Comparative ecology of sexual and asexual parasitoid wasps

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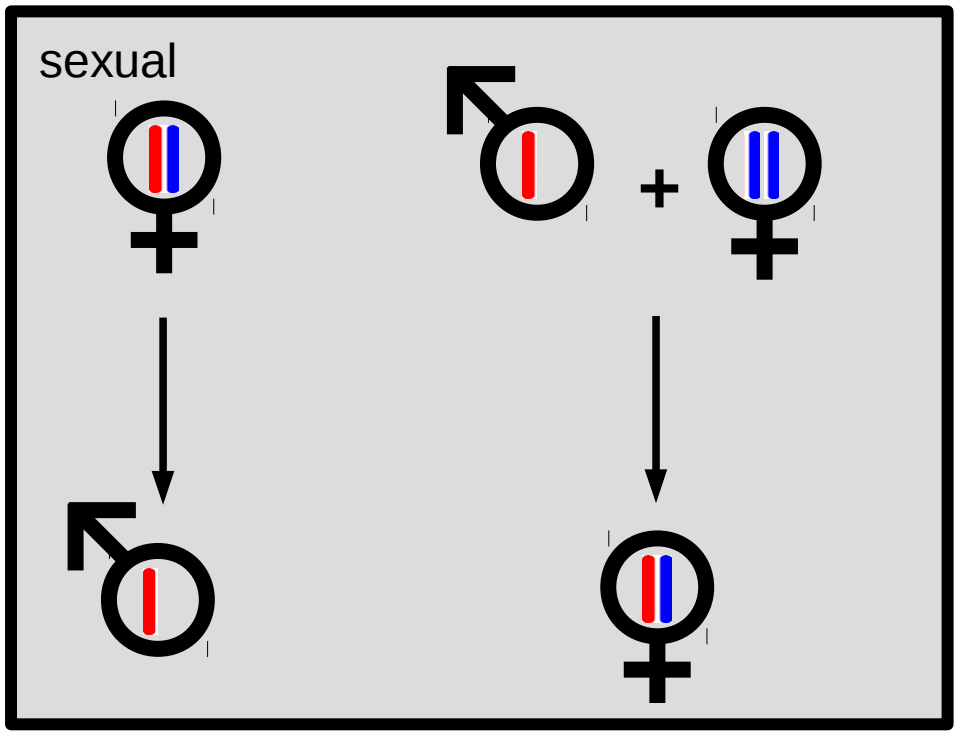
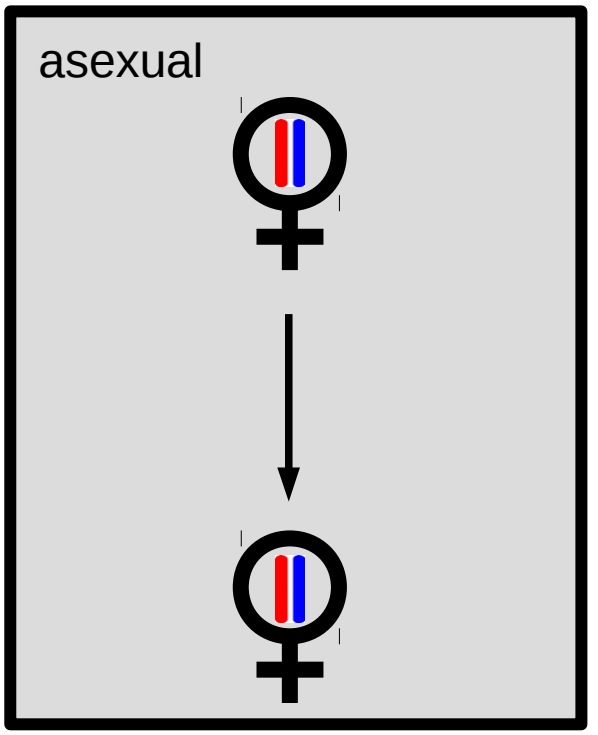
Background

- 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)





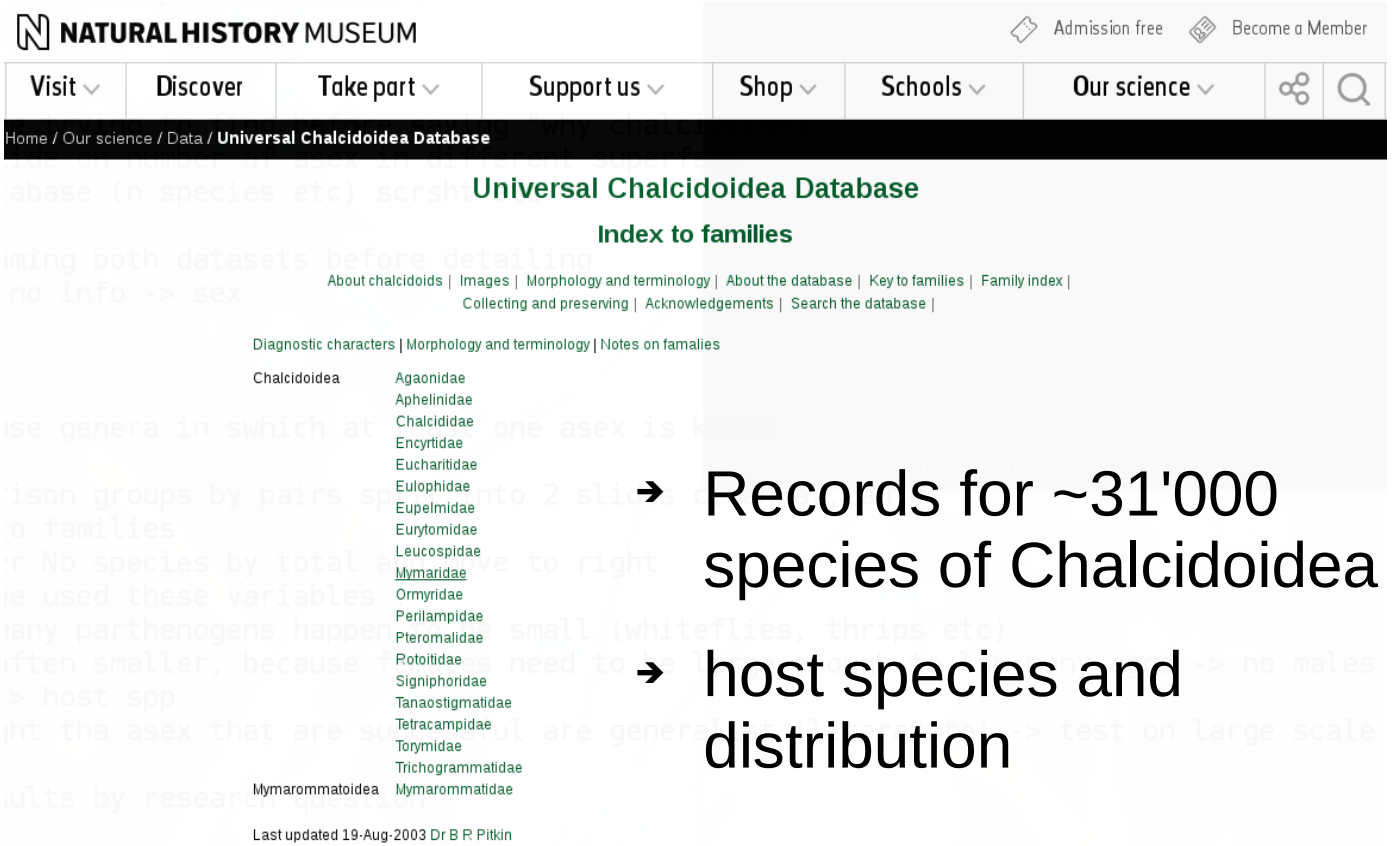
The study

- Gather data on different ecological variables for species in Chalcidoidea.

- Compare those variables between parthenogenetic and sexual species.

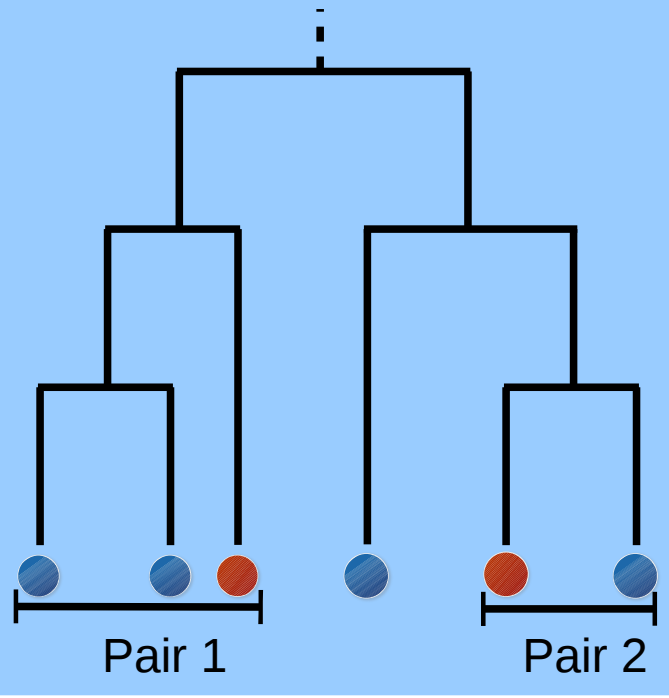
Why Chalcidoidea ?

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

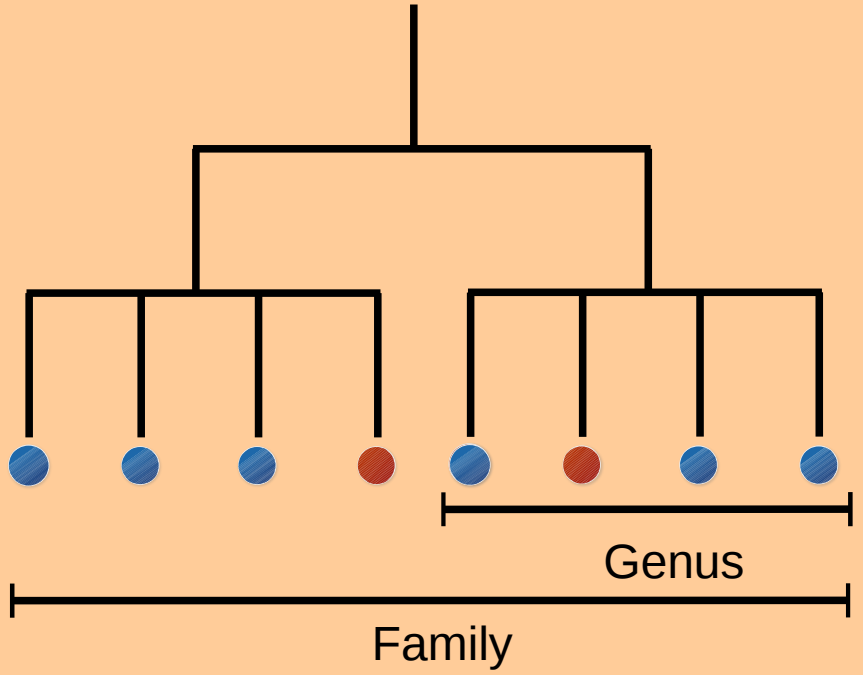


- ➔ Records for ~31'000 species of Chalcidoidea
- ➔ host species and distribution

- 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:

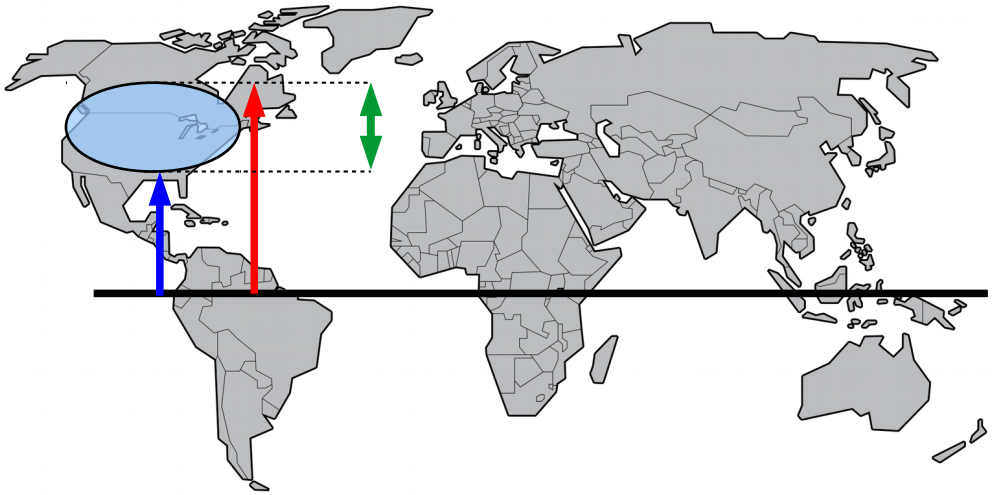
- In total: 8357 species (136 asexual, 8221 sexual) from 66 genera in 11 families.
- No pairs, using genera instead.

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

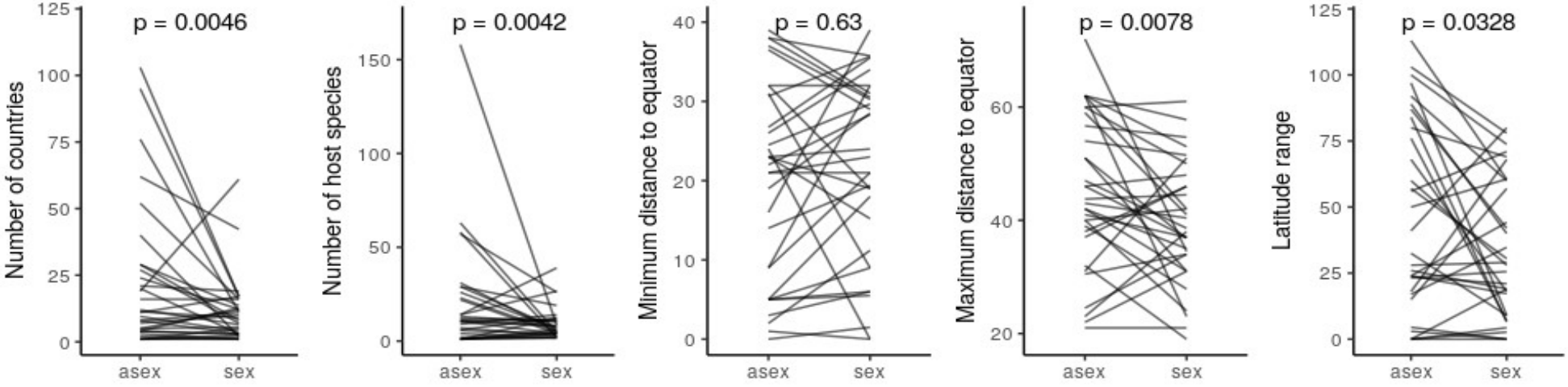
Using generalized linear mixed models:

- **Manual:** y ~ mode + (1| genus / pair)
- **Automated:** y ~ mode + (1| genus)

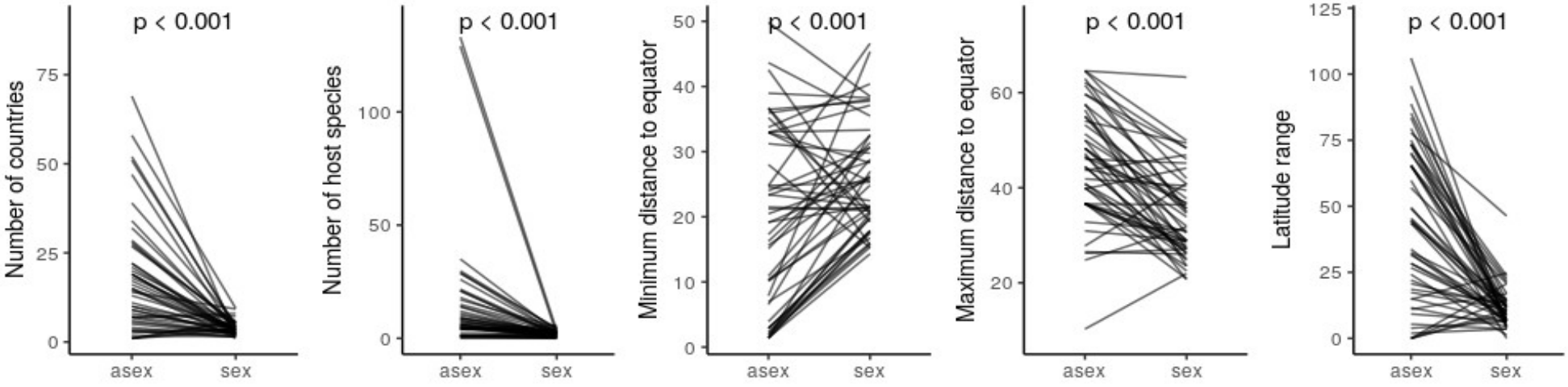
Using permutations approach to reduce poor distribution fitting bias.

Results

- Manual dataset: values per pair

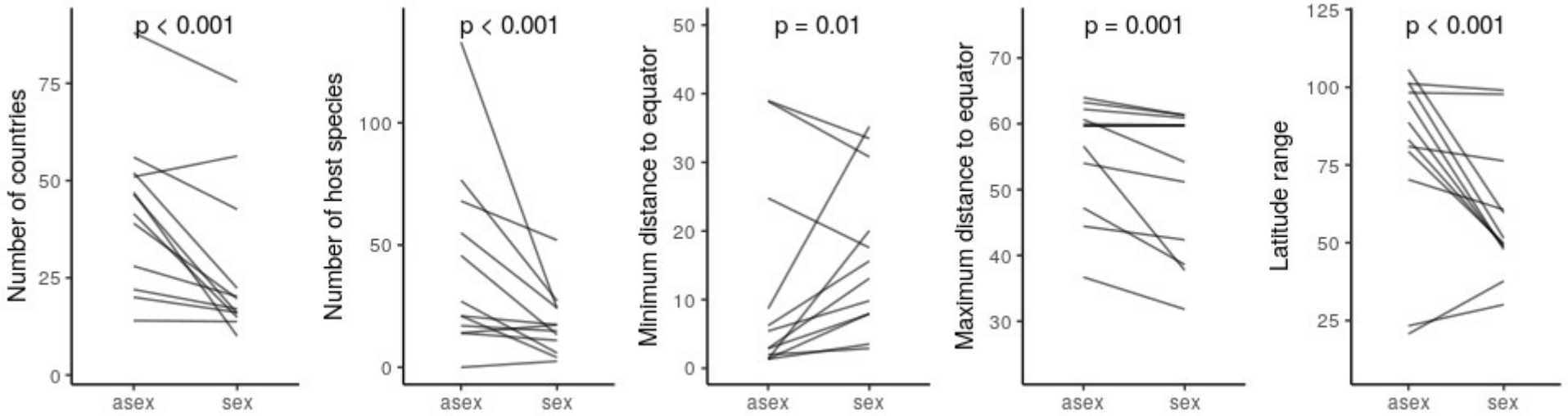


- Automated dataset: values per genus



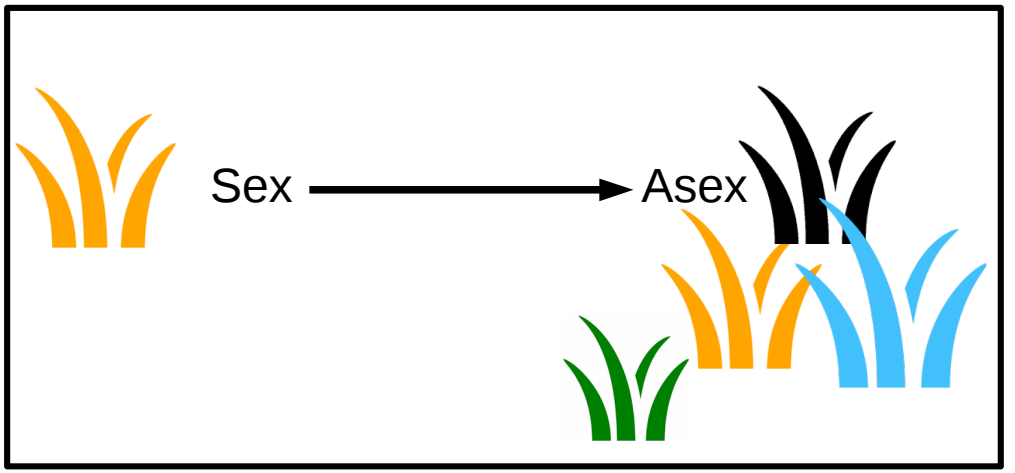
Automated dataset: Publication bias

- Poorly studied species have unknown reproductive mode and were considered sexual
- Sexual species will have fewer known hosts and countries
- Results are consistent when excluding poorly studied species (more than 10 publications)

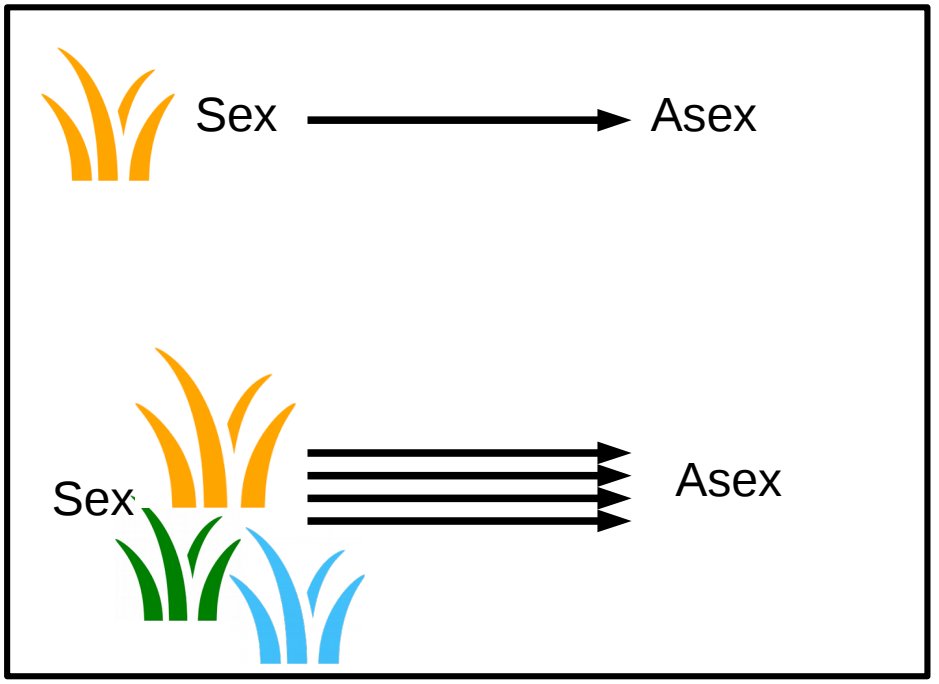


Arrow of causality

- Does the broad niche evolve after transition to asexuality?

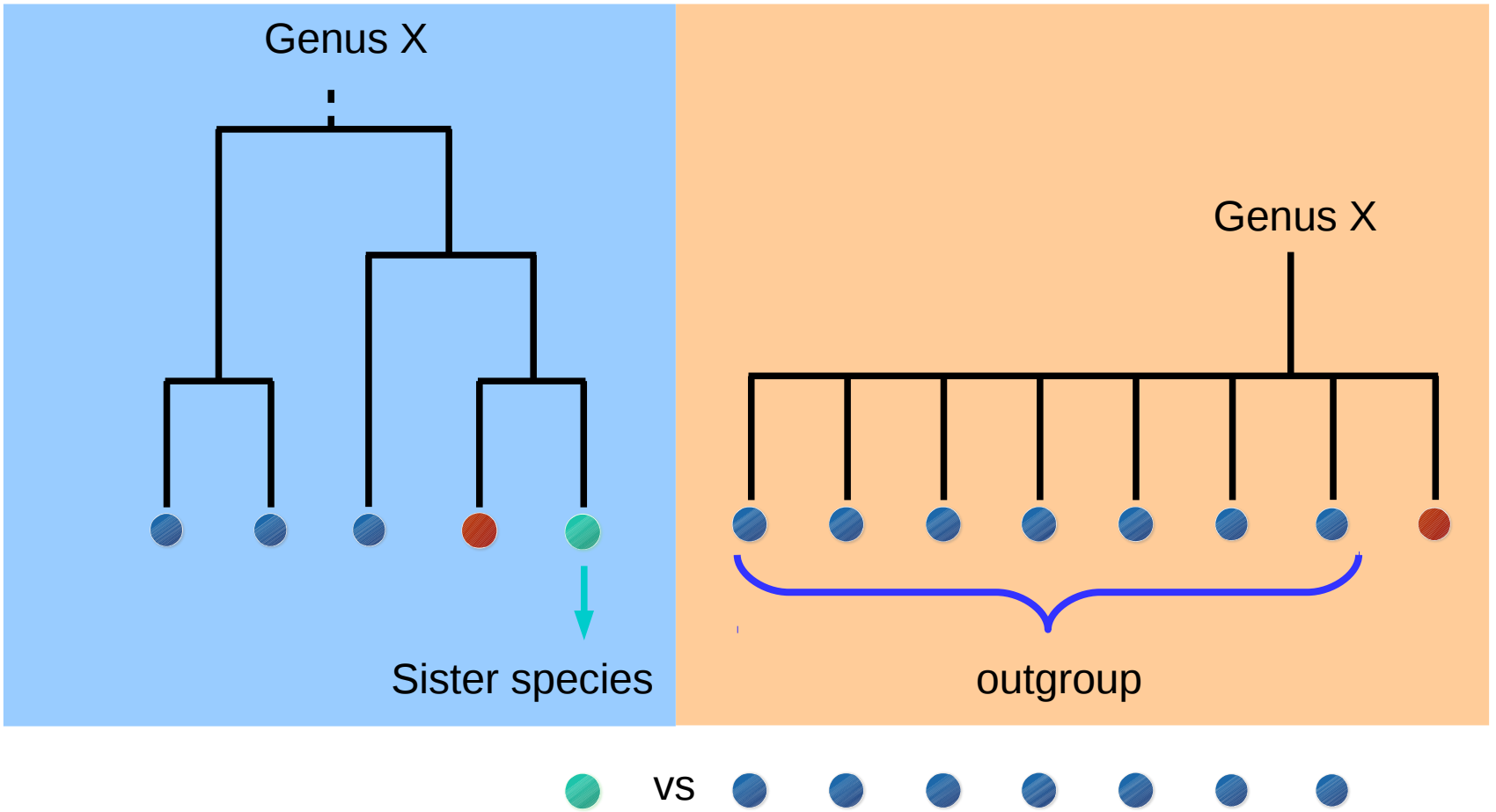


- Or are sexuals with broad ecologies and distributions more likely to give rise to asexuals?



Arrow of causality

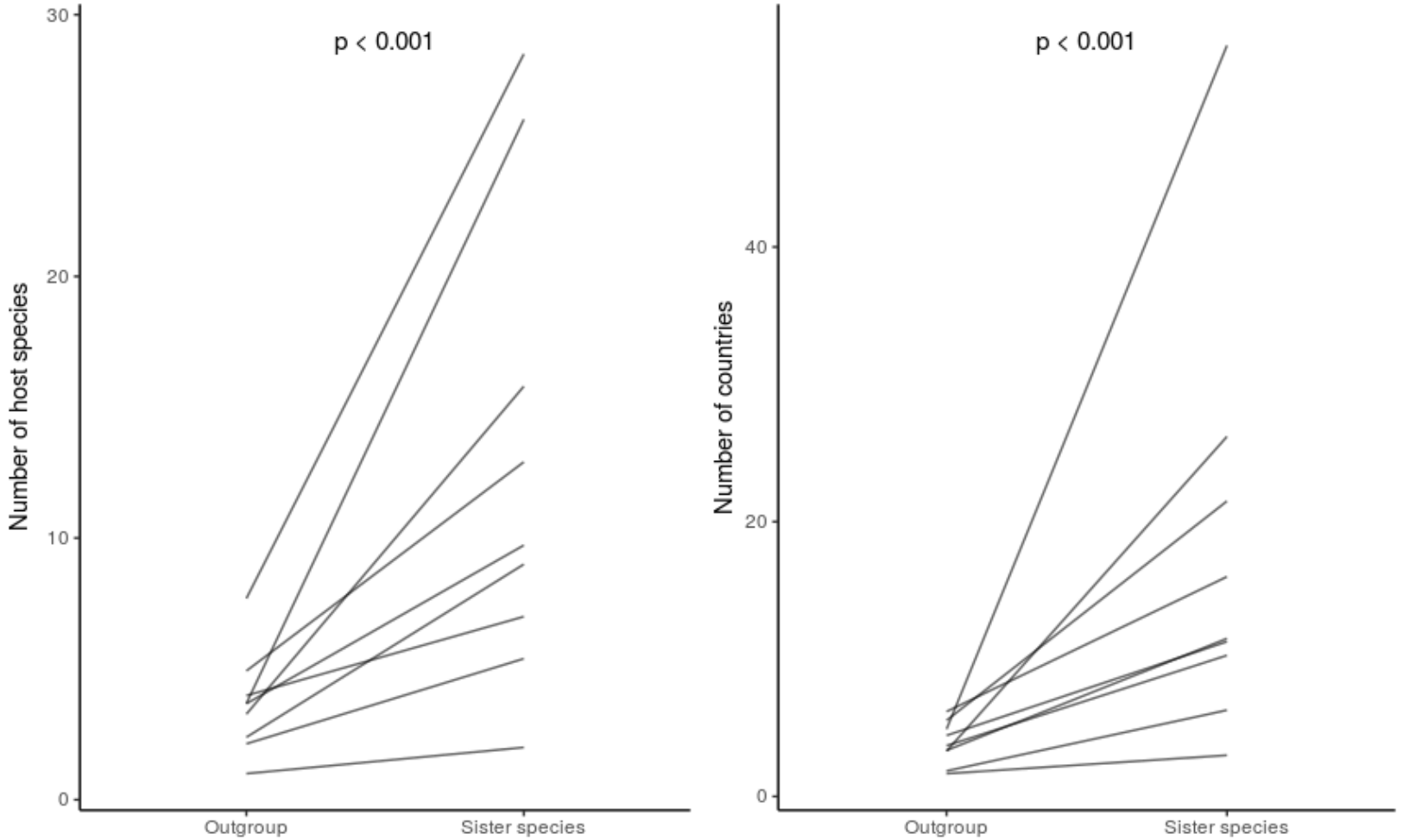
- Combining manual and automated datasets



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

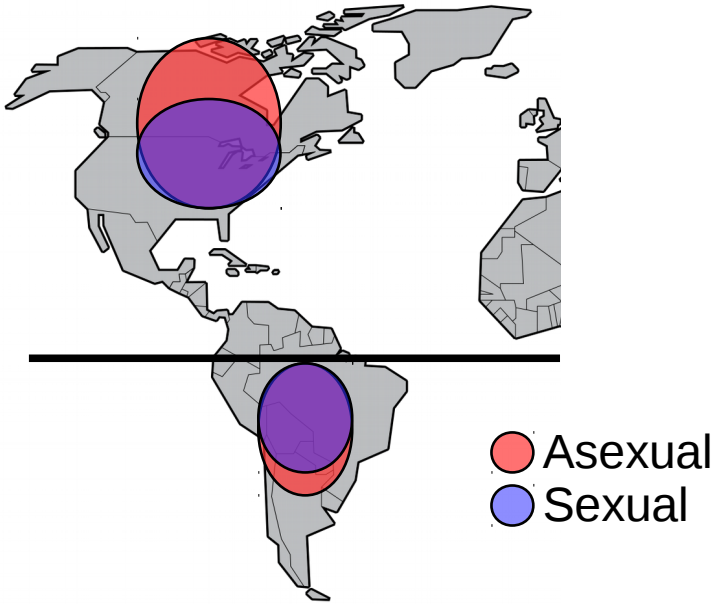
Causality: Results

- 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.

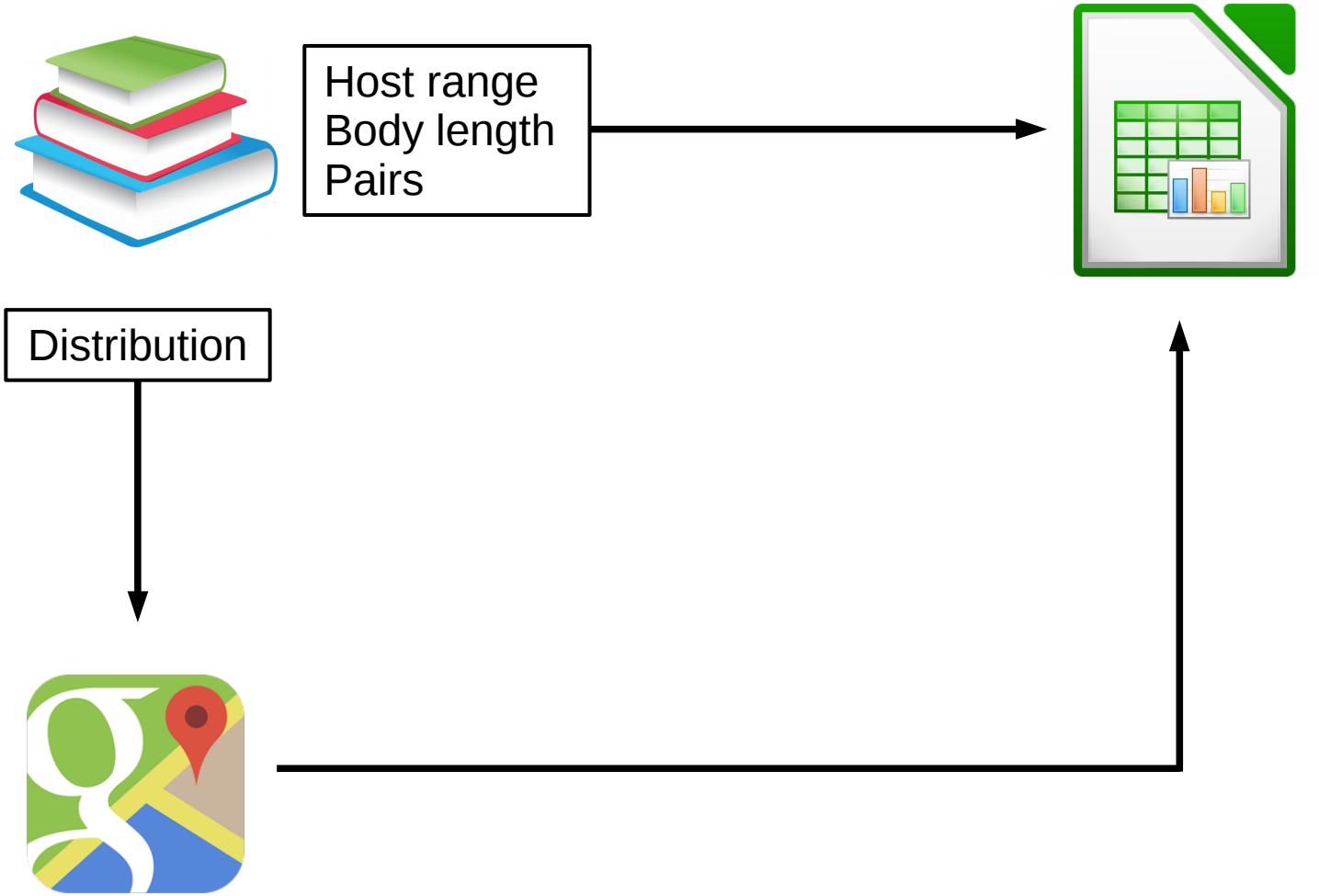


Thank you !

Questions ?

Supplementary slides

Manual dataset: flowchart



Manual dataset: Data

Species used for comparisons:

Manual dataset:

- In total: 133 species (50 asexual, 83 sexual)
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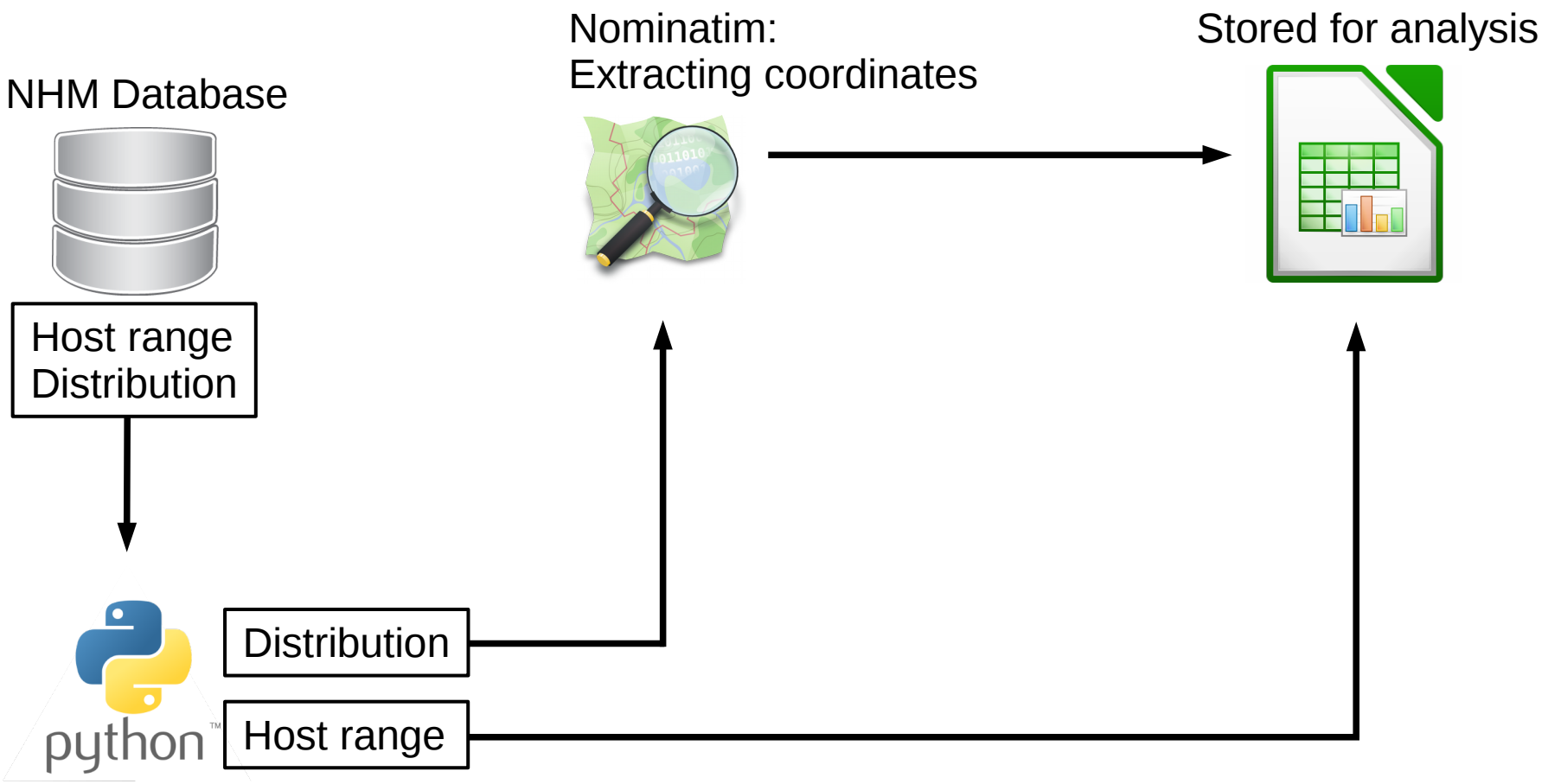
Family	Genus	Asex	Sex	Total
Aphelinidae	Aphelinus	2	9	11
	Aphytis	20	35	55
	Encarsia	7	8	15
	Eretmocerus	2	3	5
Torymidae	Megastigmus	7	11	18
	Torymus	1	2	3
Trichogrammatidae	Megaphragma	1	1	2
	Trichogramma	10	12	22
	Trichogrammatoidea	0	2	2

Automated dataset: flowchart

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



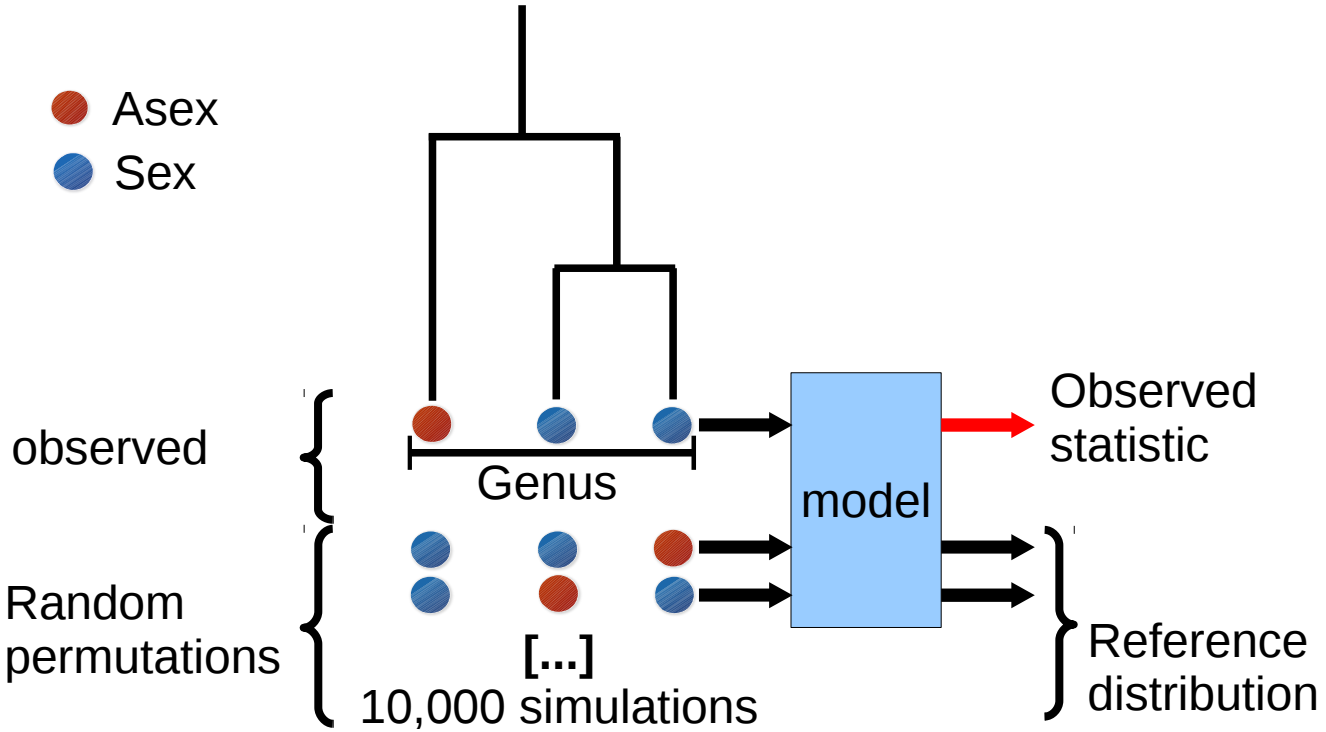
Automated dataset: Data

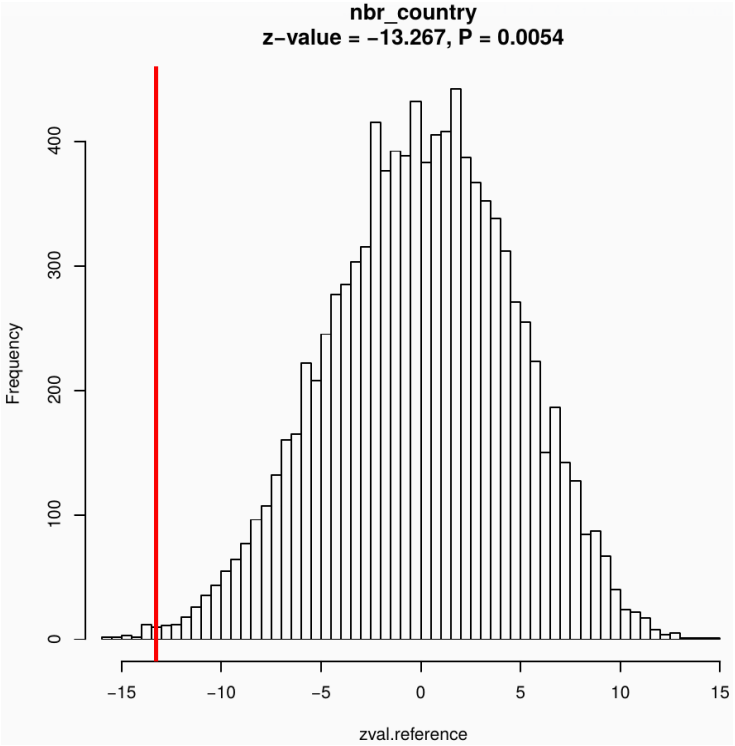
Automated dataset:

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

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

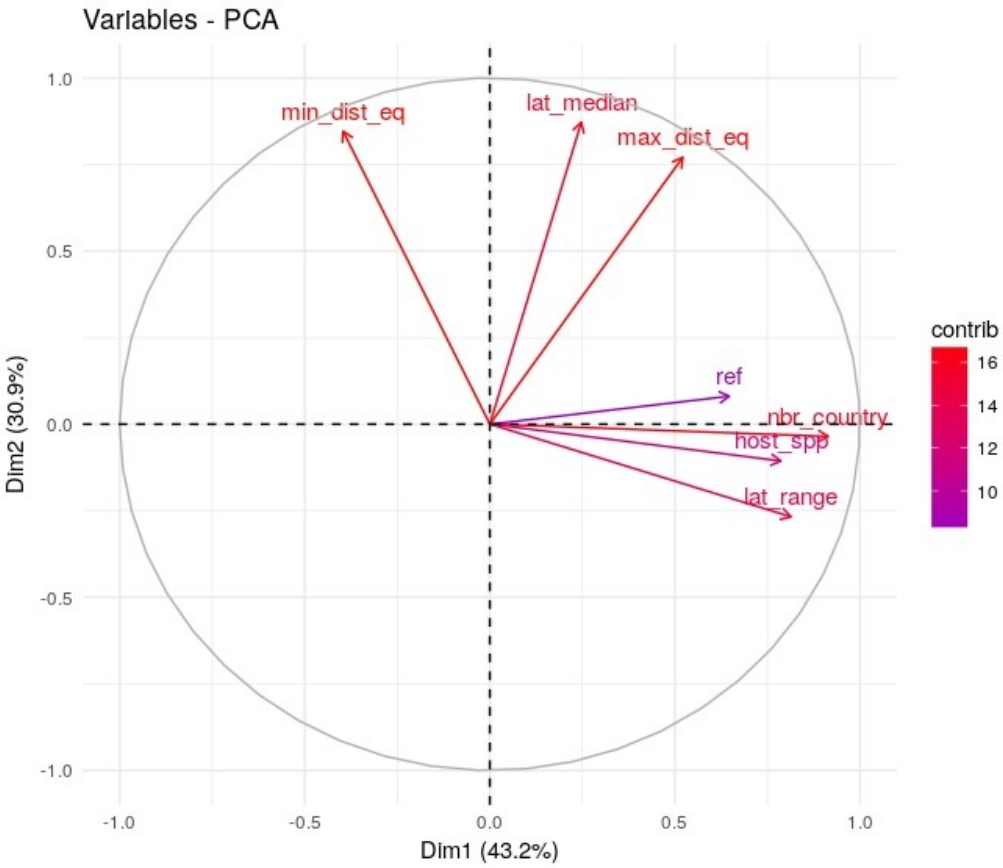
GLMM with permutation approach

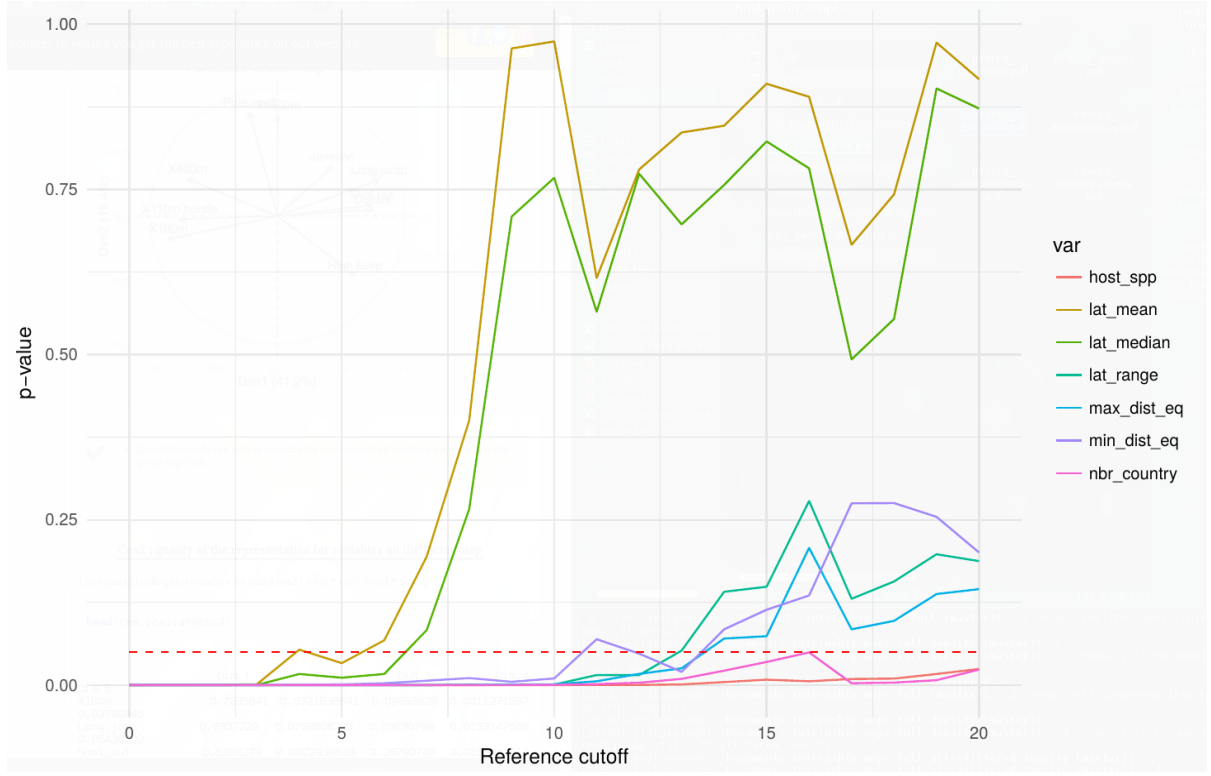
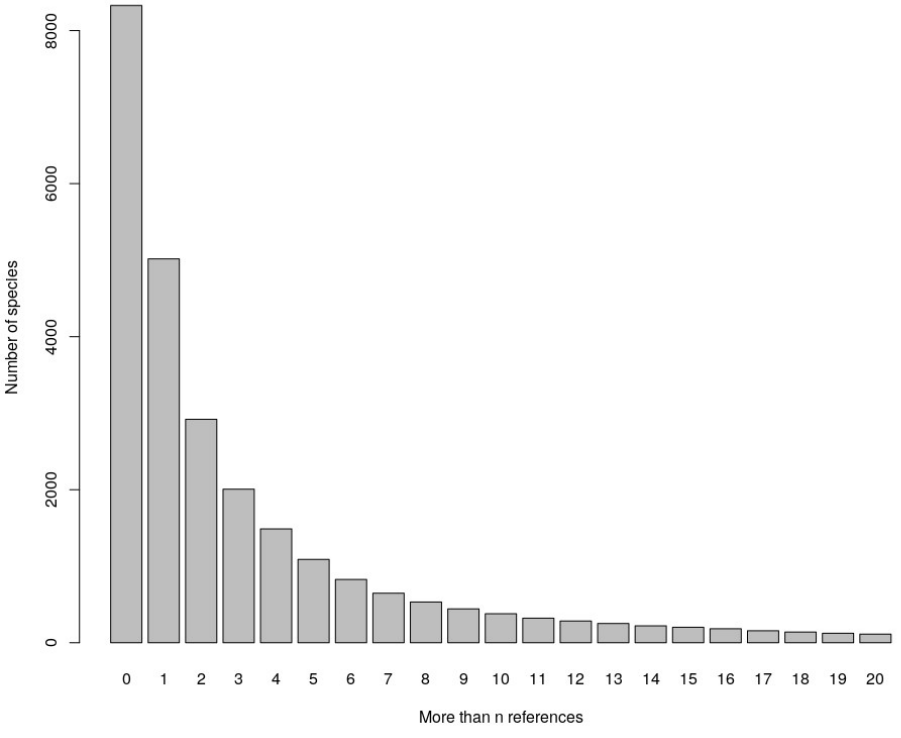




Automated dataset: Publication bias

- 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