

Hawai'i phytopathogen database for disease diagnosis, consultation, and risk assessments

Josiah Marquez, Hawai'i Department of Agriculture, Honolulu, HI

Introduction

Phytopathogen indices are essential for disease diagnosis, consultation, and risk assessments. In Hawai'i, a comprehensive phytopathogen checklist has undergone multiple iterations since the first documentation by **Nathan A. Cobb (1906)**, who worked as the plant pathologist for the Hawaiian Sugar Planters Association from 1905-1907. In **1940, George Parris**, Associate professor of Plant Pathology at the University of Hawai'i, compiled the first Hawai'i phytopathogen checklist in the Plant Disease Reporter (Parris, 1940). In **1967, Robert D. Raabe** updated the checklist with new records and nomenclature. His list of pathogens and diseases was extended in **1981** using records from the Plant Disease Clinic at the University of Hawai'i headed by **Albert P. Martinez**, Extension Agent and Ibra L. Connors, curator of the National Mycological Herbarium of Canada. In **2009 Scott Nelson**, Plant Pathologist at the University of Hawai'i, digitized and revised the checklist. Although multiple new diseases have been reported in Hawai'i since then, they have not yet been included in the checklist. Therefore, the **current objective is to build an updated phytopathogen database** using additional records and to develop a new database that can be used for data mining and analyses.

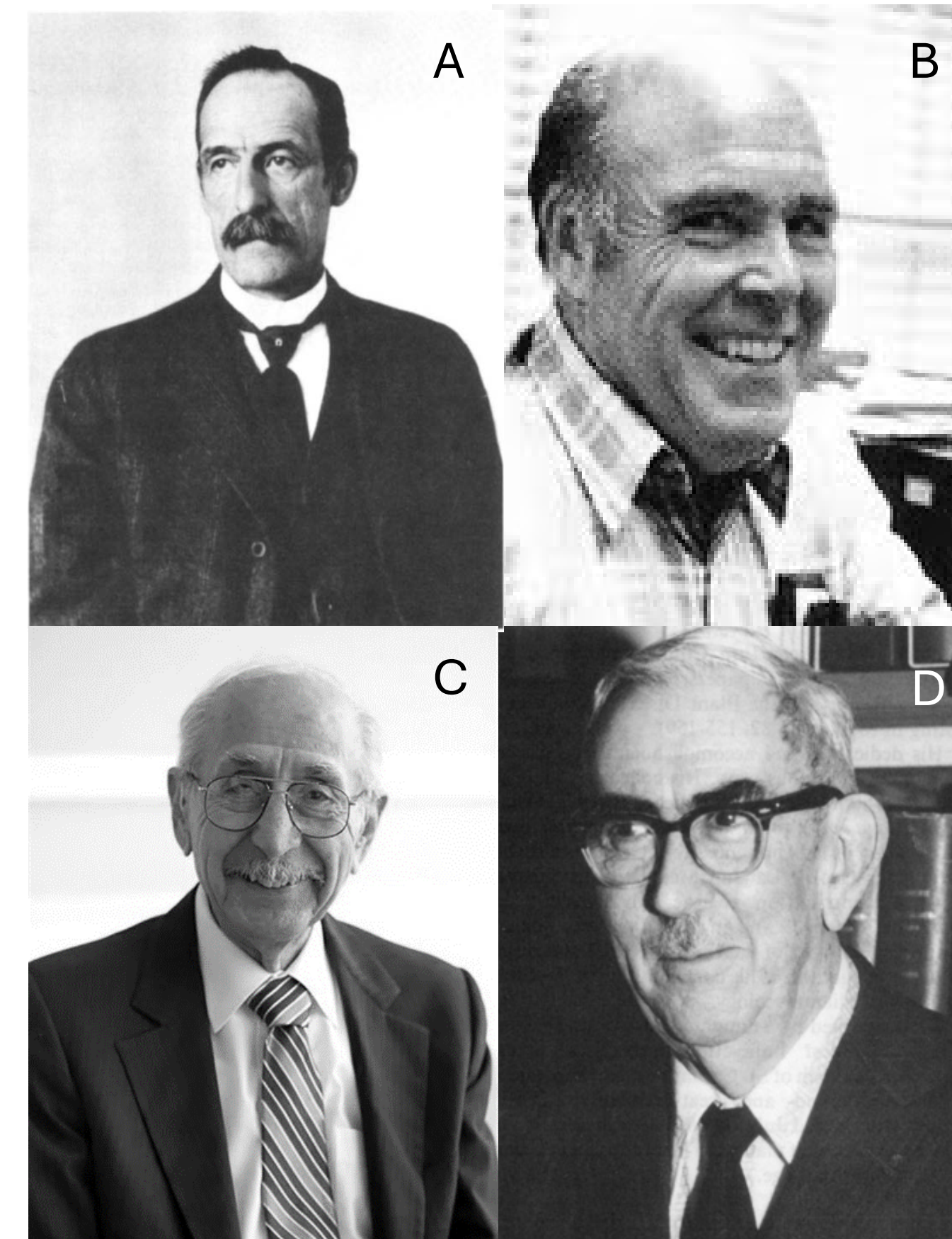


Fig. 1. Authors of Hawai'i's phytopathogen checklist include (A) **Nathan A. Cobb** who recorded the first reports of diseases in Hawai'i in **1906**; **George Parris** who wrote the first phytopathogen checklist for Hawai'i in **1940**; (B) **Robert D. Raabe** who made major updates to checklist in **1967**; (C) **Albert P. Martinez**, and (D) **Ibra L. Connors** who finalized updates by R.D. Raabe in **1981**.

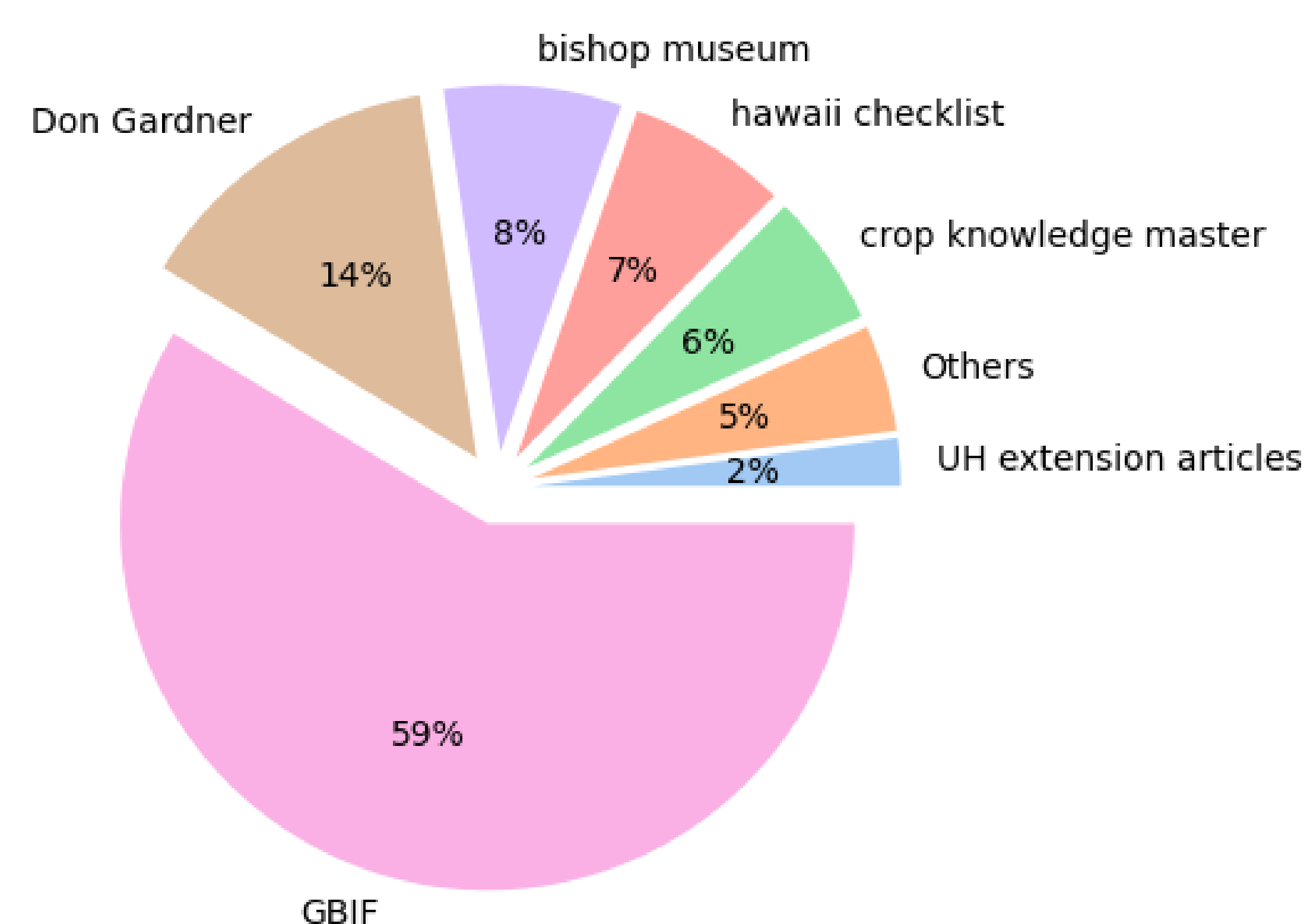
- Cobb, N.A., 1906. Fungus maladies of the sugar cane: with notes on associated insects and nematodes (No. 5). Hawaiian gazette.
- Parris, G.K. 1940. A check list of fungi, bacteria, nematodes, and viruses occurring in Hawai'i, and their hosts. Plant Disease Reporter, Supplement 121, 91 p.
- Raabe, Robert D., Ibra L. Connors, and Albert P. Martinez. 1981. Checklist of Plant Diseases in Hawai'i. Hawai'i Institute of Agriculture and Human Resources, College of Tropical Agriculture and Human Resources, University of Hawai'i (Information Text Series 022).
- Raabe RD, Connors IL, Martinez AP, Nelson SC. 2009. Checklist of plant diseases in Hawai'i, including records of microorganisms, principally fungi, found in the state. Honolulu (HI): University of Hawai'i. 313 p. (Information Text Series; ITS-022).

Data Pipeline

New Data Sources

1. Bishop museum: Data from the Bishop Museum Fungal Database
2. Board report: From National Agricultural Pest Information System (NAPIS) board reports
3. Bugwood: Widely prevalent Fungi, Bacteria, and Viruses in Hawai'i from the Bugwood database
4. CAPS survey data: Cooperative Agriculture Pest Survey databases (negative data)
5. Crop Knowledge Master: University of Hawai'i Cooperative Extension Crop Knowledge Master Website
6. CTAHR New Pest reports: Collected by Dr. Michael Melzer at the University of Hawai'i Agrosecurity Lab
7. Don Gardner: Data from Don Gardner's legacy database; University of Hawai'i
8. First report: First reports found from literature search of scientific journals
9. GBIF: Global Biodiversity Information Facility
10. Hawai'i NPND data: National Plant Diagnostic Network Data of samples from Hawai'i (detections from plant disease clinics in HI, AZ, FL, HI, NC, NY, OR, SC, and WI).
11. HDOA new pest advisory: Hawai'i Department of Agriculture
12. Miscellaneous: manual literature search
13. NAPIS data: National Agricultural Pest Information System database (positive data)
14. UH extension articles: University of Hawai'i
15. USDA confirmations: USDA National Agricultural Statistics Service

Fig. 2. A pie chart of 30,365 records of phytopathogens and saprophytes in Hawai'i from 16 data sources. Others include the following sources that represent less than 2% of the total reports included in the phytopathogen database: CAPS survey data, CTAHR New Pest reports, First report, HDOA new pest advisory, Hawai'i NPND data, Miscellaneous, NAPIS data, USDA confirmations, board reports, and Bugwood.



Data Processing

1. All data sources were transformed for initial concatenation of phytopathogen records, plant host names, date, location information, and citation
2. Phytopathogen and plant host scientific names spellings were corrected
3. Pathogen groups were assigned (Fungi, Bacteria, Nematode, and Virus) based on NCBI taxonomy database and manual inputs
4. Phytopathogen status (pathogen or saprophyte) was assigned based on USDA fungal-host database and NPND pathogen list
5. Year and county location were reformatted
6. Final database will be created as an open-source comma-separated values (csv) file and backed up to OneDrive and GitHub.

Photo Citations

- **Nathan A. Cobb:** Huettel, R.N. and Golden, A.M., 1991. Nathan Augustus Cobb: the father of nematology in the United States. Annual Review of Phytopathology, 29(1), pp.15-27.
- **Robert D. Raabe:** <https://senate.universityofcalifornia.edu/files/inmemoriam/html/robertdraabe.html>
- **Albert Peter Martinez:** <https://cms.ctahr.hawaii.edu/fcs2/SiteAdm/Alumni-News-Articles/ArtMID/51791/ArticleID/2373/Albert-Peter-Martinez>
- **Ibra L. Connors:** Ginns, J. 1990. Ibra Lockwood Connors, 1894-1989. Mycologia, 82:2, 155-159, DOI: [10.1080/00275514.1990.12025859](https://doi.org/10.1080/00275514.1990.12025859)

Results

Other New Additions

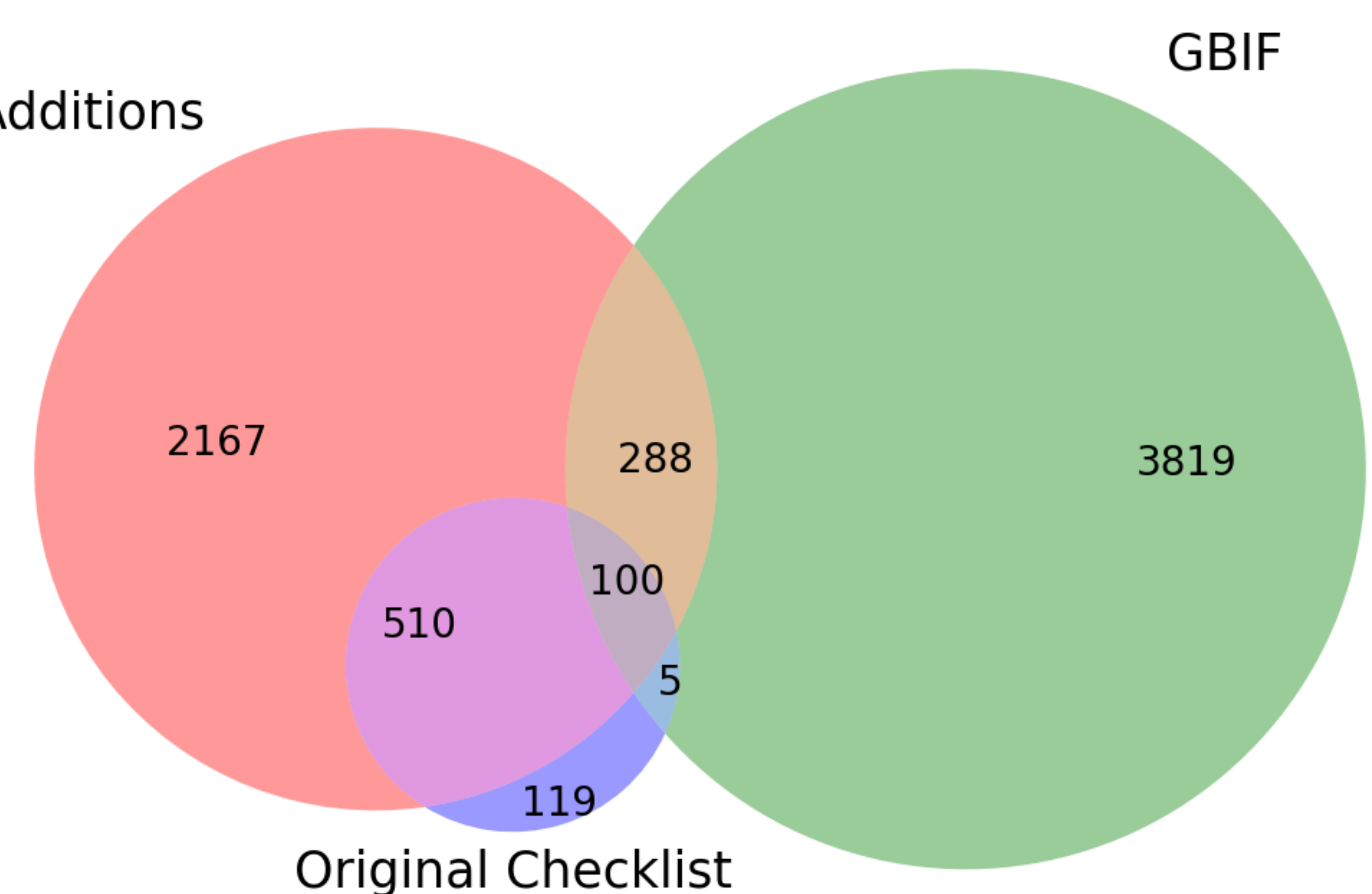


Fig. 3. Venn diagram of unique phytopathogens added to the original Hawai'i Phytopathogen Checklist (Raabe et al., 2009). GBIF = Global Biodiversity Information Facility. The other new additions include data sources listed in the Data Pipeline section other than the original checklist and GBIF database.

Fig. 4. A pie chart of phytopathogen groups in Hawai'i. Percentages are calculated from total phytopathogen reports and do not include reports of saprophytes in Hawai'i. The blue section consists of Plant-parasitic nematodes (1.6%), viruses (2.4%), and phytoplasmas (0.03%)

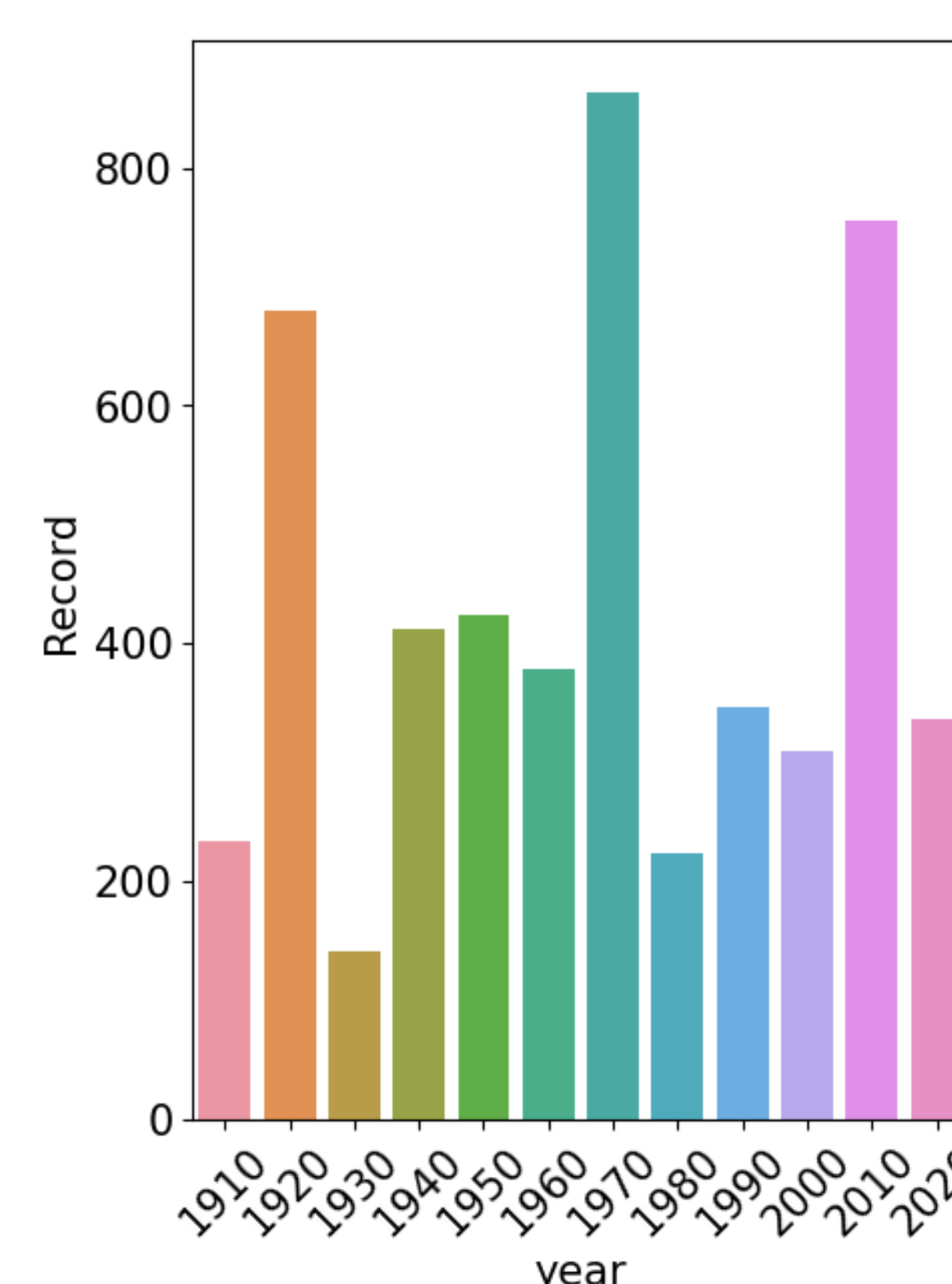
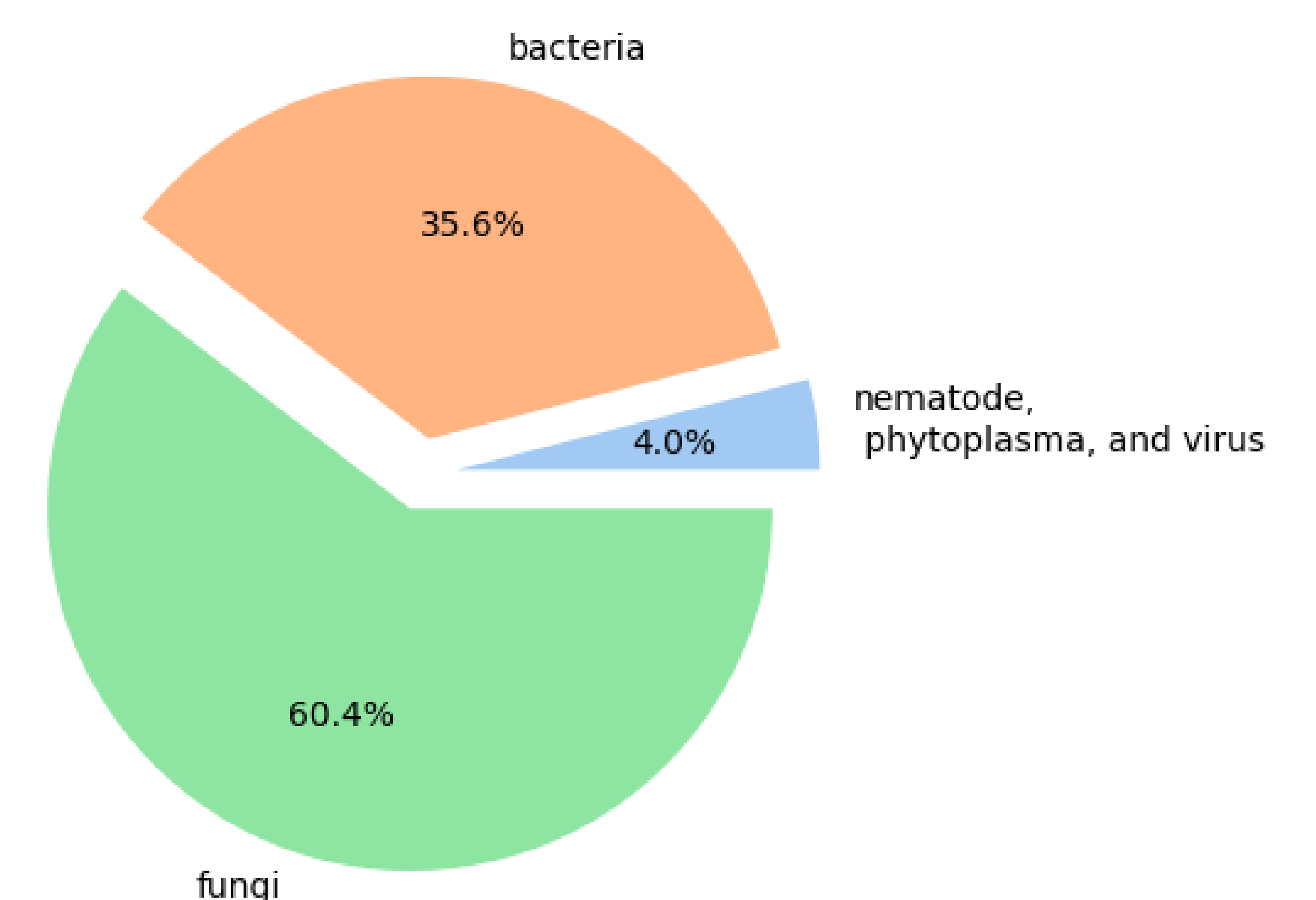


Fig. 5. Bar chart showing number of phytopathogen records reported in Hawai'i for each decade.

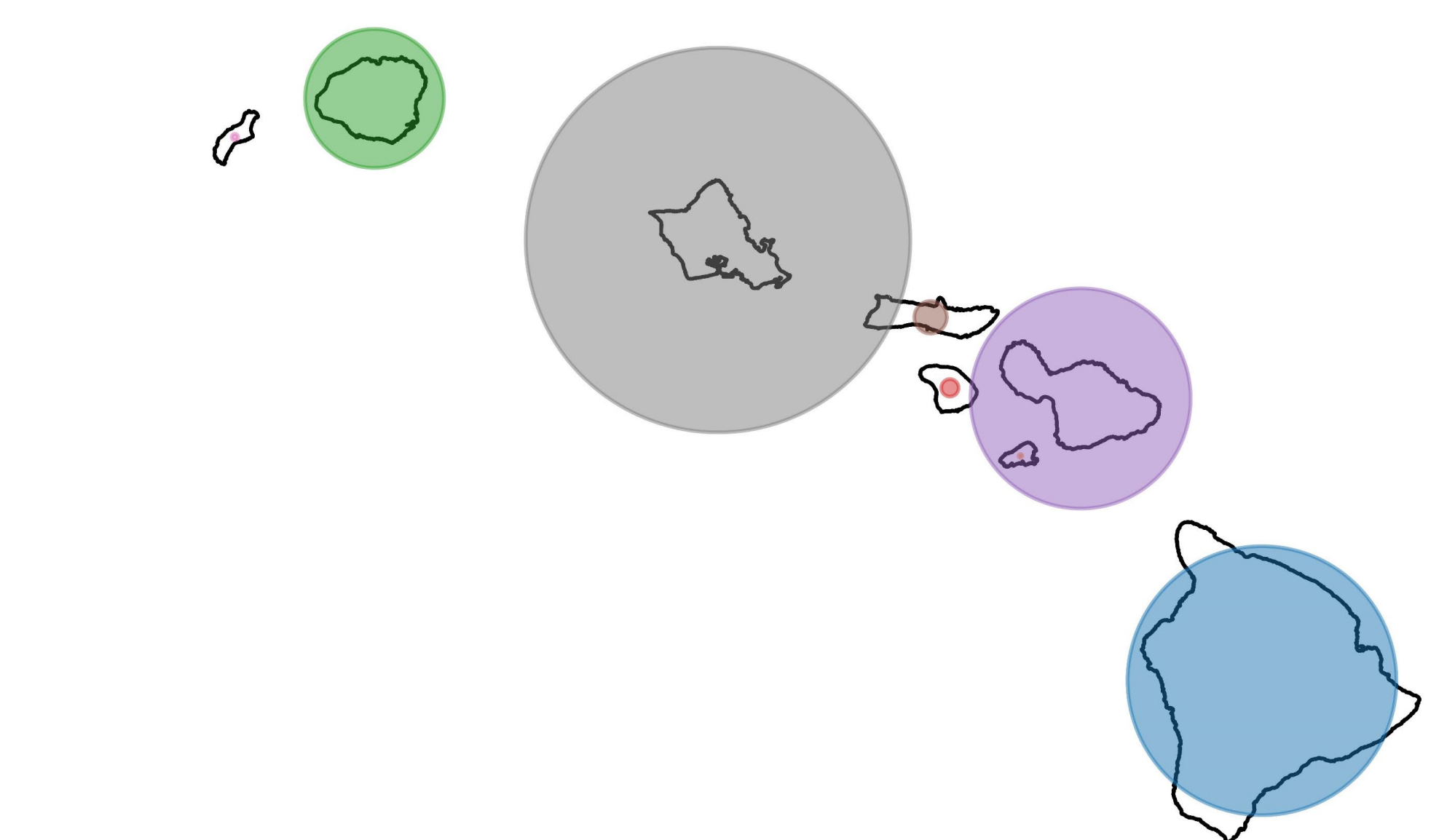


Fig. 6. Map of phytopathogen records reported on each island of the state of Hawai'i. The island of Hawai'i has 5,245 records, Maui 3,516, Kaho'olawe 1, Lāna'i 22, Moloka'i 77, O'ahu 10,733, Kaua'i 1,398, and Ni'ihau 3.

Discussion and Conclusion

1. New data sources provided a significant number of new records of phytopathogens in Hawai'i (Fig. 3)
2. In Hawai'i 60.4% of the reported phytopathogens are fungi followed by bacteria, viruses, nematodes, and phytoplasmas (Fig. 4). Starting from 1906 phytopathogen records span more than a century.
3. Higher numbers of reports were found during the 1920s, 1970s, and 2010s (Fig. 5). This may correspond to reporting activity rather than disease incidence.
4. Location data is mostly represented from data collected by the Bishop Museum and Global Biodiversity Information Facility (Fig. 6). High numbers of phytopathogen records from Oahu island is most likely a detector bias, since this is the most populated island.

Future Work

1. Organization of an editorial board for quality control
2. Deployment of the database for public access
3. Using phytopathogen database for plant pathogen ratings to create limited distribution and prevention lists for the state of Hawai'i biosecurity plans
4. Filling gaps with statewide phytopathogen surveys