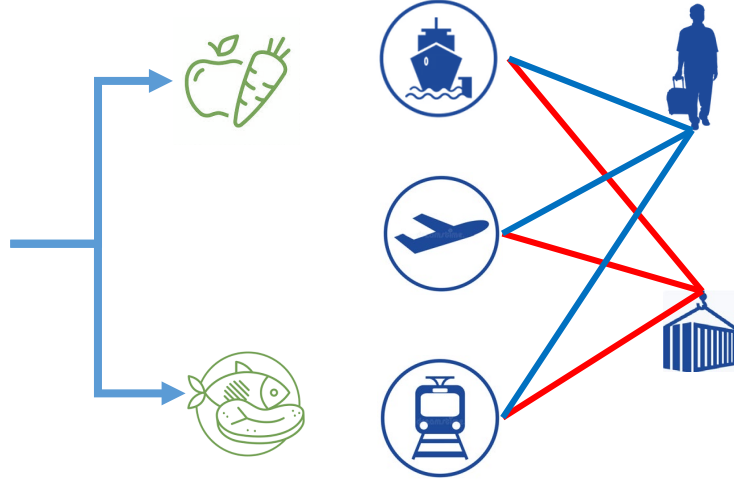


Genomic Collection of Motif Fingerprints

Real-time Data Streams Analytics



Real-time Data Streams Analytics



Risk Level using a Probabilistic Approach

Static

Country SEI

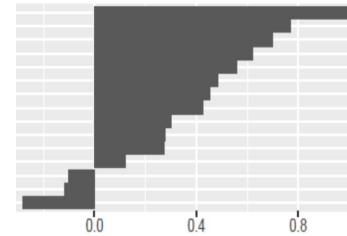
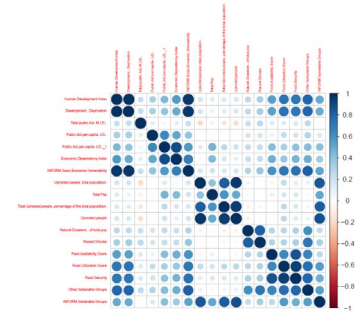
144/33

- Human hazard
- Projected risk of conflict
- Conflict intensity
- Socio-economic vulnerability
- Global Humanitarian Funding
- Health conditions

Disease Matrix

32/9

- Impact on Human Health
- Impact on Animal Health
- Potential of Agroterrorism
- Impact on Trade
- Impact on Food Security
- Persistence in the Environment



Dynamic

Country Capability

17

- Number of World Researchers
- Number of World Institutions
- Number of World Outputs
- Number of Country Researchers
- Number of Country Institutions
- Number of Country Outputs

Disease Event

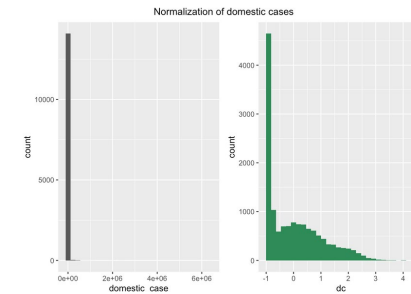
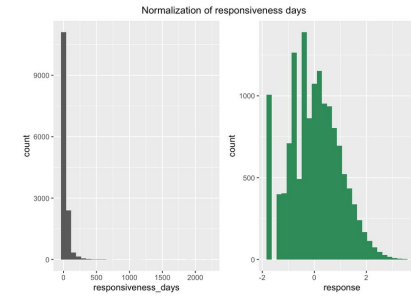
48

- Disease World Locations
- Disease World Reporting Period
- Disease World Domestic Cases
- Disease Country Locations
- Disease Country World Reporting Period
- Disease Country Domestic Cases

Trade Matrix

33

- Number of Incoming Vessels
- Number of Departing Ports
- Number of Arriving Ports
- Number of Containers
- Number of Commodity Containers
- Number of Shippers
- Number of Importers



$$score = dc + dd + cargo + locale + response - researchers$$

Risk Level using a Probabilistic Approach



Data-Driven Risk-Based Enterprise for Operational Decision Support



Drag and Drop or Select Files

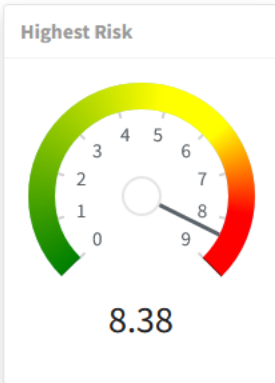
Select Dataset

Default

Simulation Parameters

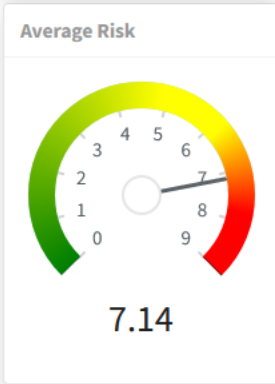
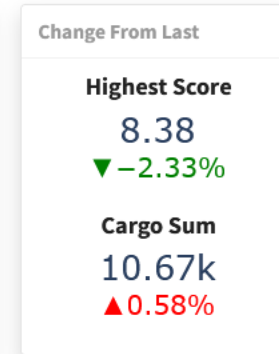
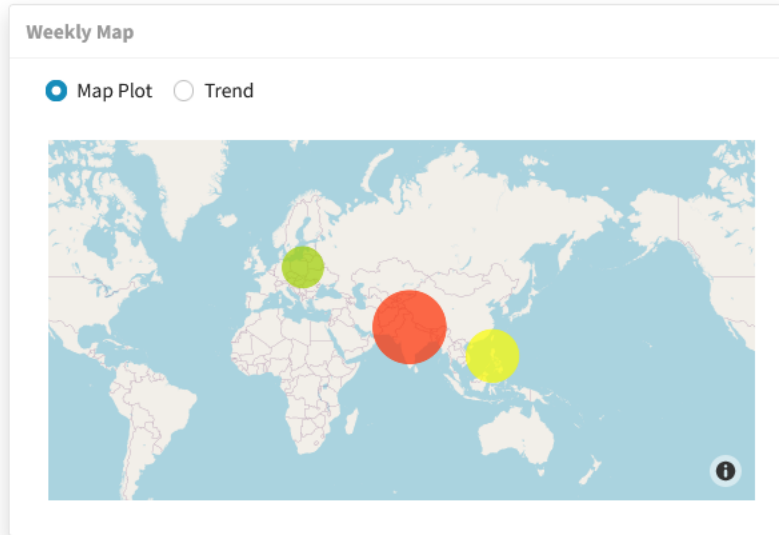
Download Input File

Summary Dashboard Detailed Analysis



Country Risks

India (African swine fever)	8.38
Philippines (Influenza - Avian)	6.84
Poland (Influenza - Avian)	6.19

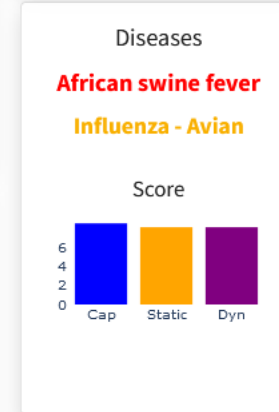


1

Total Commodities: 151926 tons	Commodities: 1254 tons	Percentage: 0.83%
Animal Feed, Hay (585 tons / 46.65%)	Hides And Skins (530 tons / 42.26%)	Meat (139 tons / 11.08%)

2

3



Risk Factor

- fscore_cargo
- fscore_passengers
- fscore_cargo**
- p_risk

Disease Related
 Commodity

Risk Level using a Probabilistic Approach

CROSS-BORDER THREAT SCREENING AND SUPPLY CHAIN DEFENSE

Data-Driven Risk-Based Enterprise for Operational Decision Support



Drag and Drop or Select Files

Select Dataset

Default

Plot Type

Scatter

Simulation Parameters

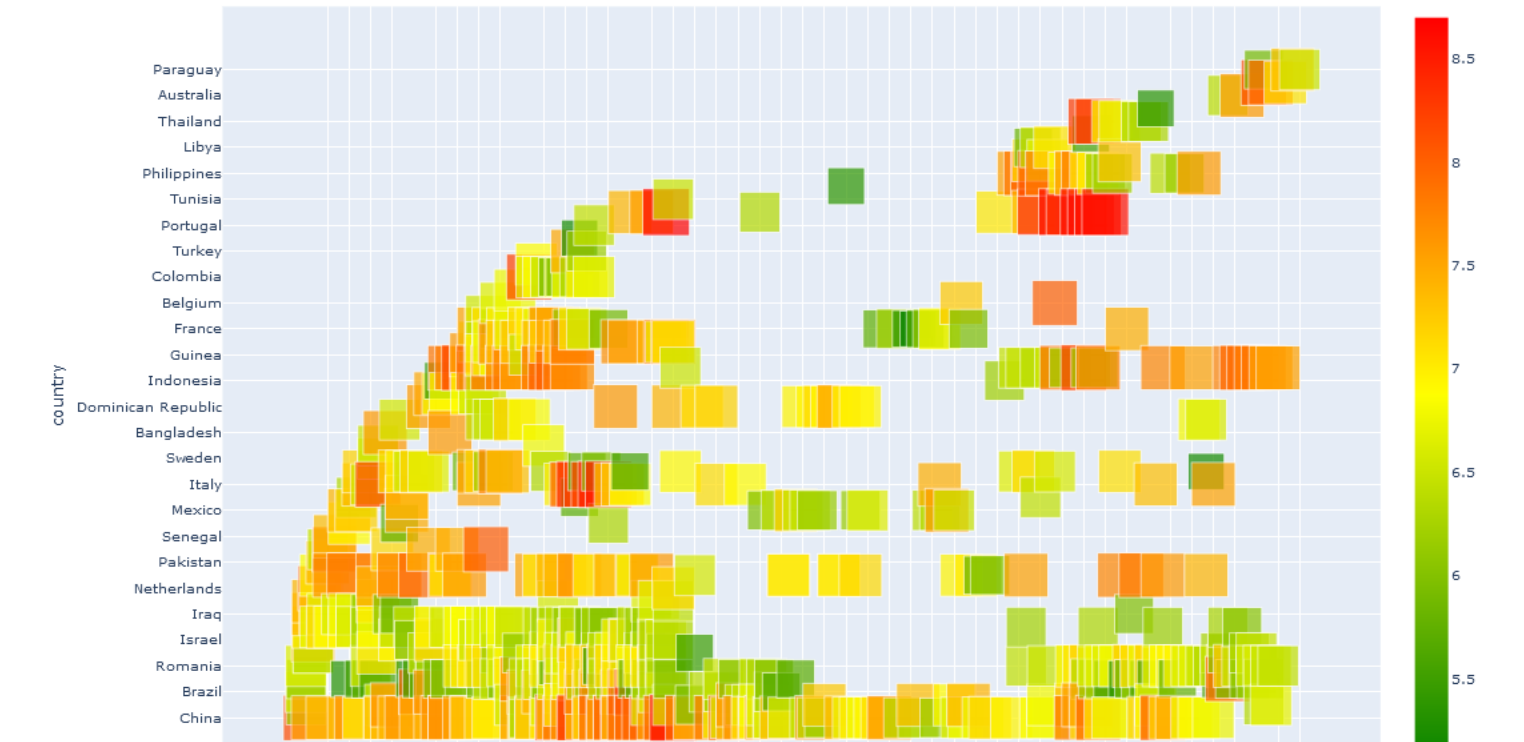
Download Input File

Summary Dashboard Detailed Analysis

Low Medium High All

1

Graph Table



2

Variable

fscore_cargo

Year

ALL

Week

ALL

Country

ALL

3

Disease

ALL

Product Type

No filter

Animal

Plant

Processed Food

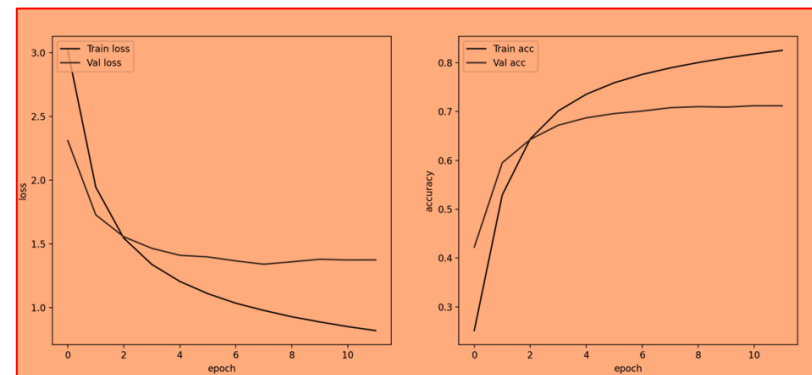
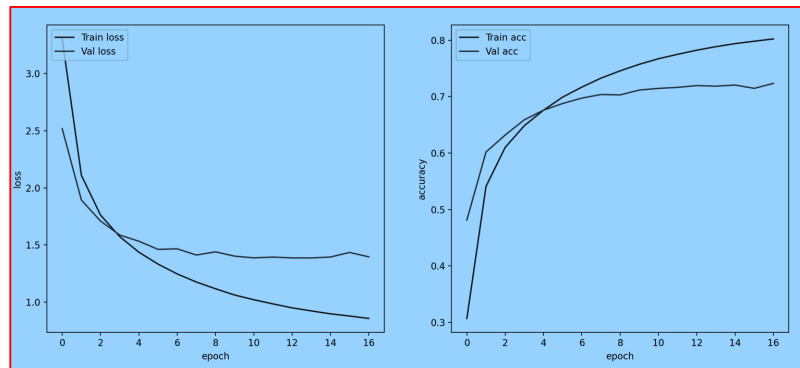
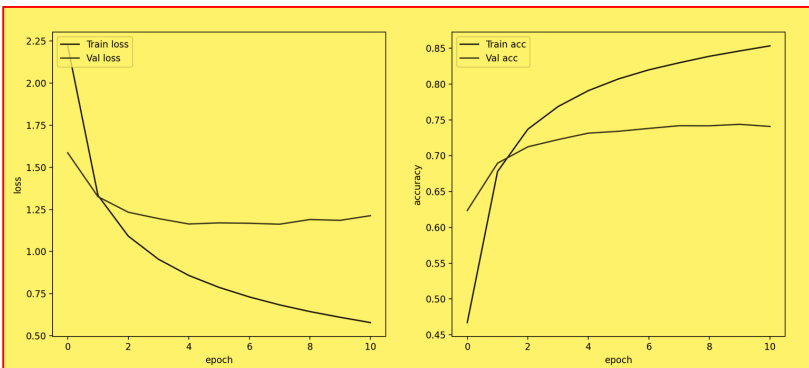
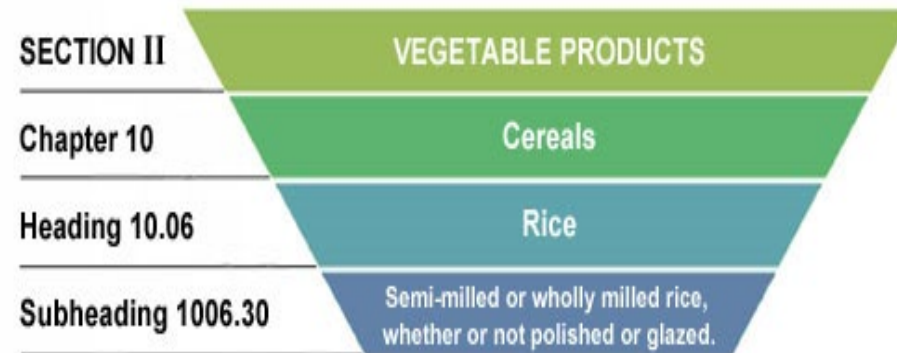
4

ALL

No filter

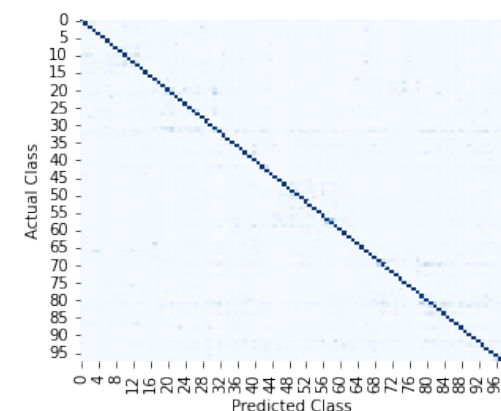
Automated Harmonized Trade Code Mapping

Section (21) – roman numerals
 Chapters (99)
 Headings (1,244)
 Sub-heading (5,224)



HEDGEHOGZ BRN LG INVINCIBLES SNAKE BLU LG INVINCIBLES FOX ORG XS POPPERS CHICKEN YLW XS
 HEDGEHOGZ BRN LG INVINCIBLES SNAKE BLU LG INVINCIBLES FOX ORG XS POPPERS CHICKEN YLW XS
 ROPIEZ DRAGON BLU RANCH ROPERZ CHICKEN YLW SM MAGIC MATS UNICORN PRP LG RANCH ROPERZ CHICKEN YLW SM LONGITUDES FARM MLT LON
 TERRACOTTA TURTLE O14 TERRACOTTA TURTLE, O14 TERRACOTTA TORTOISE AS PER PO NO.464482 O14 A5 TERRACOTTA CHICKEN AS PER PO NO
 SHIPPER S LOAD, COUNT, SEAL AND WEIGHT 10X40 HC CY/CY 10 CNTRS. 63,216 CARTONS PET FOOD UNDER
 BIRD CAGE CHRISTMAS DECORATIONS CHICKEN CAGE ONTAINS NO WOOD PACKING MATERIAL (WPM)
 BIRD CAGE GARDEN CART KNEEL CHAIR BIRD CAGE BIRD CAGE SNOW ROOF RAKE FIREPLACE STORAGE STAND B
 RAISED GARDEN BED BABY PLAYPEN DOG TRAINING KIT PLASTIC BARRIER COOP CHICKEN CAGE TRAINING NET
 RAISED GARDEN BED BABY PLAYPEN DOG TRAINING KIT PLASTIC BARRIER COOP CHICKEN CAGE TRAINING NET
 WOODEN DOG HOUSEWOODEN ENCLOSUREWOODEN BIRD FEEDERWOODEN CHICKEN HOUSE
 WOODEN RABBIT CAGE CHICKEN COOP BIRD FEEDER B.
 SHIPPERS LOAD, COUNT, SEAL AND WEIGHT 10X40 HC CY/CY 10 CNTRS. 65,250 CARTONS CUP CATFOOD,CUP DOGFOOD UNDER RO NOS. 567615-
 SHIPPERS LOAD, COUNT, SEAL AND WEIGHT 10X40 HC CY/CY 10 CNTRS. 66,489 CARTONS PET FOOD UNDER RO NOS.416425-28,416425-29,416
 ANIMAL FEED PREP EXCEPT DOG OR CAT FOOD RETA 01 CONTAINER 40 HC CONTAINING 1075 PACKAGES WITH PET FOOD AS COMMERCIAL INVOIC
 PREPARATIONS OF A KIND USED IN ANIMAL FEEDING- 0 - 01 CONTAINER 40 HC CONTAINING: 1.080 PACKAGES WITH PET FOOD AS COMMERCIA
 36 CARTON 54 KEYS DIGITAL KEYBOARD ORDER 859202 ITEM 486722 HTS 108.0 EACHCARTON36.0 EACH INVOICE SHIPPER: SUN MATE CORP YT

TOP1 Accuracy: 0.8283085710154358
Top1 F1 : 0.7055735123299153
Top1 recall : 0.7077082504910289
Top1 precision : 0.7146320936905665



Automated News Classification and NER for Pests

```

▼ 0:
  search_phrase:          null
  article_category:      null
  ▼ article_title:       "us (fl): scientists warn of invasive plant pest; say early detection, reporting key"
  translated_article_title: null
  ▼ article_title_sentiment:
    polarity:            0.05
    subjectivity:        0.65
  translated_article_title_sentiment: null
  ▼ keywords:
    0:                   "early"
    1:                   "including"
    2:                   "species"
    3:                   "key"
    4:                   "osborne"
    5:                   "pest"
    6:                   "scientists"

```

```

▼ persons:
  lance osborne:        1
  muhammad:             1
  cindy mckenzie:      1
  john roberts:         1
  alexandra revynthi:  1
  translated_persons:   {}
  ▼ organizations:
    uf/ifas:            1
    zee:                1
    usda:               2
    the florida department of agriculture: 1
  translated_organizations: {}
  events:               {}
  translated_events:    {}
  diseases:             {}
  translated_diseases:  {}
  chemicals:            {}
  translated_chemicals: {}
  ▼ organisms:
    ▼ ncbi:1350418:
      thrips parvispinus: 4
    ▼ ncbi:706740:
      osbornellus:        5

```

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▼ palm beach county:
  times_mentioned_in_article: 1
  locaton_type:               "administrative"
  latitude:                   26.6279798
  longitude:                   -80.4494174
  ▼ weather:
    average_temp_celsius:     23.1
    min_temp_celsius:         20.7
    max_temp_celsius:         26.7
    precipitation_mm:         0
    snow_mm:                  null
    wind_direction_degrees:   57
    wind_speed_km_per_hour:   20.3
    wind_peak_gust_km_per_hour: null
    atmospheric_pressure_hpa: 1020.7
    one_hour_sunshine_in_mins: null

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```

"fl"
"warn"
"reporting"
"invasive"
"florida"
"thrips"
"plants"
"insect"
"research"

```

US (FL): Scientists warn of invasive plant pest; say early detection, reporting key

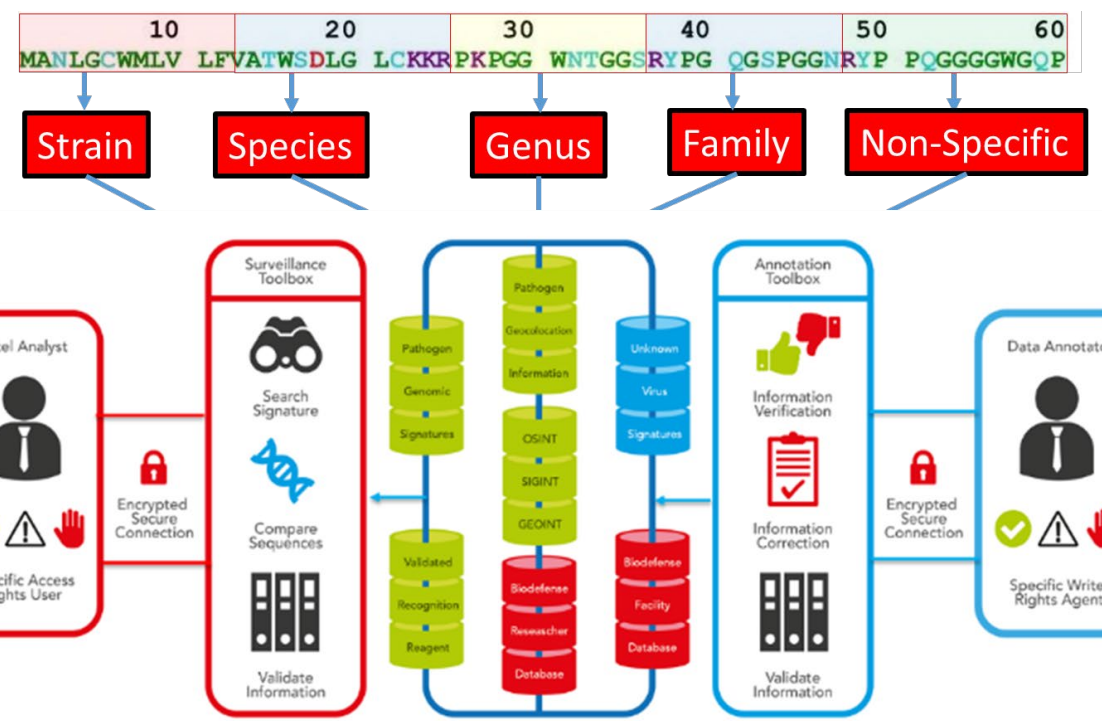
An invasive thrips species have started to wreak havoc in Florida. The insect was first detected in Florida in 2020 but has since spread significantly across the state. What once was isolated to greenhouses now has begun to harm a wide range of plants, including those in residential landscapes.

The insect, *Thrips parvispinus* — commonly known as pepper thrips — is one of the smallest thrips species in Florida. Its size makes it challenging to detect. The tiny insects fly and hop from plant to plant, rasping the plant with their mouthparts and sucking the sap. Feeding on the plant restricts the plant's growth and reduces crop yields. Researchers don't know of any viruses this species transmits, but often, thrips can transmit viruses between plants, killing the plants.

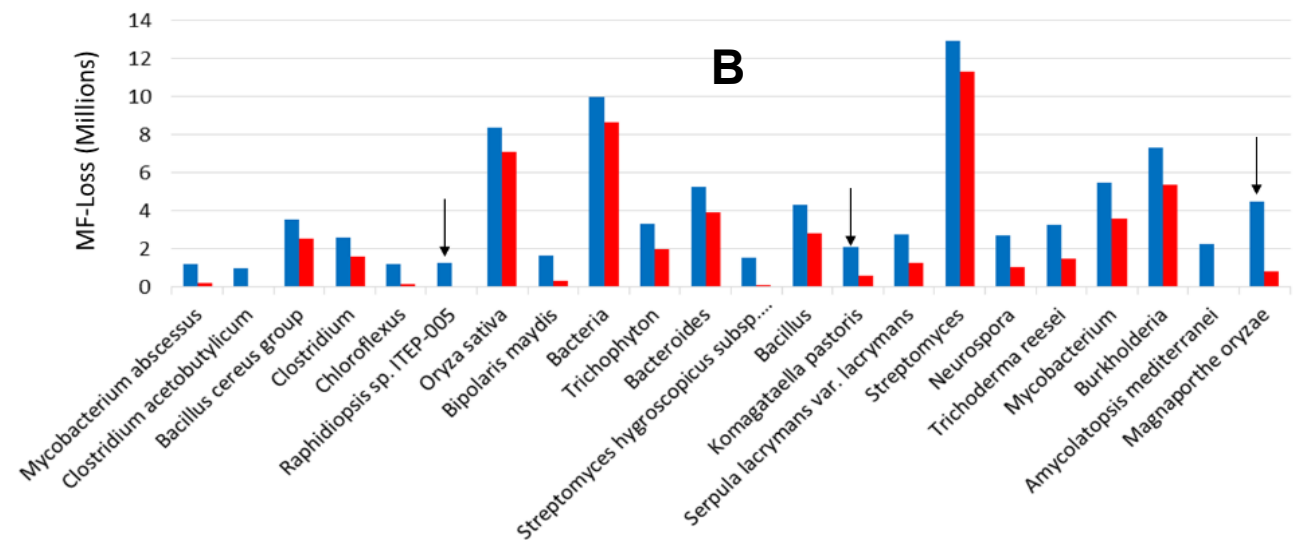
"In order to minimize any kind of negative impacts, we started warning people right away that this pest had made its way to Florida," said Lance Osborne, UF/IFAS entomologist at the Mid-Florida Research and Education Center. "We better be careful. This insect is notorious for damaging peppers around the world, but now it has moved from the greenhouse to the environment and has established itself in several areas around the state."

Genomic-Based Biosurveillance: Motif Fingerprint

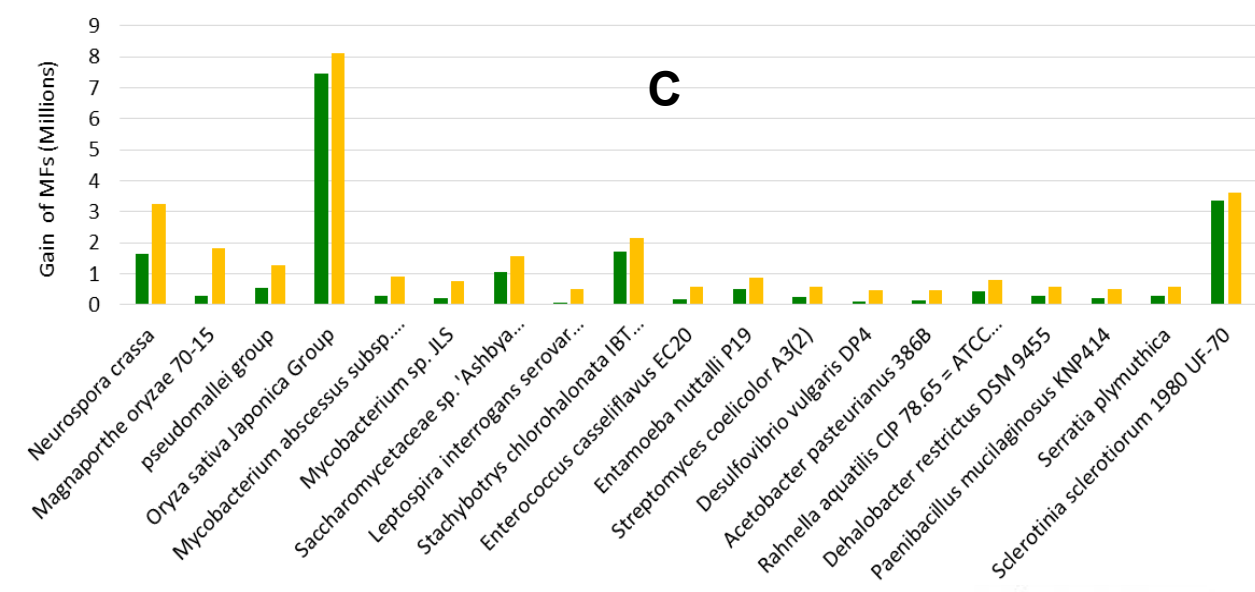
A



B

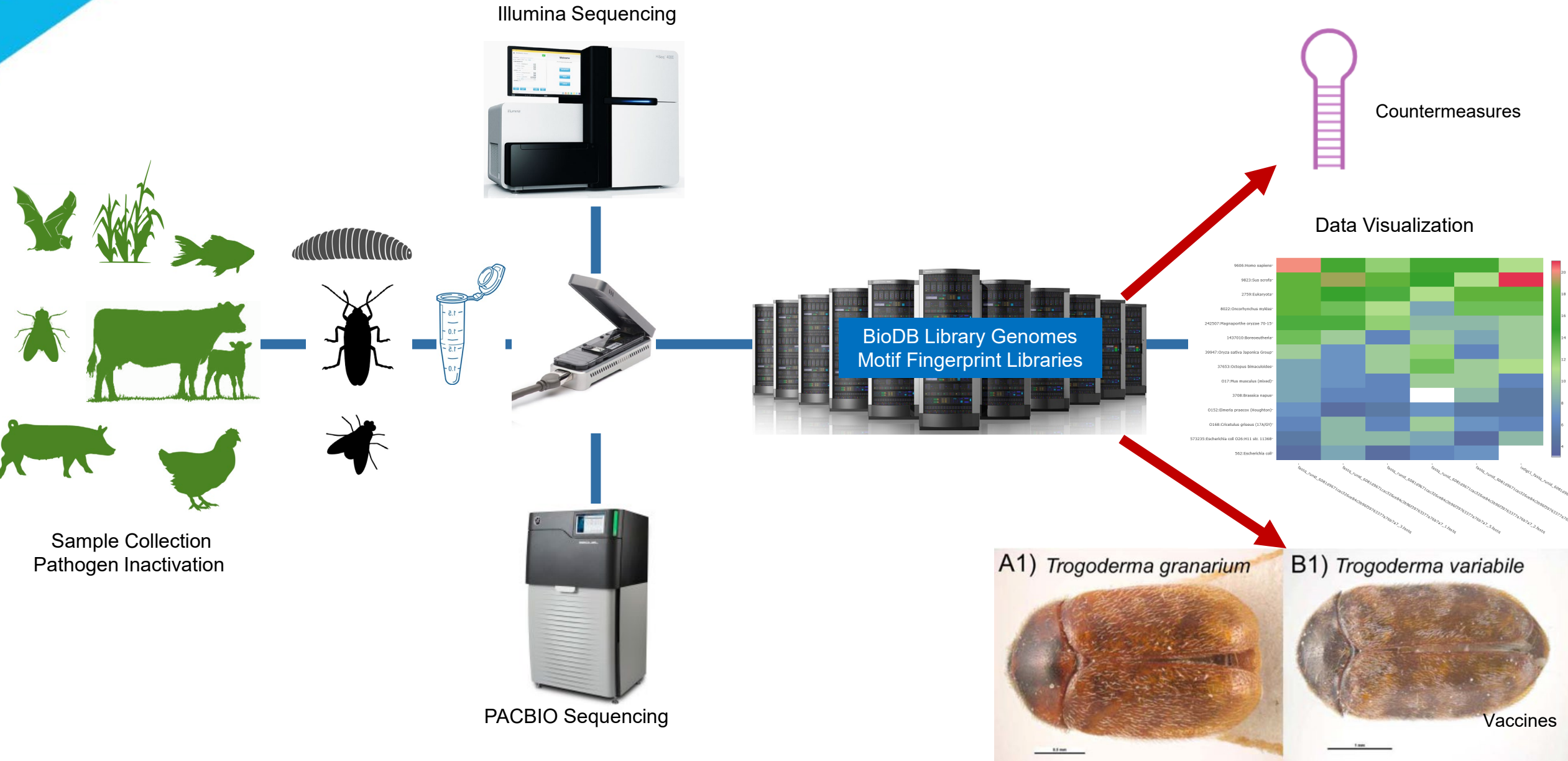


C



9.5 billion motif fingerprints
8.5 million taxonomies resolving at the strain level
600,000 plasmids, including 29 profiles of AMR
Pesticide Resistance Profiles

Molecular Taxonomic Profiling:



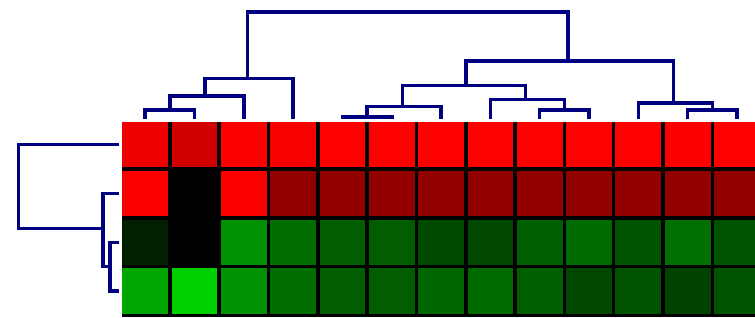
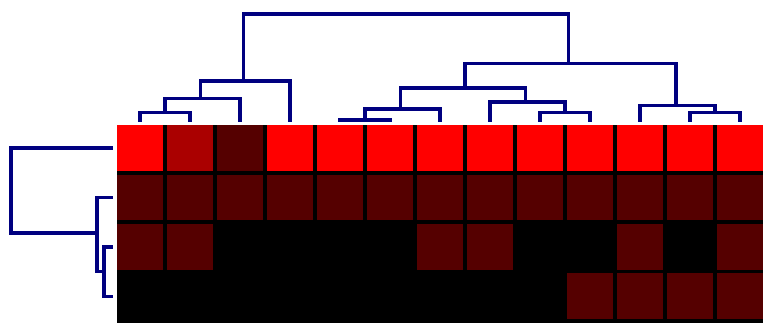
Molecular Taxonomic Profiling: Maize streak virus

HOMOLOGY COMPARISON

RIGEL MTP

maize_streak_500
 maize_streak_700
 maize_streak_1000
 maize_streak_30
 maize_streak_70
 maize_streak_40
 maize_streak_60
 maize_streak_50
 maize_streak_90
 maize_streak_100
 maize_streak_80
 maize_streak_150
 maize_streak_200

maize_streak_500
 maize_streak_700
 maize_streak_1000
 maize_streak_30
 maize_streak_70
 maize_streak_40
 maize_streak_60
 maize_streak_50
 maize_streak_90
 maize_streak_100
 maize_streak_80
 maize_streak_150
 maize_streak_200



Read Count

Discrimination call



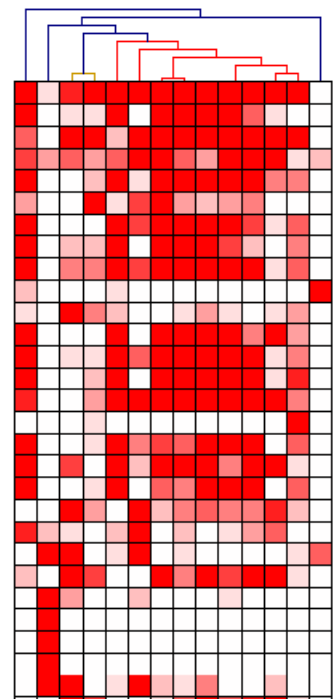
- 10821:Maize streak virus
- 046536:Maize streak virus (MSV-B)
- 288326:Maize streak virus - A[Nigeria1]
- 02763687:Maize streak virus - A[Bambui] (MB1K1)

9.5 billion motif fingerprints
 8.5 million taxonomies resolving at the subtype, serovar, strain level
 600,000 plasmids, including 29 profiles of AMR,



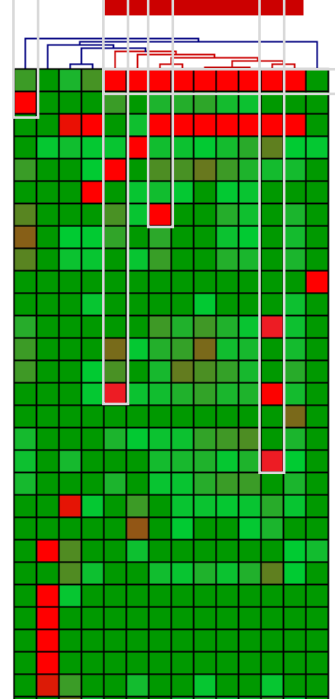
Molecular Taxonomic Profiling: *Fusarium spp.*

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 srr1382101_fusarium_virguliforme.fas
 srr2273546_fusarium_verticillioideis.fas
 fusarium_oxysporum_f_sp_cubense_race_1.fas
 aaxh01_fusarium_oxysporum_f_sp_lycopersici.fas
 srr4129147_fusarium_oxysporum_f_sp_pisi.fas
 srr1343468_fusarium_oxysporum_f_sp_melonis.fas
 srr637400_fusarium_oxysporum_f_sp_ciceris.fas
 srr3130027_fusarium_oxysporum_f_sp_radici_cucumerinum.fas
 srr2918105_fusarium_oxysporum_f_sp_cepae.fas
 srr500166_fusarium_oxysporum_f_sp_cubense_race_4.fas
 srr3437483_fusarium_oxysporum_f_sp_apii_race_2_isolate_247.fas
 srr2148511_fusarium_mock.sra



- 5507:Fusarium oxysporum
- 1089457:Fusarium oxysporum f. sp. conglutinans race 2 54008
- 5506:Fusarium
- 33154:Opisthokonta
- 1229664:Fusarium oxysporum f. sp. cubense race 1
- 334819:Fusarium verticillioideis 7600
- 1080344:Fusarium oxysporum f. sp. pisi HDV247
- 1089458:Fusarium oxysporum f. sp. raphani 54005
- 426428:Fusarium oxysporum f. sp. lycopersici 4287
- 278163:Fusarium fujikuroi var. intermedia
- 660122:Nectria haematococca mpVI 77-13-4
- 1229665:Fusarium oxysporum f. sp. cubense race 4
- 1089449:Fusarium oxysporum f. sp. vasinfectum 25433
- 1089402:Fusarium oxysporum f. sp. melonis 20400
- 61366:Fusarium oxysporum f. cubense
- 0304339:Ralstonia solanacearum (Phyl III-seqV23)
- 1080343:Fusarium oxysporum f. sp. lycopersici MN25
- 1089451:Fusarium oxysporum f. sp. cubense tropical race 4 54006
- 1089448:Fusarium oxysporum f. sp. radici-lycopersici 26381
- 716546:leotiomyceta
- 131567:cellular organisms
- 016:Zea mays (B73)
- 5125:Hypocreales
- 03634:Medicago truncatula (A17)
- 3659:Cucumis sativus
- 564808:Micromonas pusilla CCMP1545
- 472368:Dorcoceras hygrometricum
- 0571:Capitella teleta (I ESC-2004)

fusarium_oxysporum_f_sp_conglutinans.fas
 srr3274659_fusarium_mangiferae.fas
 srr1382101_fusarium_virguliforme.fas
 srr2273546_fusarium_verticillioideis.fas
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 srr2148511_fusarium_mock.sra



- 5507:Fusarium oxysporum
- 1089457:Fusarium oxysporum f. sp. conglutinans race 2 54008
- 5506:Fusarium
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- 1229664:Fusarium oxysporum f. sp. cubense race 1
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- 1229665:Fusarium oxysporum f. sp. cubense race 4
- 1089449:Fusarium oxysporum f. sp. vasinfectum 25433
- 1089452:Fusarium oxysporum f. sp. melonis 26406
- 61366:Fusarium oxysporum f. cubense
- 0304339:Ralstonia solanacearum (Phyl III-seqV23)
- 1080343:Fusarium oxysporum f. sp. lycopersici MN25
- 1089451:Fusarium oxysporum f. sp. cubense tropical race 4 54006
- 1089448:Fusarium oxysporum f. sp. radici-lycopersici 26381
- 716546:leotiomyceta
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- 3659:Cucumis sativus
- 564808:Micromonas pusilla CCMP1545
- 472368:Dorcoceras hygrometricum
- 0571:Capitella teleta (I ESC-2004)



Molecular Taxonomic Profiling: Bactrocera spp.



Adult

10-14 days



Puparia

7-14 days to sexual maturation



Oriental fruit fly Life Cycle

1-3 months



7-12 days

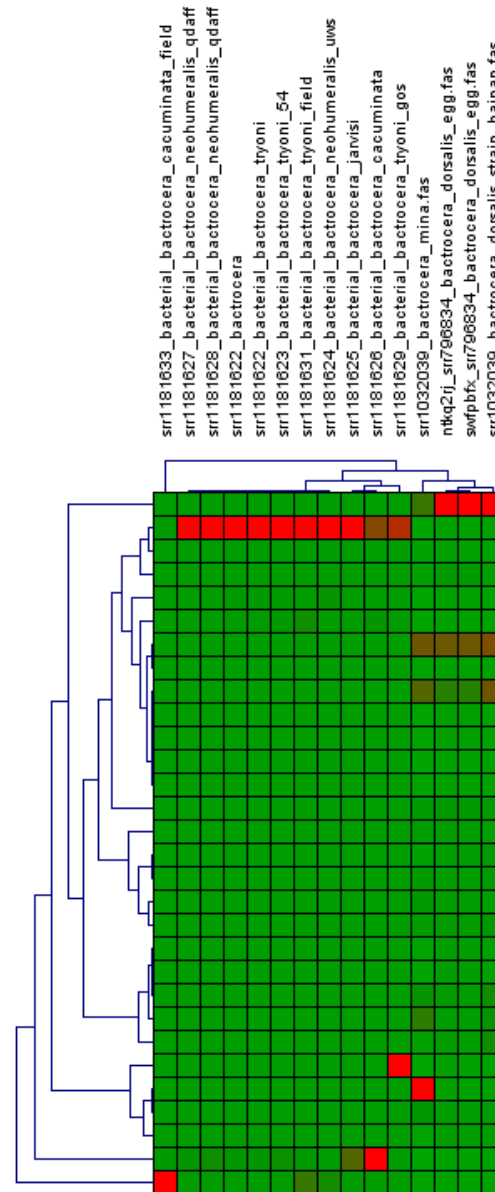


Eggs

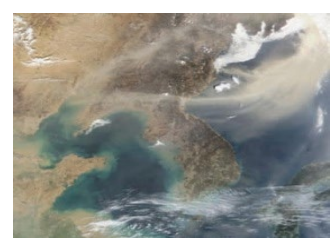
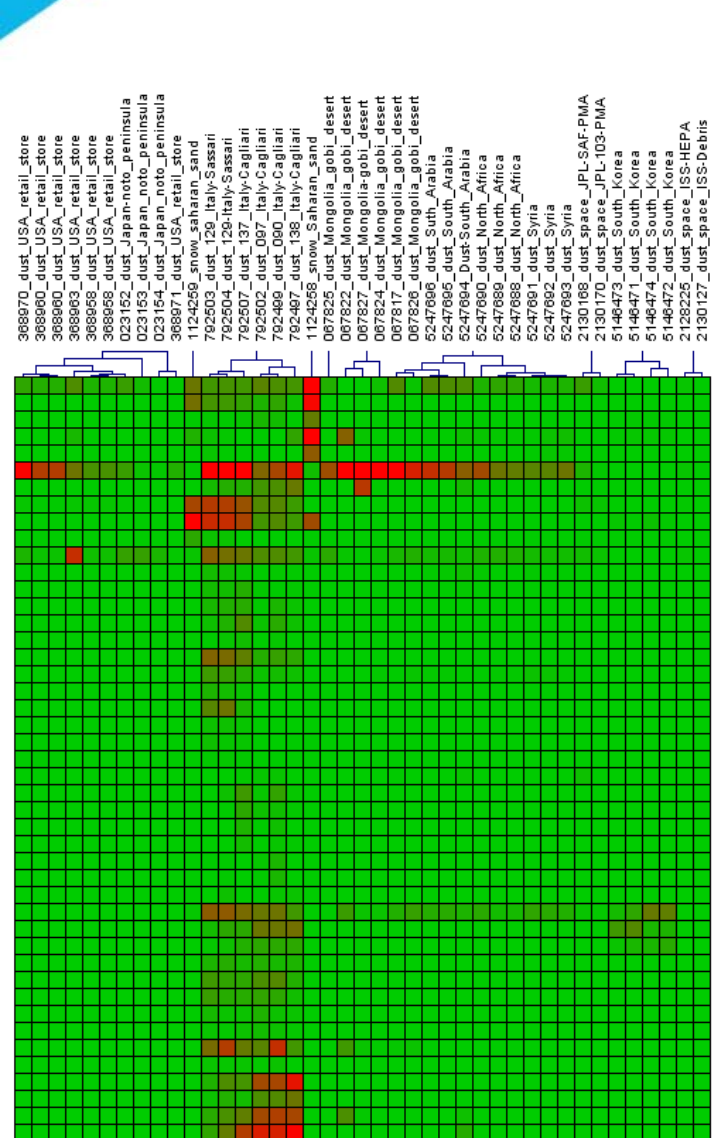
1-2 days



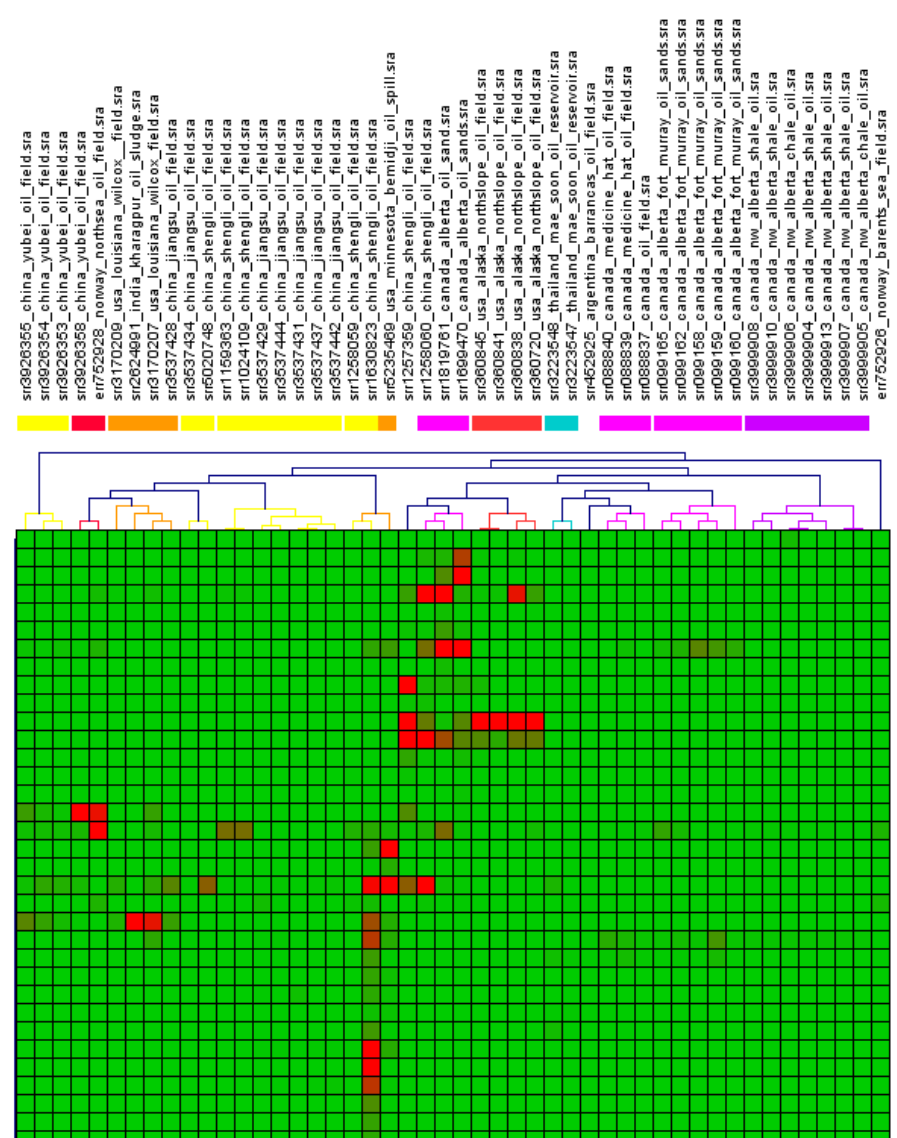
Larvae



Molecular Taxonomic Profiling: Complex Samples



- 1091495: Taylorella asinigenitalis 14/45
- 520463: Brucella pinnipedialis M163/99/10
- 656088: Mycoplasma mycoides group
- 03634: Medicago truncatula (A17)
- 58024: Spermatophyta
- 77133: uncultured bacterium
- 543: Enterobacteriaceae
- 393480: Fusobacterium nucleatum subsp. polymorphum ATCC
- 554131: Thiomonas sp. CB2
- 1701324: uncultured bacterium 5E7
- 131567: cellular organisms
- 0841: Mucor ambiguus (NBRC 6742)
- 748671: Lactobacillus crispatus ST1
- 1883: Streptomyces
- 1744: Propionibacterium freudenreichii
- 9608: Homo sapiens
- 80840: Burkholderiales
- 1150469: Parahodospirillum photometricum DSM 122
- 0805907: Candidatus Nitrosoglobus terrae (TAO100)
- 1701325: uncultured bacterium 5G12
- 41295: Rhodospirillaceae
- 506: Alcaligenaceae
- 2759: Eukaryota
- 47715: Lactobacillus rhamnosus
- 1412570: Salmonella enterica subsp. enterica serovar Enteritidis
- 01559351: Vibrio campbellii ATCC BAA-1116 (ATCC BAA-1116)
- 0543568: Klebsiella pneumoniae (CAV1417)
- 198214: Shigella flexneri 2a str. 301
- 28035: Staphylococcus lugdunensis
- 435837: Staphylococcus hominis subsp. hominis C80
- 01640943: Xanthomonas fragariae (P55205)
- 2: Bacteria
- 91347: Enterobacteriales
- 04934: Clonorchis sinensis (Henan)
- 243233: Methylococcus capsulatus str. Bath
- 03354912: Staphylococcus lugdunensis (VLSLISI_22)
- 1578: Lactobacillus
- 1353243: Streptococcus anginosus subsp. whileyi MAS624
- 0742432: Lactobacillus sakei (LK-146)
- 0304339: Ralstonia solanacearum (Phyl III-seqV23)
- 568704: Lactobacillus rhamnosus Lc 705
- 08746: Pinus taeda (1274)
- 0783549: Escherichia coli (ST2747)
- 941280: Escherichia coli O25b:H4
- 573: Klebsiella pneumoniae



- 1385930: Burkholderia dolosa PC543
- 6279: Buglia malayi
- 01662268: Vitreoscilla filiformis (ATCC 15551)
- 36087: Trichuris trichiura
- 0104582: Thermus thermophilus (TMY)
- 1701324: uncultured bacterium 5E7
- 1091495: Taylorella asinigenitalis 14/45
- 196164: Corynebacterium efficiens YS-314
- 455088: uncultured planctomycete 6FN
- 39947: Oryza sativa Japonica Group
- 01788349: Modestobacter marinus (BC501)
- 1783272: Terrabacteria group
- 3880: Medicago truncatula
- 754164: Influenza A virus (A/Gangwon/1805/2009(H1N1))
- 069982: Escherichia coli (DS1)
- 3871: Lupinus angustifolius
- 131567: cellular organisms
- 457427: Streptomyces himastatinicus ATCC 53653
- 431944: Magnetospirillum gryphiswaldense MSR-1
- 02507879: Heliobacterium modesticaldum lce1 (lce1; ATCC 51547)
- 1437201: Pentapetalae
- 667019: Curvibacter putative symbiont of Hydra magnipapillata
- 3555: Beta vulgaris subsp. vulgaris
- 941280: Escherichia coli O25b:H4
- 166314: Synechococcus sp. WH 8109
- 391296: Streptococcus suis 98HAH33
- 537937: Bifidobacterium longum subsp. infantis CCUG 52486
- 585145: Staphylococcus aureus subsp. aureus 65-1322
- 91891: Legionella pneumophila subsp. pneumophila
- 573: Klebsiella pneumoniae
- 201089: uncultured Desulfobacterium sp.
- 0841: Mucor ambiguus (NBRC 6742)
- 1150469: Parahodospirillum photometricum DSM 122
- 024329: Flammeovirga yaeyamensis (MY04)

RIGEL Genomic Enterprise for Global Situational Awareness

DATA COLLECTION

RISK-BASED ANALYTICS

HSE MISSION



*Known and Unknown Transboundary Infectious Diseases as Hybrid Threats
Valdivia-Granda, W.A. Frontiers in Public Health (2021)*



Acknowledgments



A Data-Driven Risk-Based Enterprise for Operational Decision

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CROSS-BORDER THREAT SCREENING
AND SUPPLY CHAIN DEFENSE