

# Comparative ecology of sexual and asexual parasitoid wasps

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Directed by Tanja Schwander

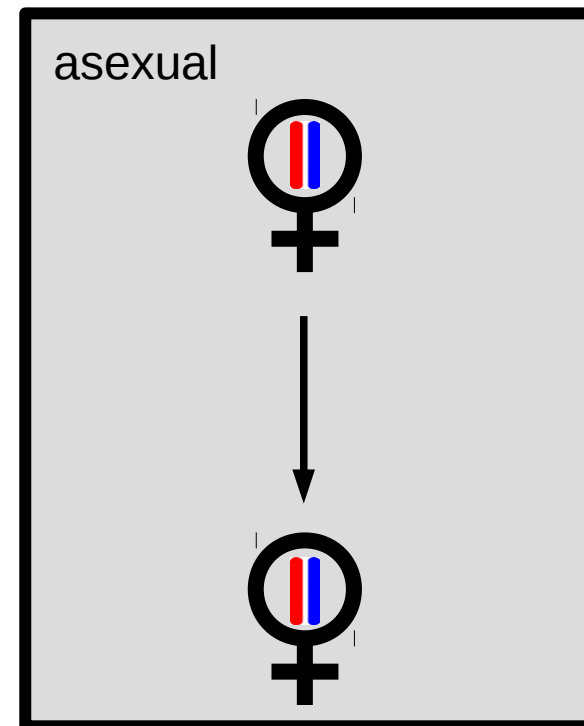
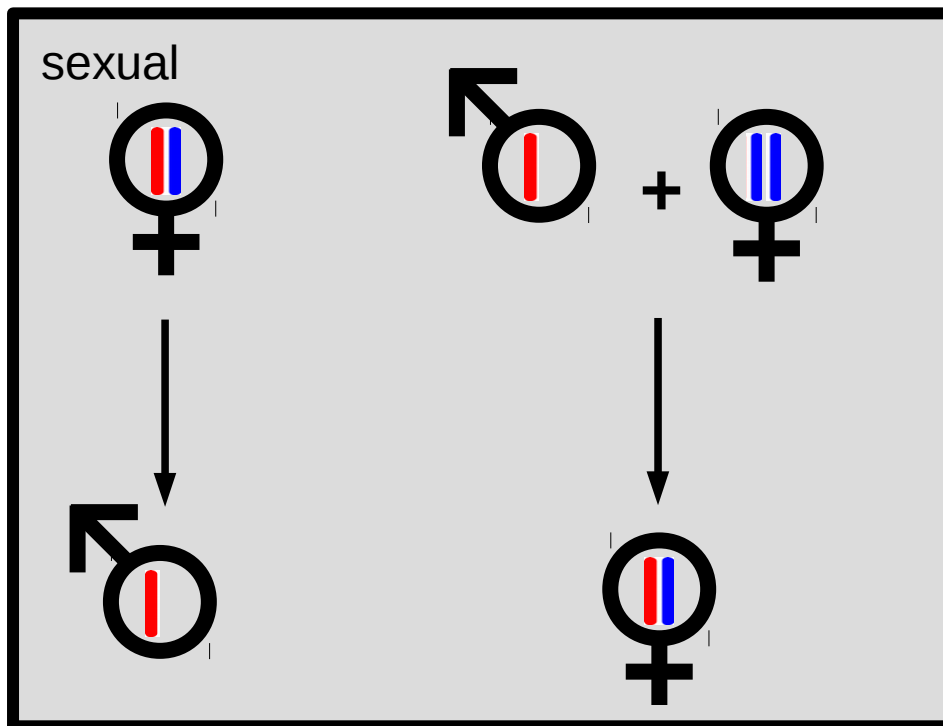


# Background

- In general, few species reproduce asexually
- Hypotheses predict asexual and sexual species to differ in host range and geographical distribution.
- Never tested on a large scale analysis
- Many asexual species in certain clades of haplodiploid arthropods

# Haplodiploid arthropods

- Occurs in many insect species
- Offspring can develop without egg fertilization (parthenogenetically)



# The study

- Gather data on different ecological variables for species in Chalcidoidea.
- Compare those variables between parthenogenetic and sexual species.

# Why Chalcidoidea ?

- Many (240) parthenogenetic species
- Well studied, many species relevant for biocontrol.
- Great database available!

The screenshot shows the homepage of the Universal Chalcidoidea Database. At the top is the Natural History Museum logo and navigation links: Visit, Discover, Take part, Support us, Shop, Schools, and Our science. There are also links for 'Admission free' and 'Become a Member'. Below the navigation bar is a breadcrumb trail: Home / Our science / Data / Universal Chalcidoidea Database. The main heading is 'Universal Chalcidoidea Database' in green, followed by 'Index to families'. A list of links includes: About chalcidoids, Images, Morphology and terminology, About the database, Key to families, Family index, Collecting and preserving, Acknowledgements, and Search the database. A section titled 'Diagnostic characters | Morphology and terminology | Notes on families' lists various chalcid families under the heading 'Chalcidoidea'. The families listed are: Agaonidae, Aphelinidae, Chalcididae, Encyrtidae, Eucharitidae, Eulophidae, Eupelmidae, Eurytomidae, Leucospidae, Mymaridae, Ormyridae, Perilampidae, Pteromalidae, Rotoitidae, Signiphoridae, Tanaostigmatidae, Tetracampidae, Torymidae, Trichogrammatidae, and Mymarommatoidea. At the bottom, it says 'Last updated 19-Aug-2003 Dr B R Pitkin'.

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## Universal Chalcidoidea Database

### Index to families

About chalcidoids | Images | Morphology and terminology | About the database | Key to families | Family index | Collecting and preserving | Acknowledgements | Search the database |

Diagnostic characters | Morphology and terminology | Notes on families

Chalcidoidea

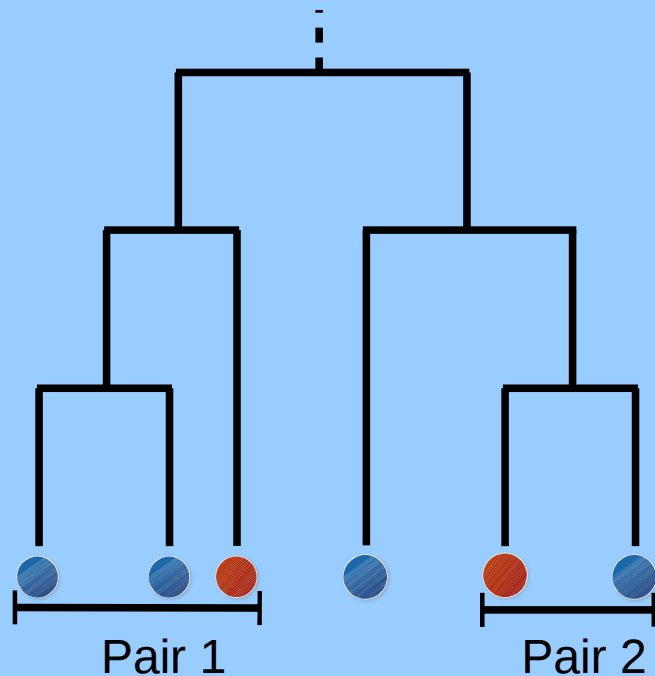
- Agaonidae
- Aphelinidae
- Chalcididae
- Encyrtidae
- Eucharitidae
- Eulophidae
- Eupelmidae
- Eurytomidae
- Leucospidae
- Mymaridae
- Ormyridae
- Perilampidae
- Pteromalidae
- Rotoitidae
- Signiphoridae
- Tanaostigmatidae
- Tetracampidae
- Torymidae
- Trichogrammatidae
- Mymarommatoidea
- Mymarommatoidea

Last updated 19-Aug-2003 Dr B R Pitkin

- Records for ~31'000 species of Chalcidoidea
- host species and distribution

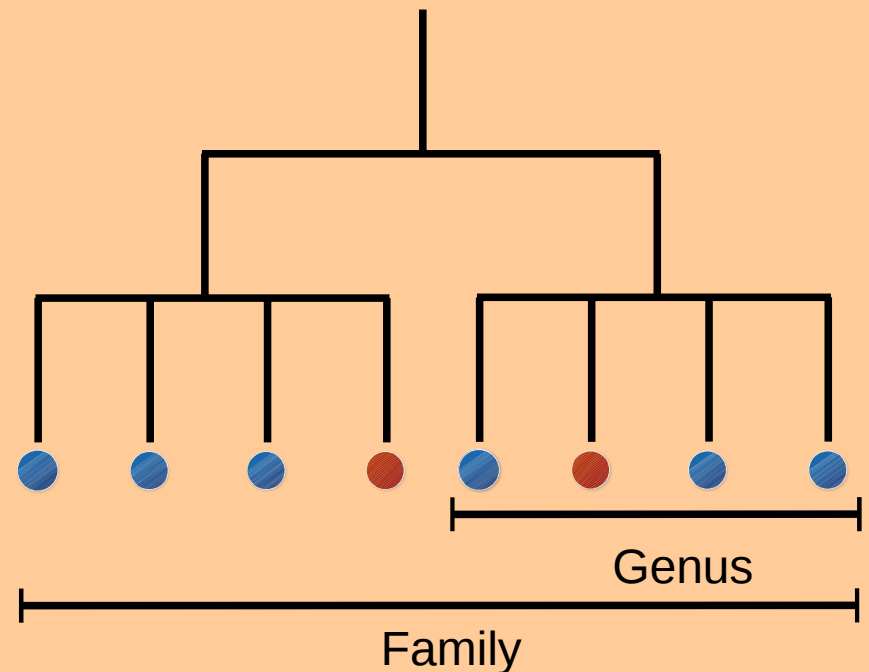
## Manual dataset

- Gathered by hand in literature
- Few species
- Comparison sex vs asex between the most closely related species.



## Automated dataset

- All data from the same database
- Many species
- Comparing asex vs sex in each genera



# Data overview

## Species used for comparisons:

### Manual dataset:

- In total: 133 species (50 asexual, 83 sexual)
- Reparted into 32 pairs.

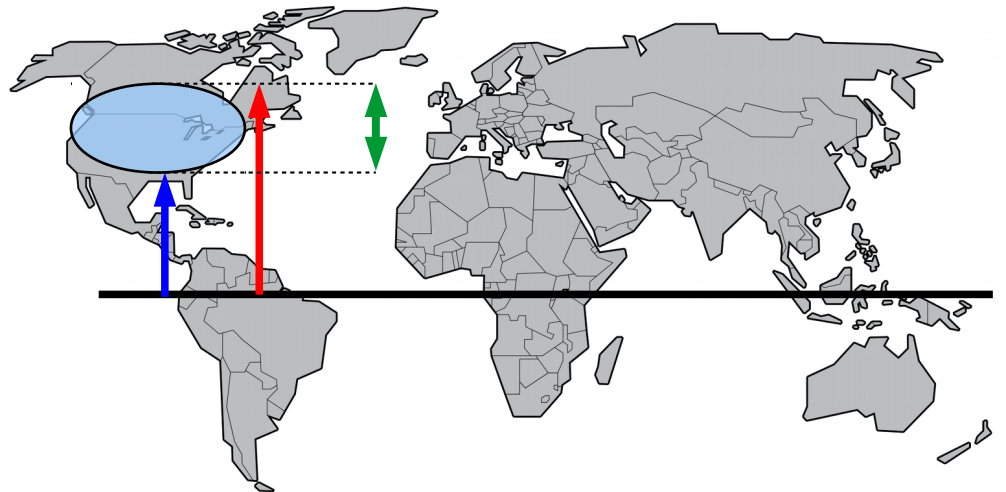
### Automated dataset:

- In total: 8357 species (136 asexual, 8221 sexual) from 66 genera in 11 families.
- No pairs, using genera instead.

# Variables studied

- Do asexuals tend to have more host species ?
  - Successful asexuals are often generalist.
    - Number of host species
- Do asexuals tend to occupy larger regions than sexuals ?
  - Number of countries/states
- Geographical distribution in more detail using latitude.

- Max distance from equator.
- Min distance from equator
- Latitude range





# Statistical analysis

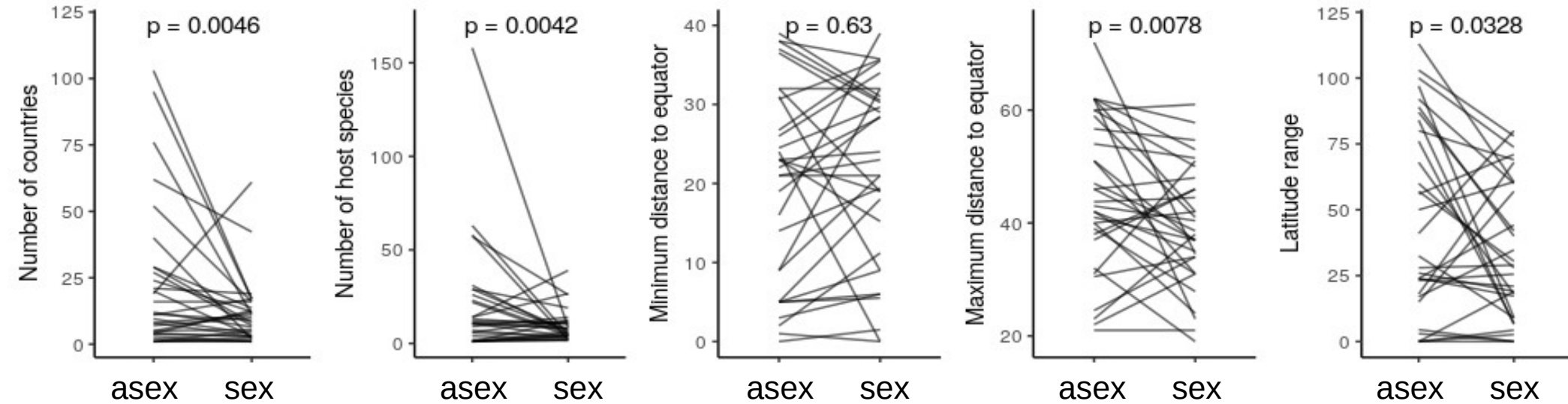
Using generalized linear mixed models:

- **Manual:**  $y \sim \text{mode} + (1 | \text{genus} / \text{pair})$
- **Automated:**  $y \sim \text{mode} + (1 | \text{genus})$

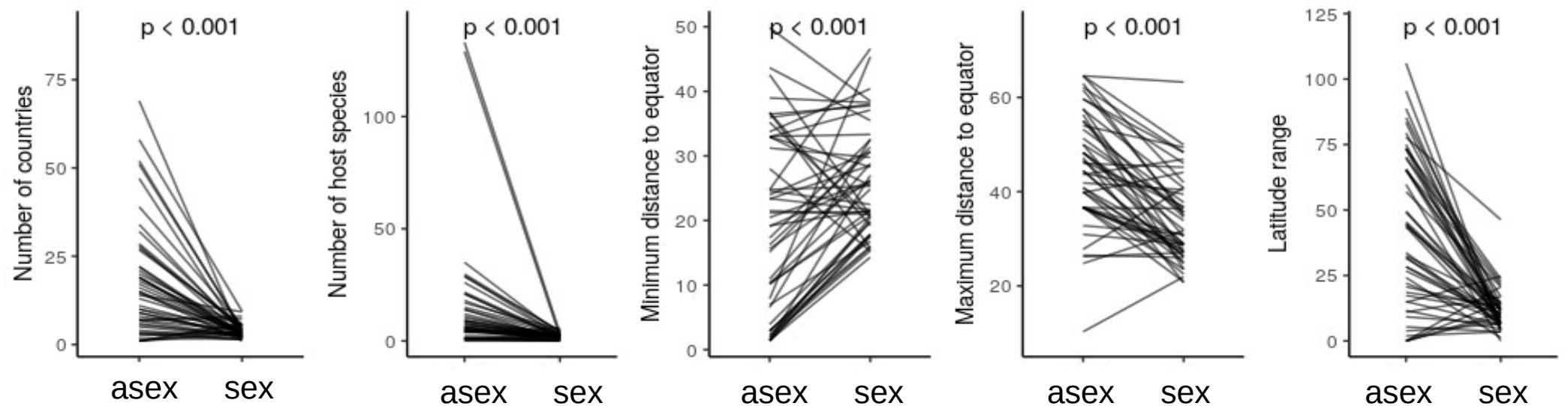
Using permutations approach to reduce poor distribution fitting bias.

# Results

- Manual dataset: values per pair

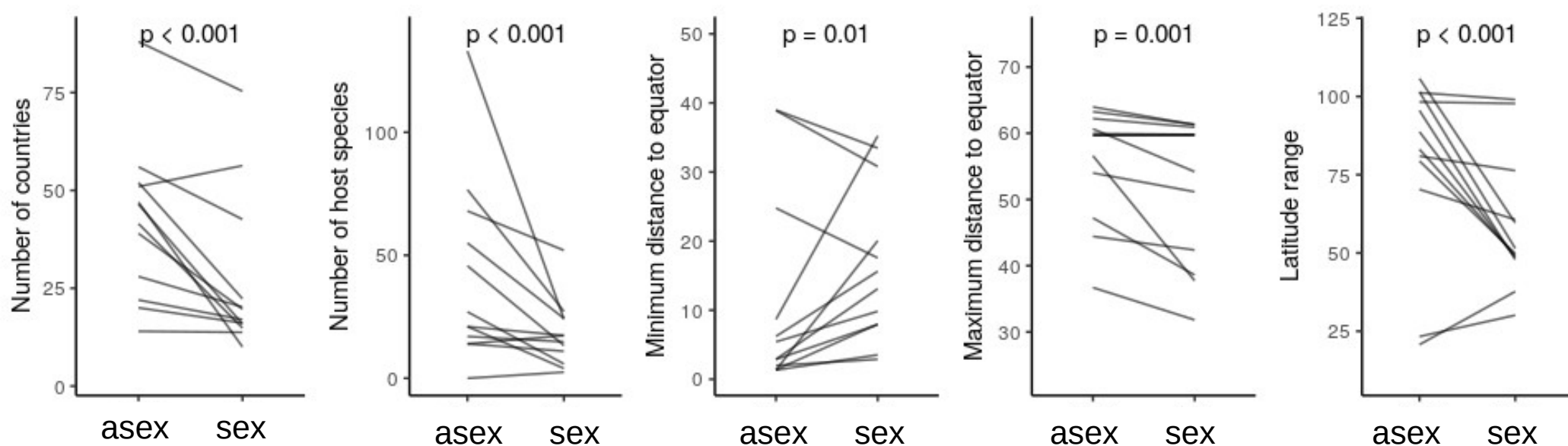


- Automated dataset: values per genus



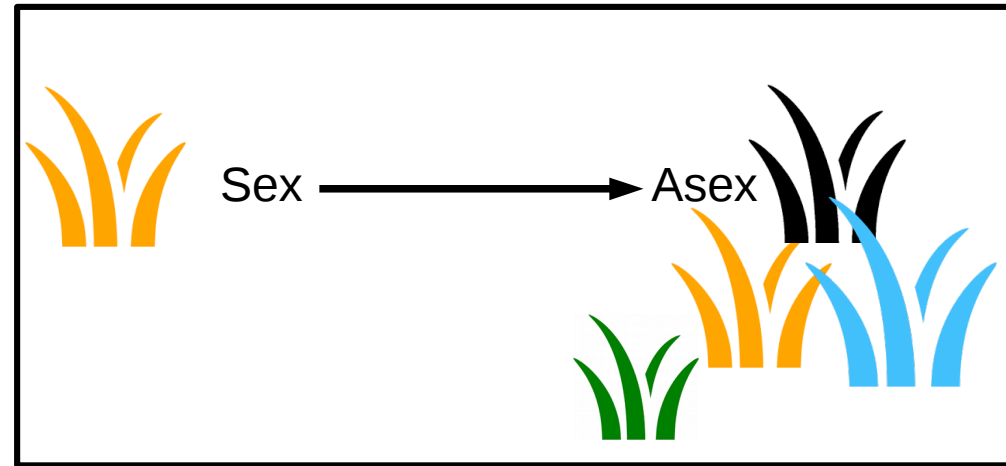
# Automated dataset: Publication bias

- Poorly studied species: unknown reproductive mode  
→ considered sexual
- Sexual species will have fewer known hosts and countries
- Results are consistent when including only well studied species (>10 publications)

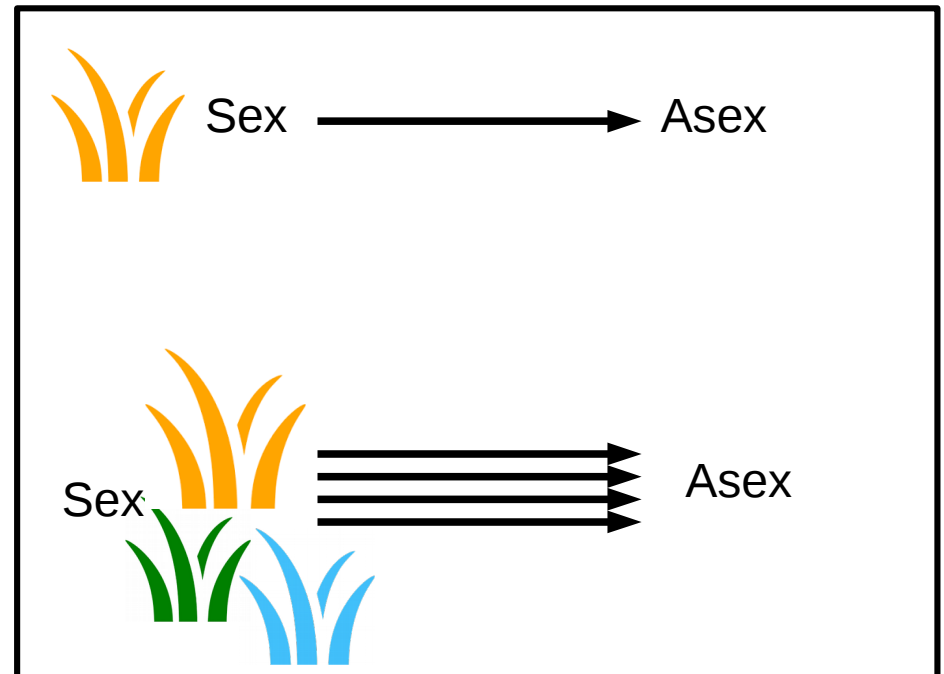


# Arrow of causality

- Does the broad niche evolve after transition to asexuality?

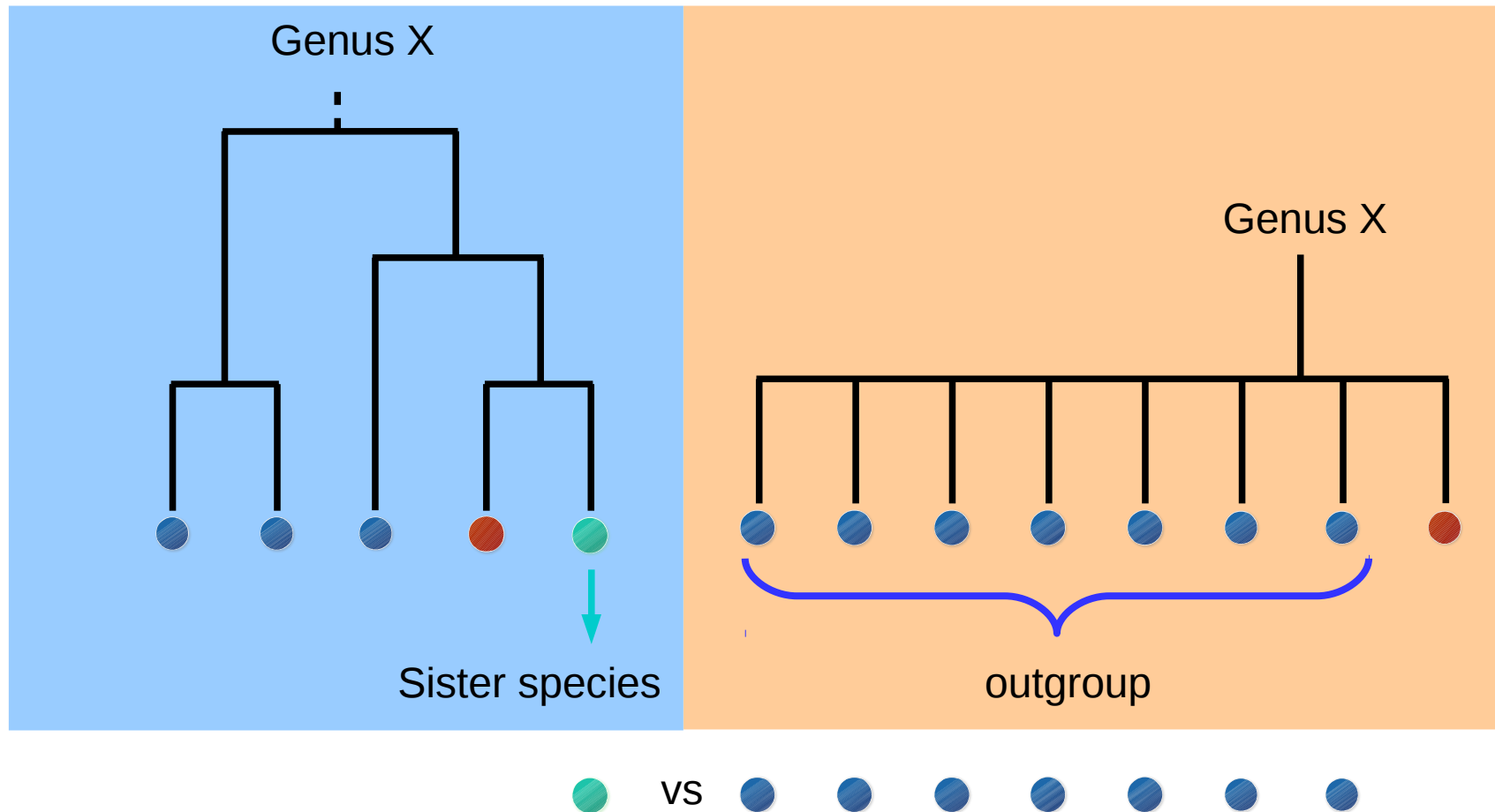


- Or are sexuals with broad niche more likely to give rise to asexuals?



# Arrow of causality

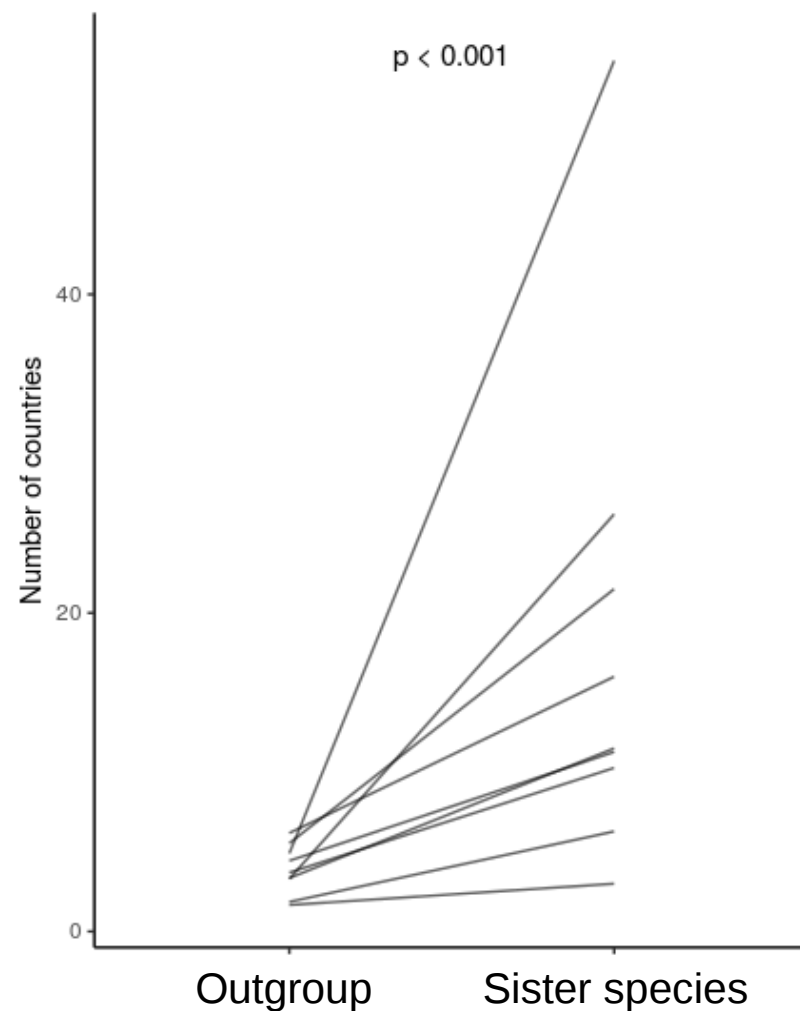
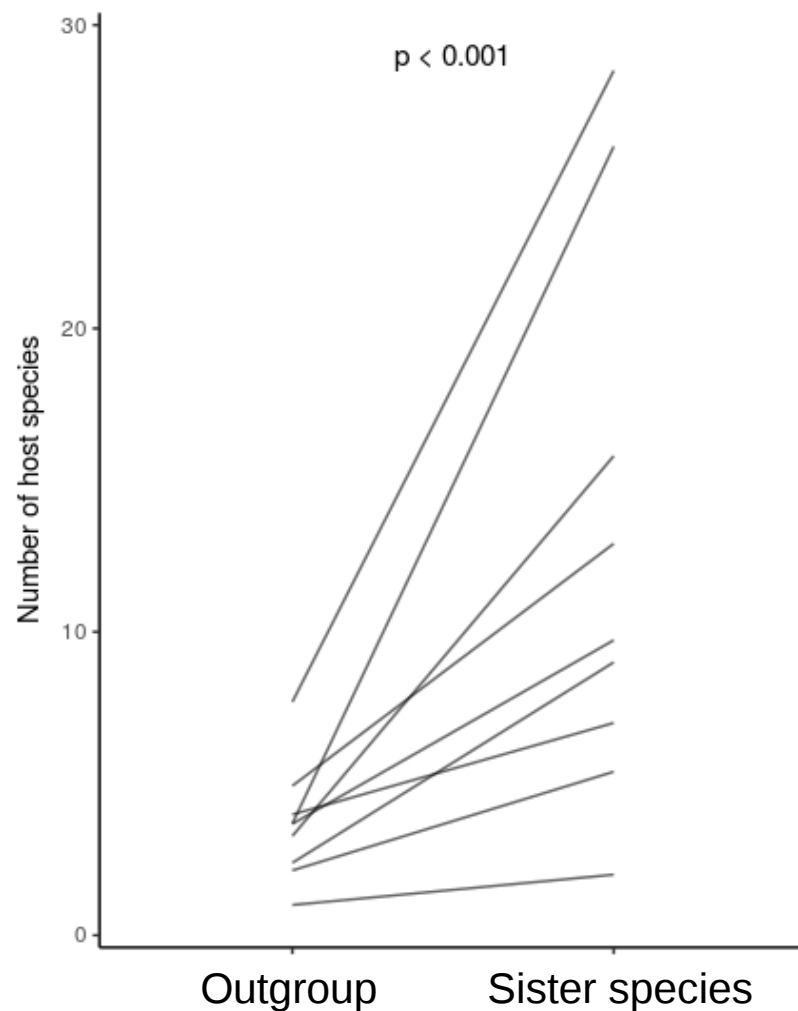
- Combining **manual** and **automated** datasets



- Comparing number of host species and countries between sister species and outgroups in each genera

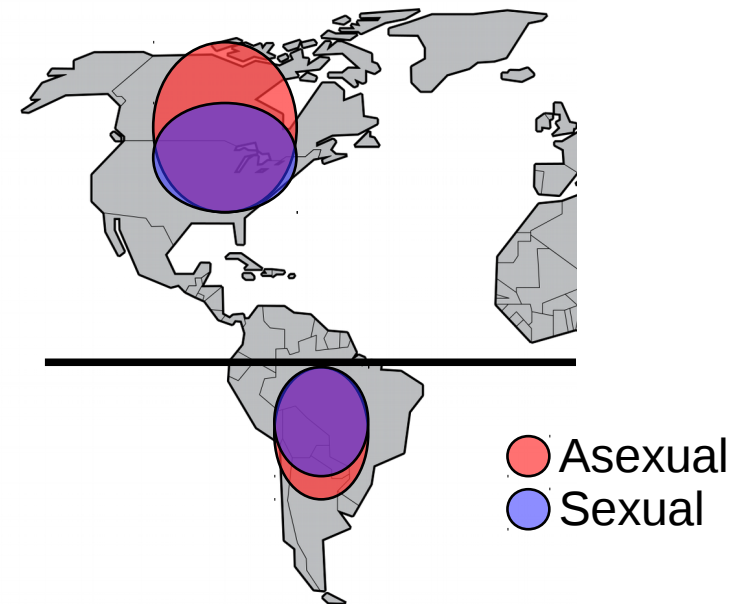
# Causality: Results

- Sexual species from which asexual sister species diverged already had a large niche



# Results: summary

- Asexuals have wider niches:
  - More host species than sexuals
  - Sampled in more countries
- Their geographical distributions can expand more towards poles.
- Asexuals arise from already widely distributed sexual species.



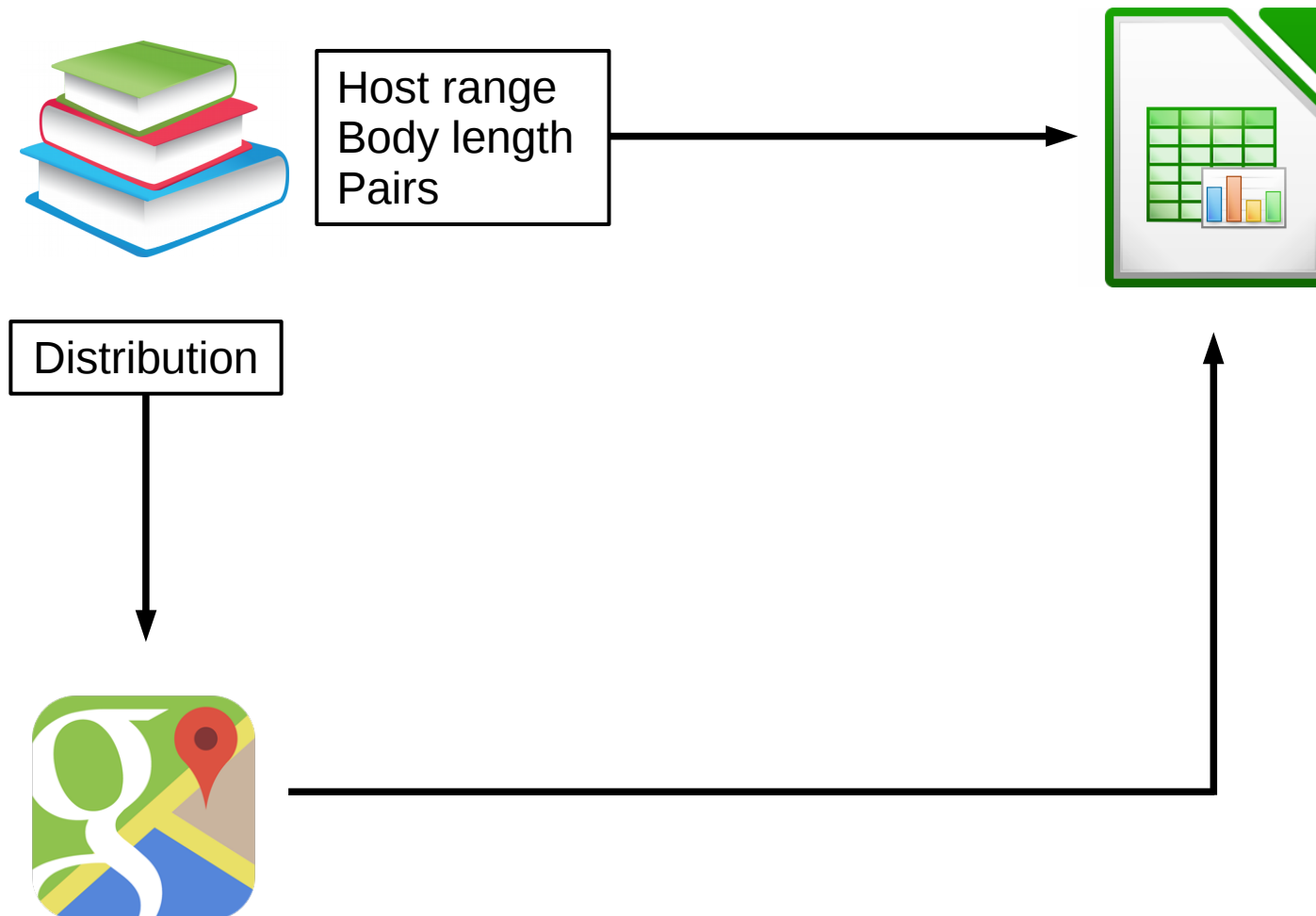
Thank you !

Questions ?



Supplementary slides

# Manual dataset: flowchart



# Manual dataset: Data

## Species used for comparisons:

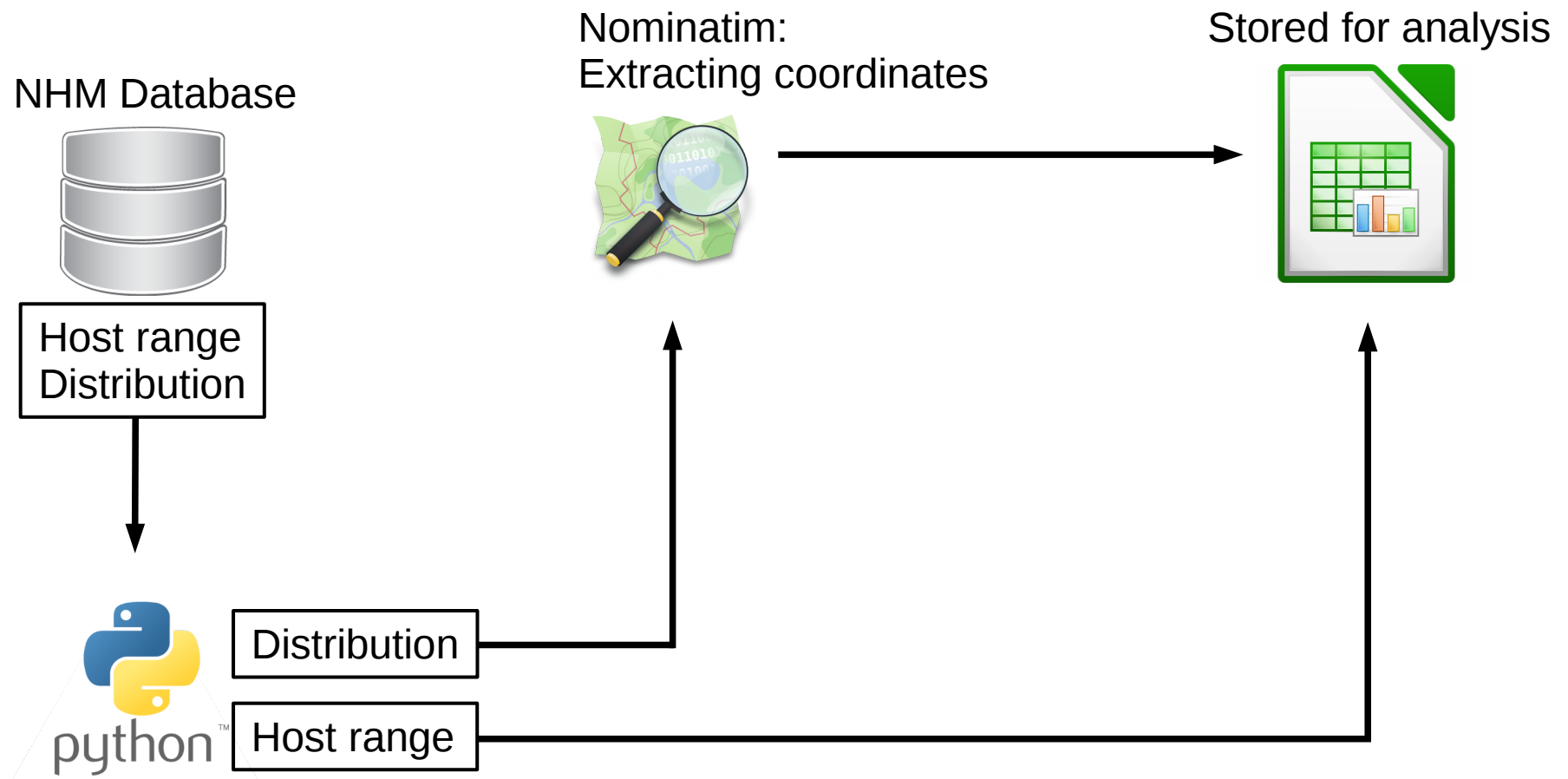
### Manual dataset:

- In total: 133 species (50 asexual, 83 sexual)
- Reparted into 32 pairs.

Family	Genus	Asex	Sex	Total
Aphelinidae	Aphelinus	2	9	11
	Aphytis	20	35	55
	Encarsia	7	8	15
	Eretmocerus	2	3	5
Torymidae	Megastigmus	7	11	18
	Torymus	1	2	3
Trichogrammatidae	Megaphragma	1	1	2
	Trichogramma	10	12	22
	Trichogrammatoidea	0	2	2

# Automated dataset: flowchart

- Only genera with at least one known parthenogen were used.



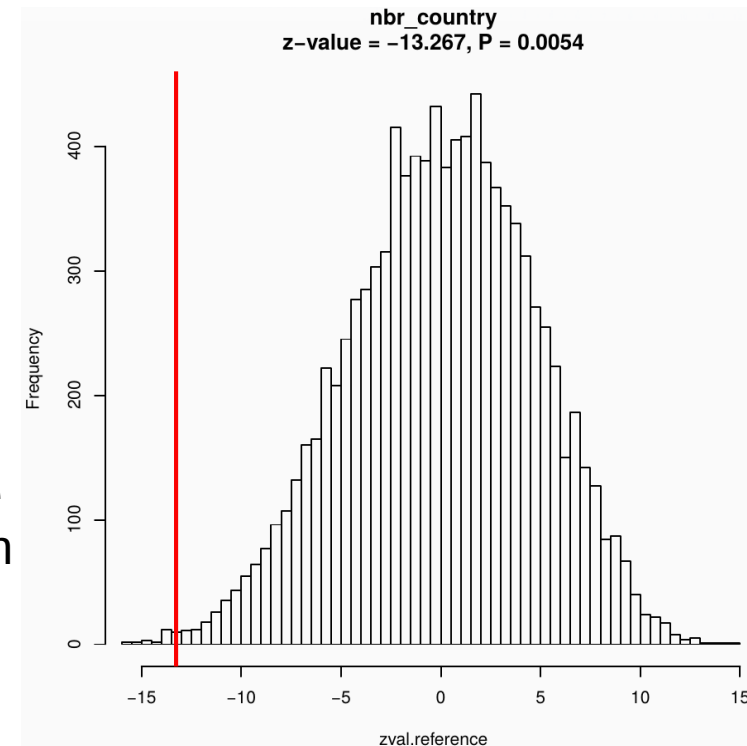
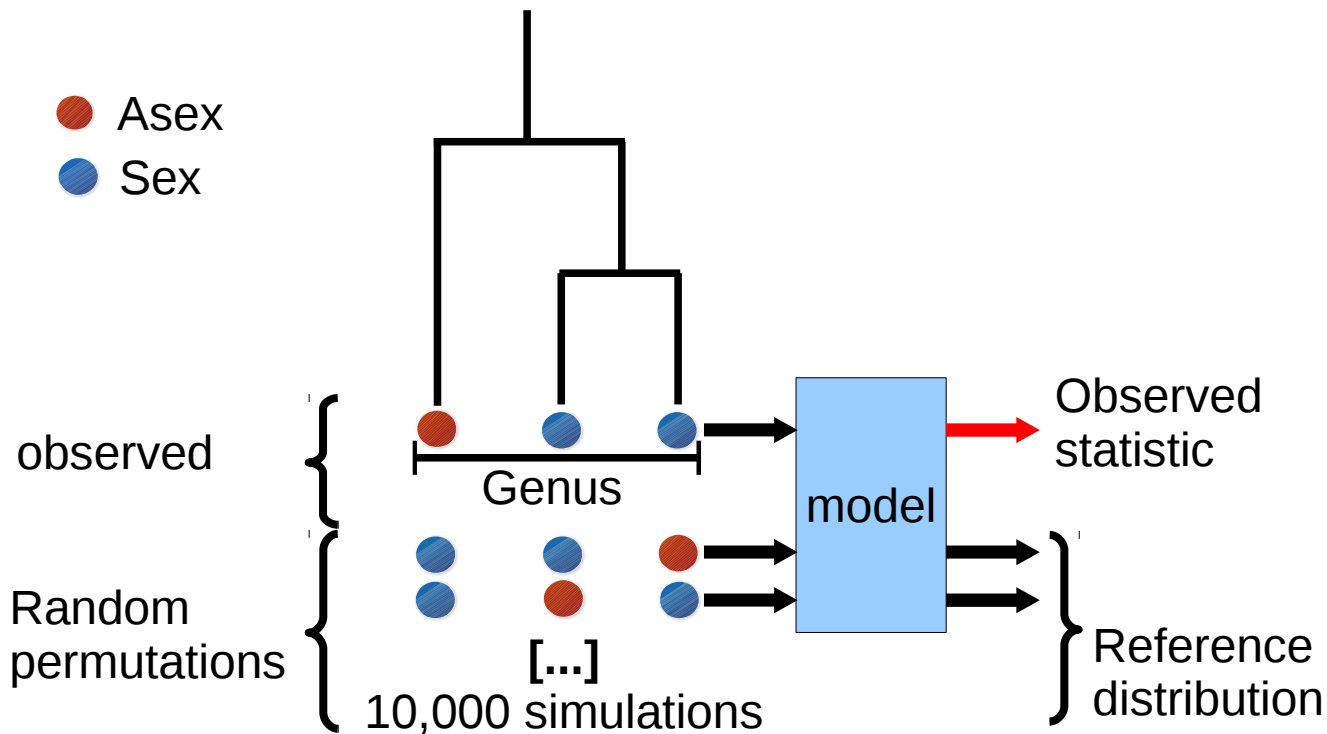
# Automated dataset: Data

## Automated dataset:

- In total: 8357 species (136 asexual, 8221 sexual) from 66 genera in 11 families.
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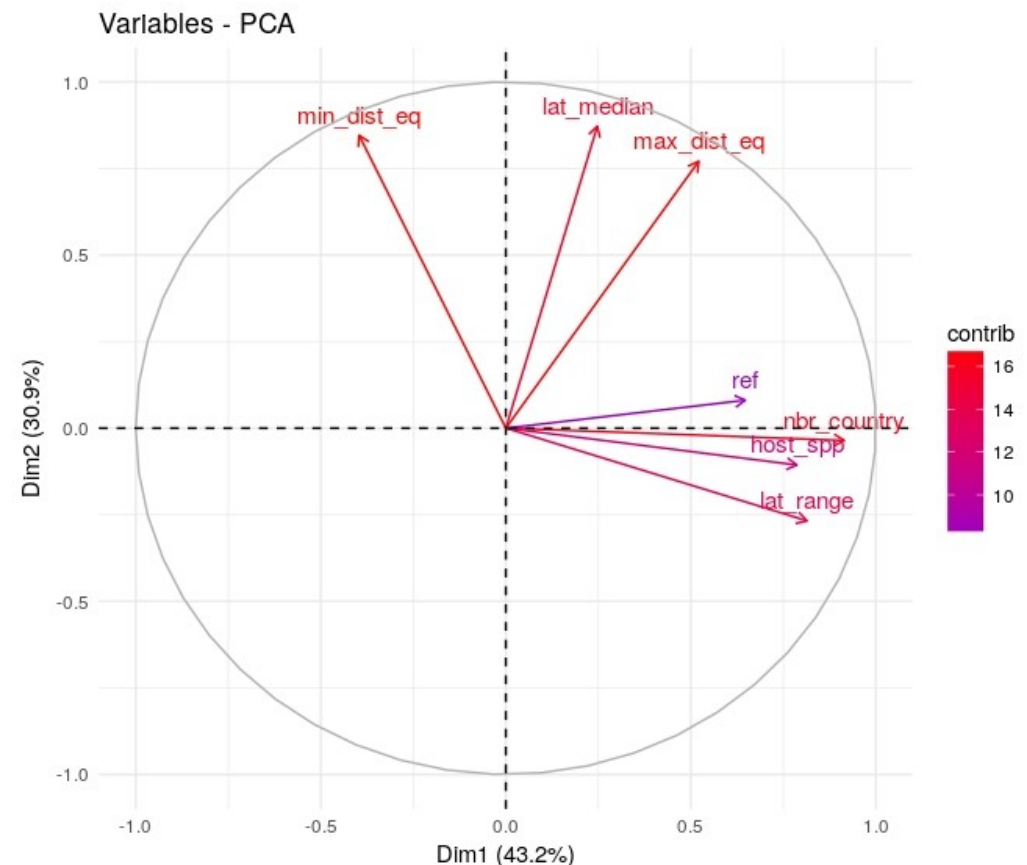
Family	Asexual	Sexual	Total
Aphelinidae	46	1006	1052
Chalcididae	1	304	305
Encyrtidae	22	1314	1336
Eulophidae	22	2148	2170
Eupelmidae	1	481	482
Eurytomidae	3	879	882
Leucospidae	1	117	118
Mymaridae	12	528	540
Pteromalidae	6	680	686
Torymidae	8	517	525
Trichogrammatidae	14	247	261

# GLMM with permutation approach



# Automated dataset: Publication bias

- Species with unknown reproductive mode considered sexual
- Some variables strongly correlate with number of publications (ref)



# Automated dataset: Publication bias

- Removing species with low number of publications
- Trade off: bias vs power

