

Comparative ecology of sexual and asexual parasitoid wasps

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Background

- 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



The study

- Do asexuals and sexuals have different ecologies and distributions ?
 - Gather data on ecological variables in Chalcidoidea
 - Compare variables between asexual and sexual species

Why Chalcidoidea ?

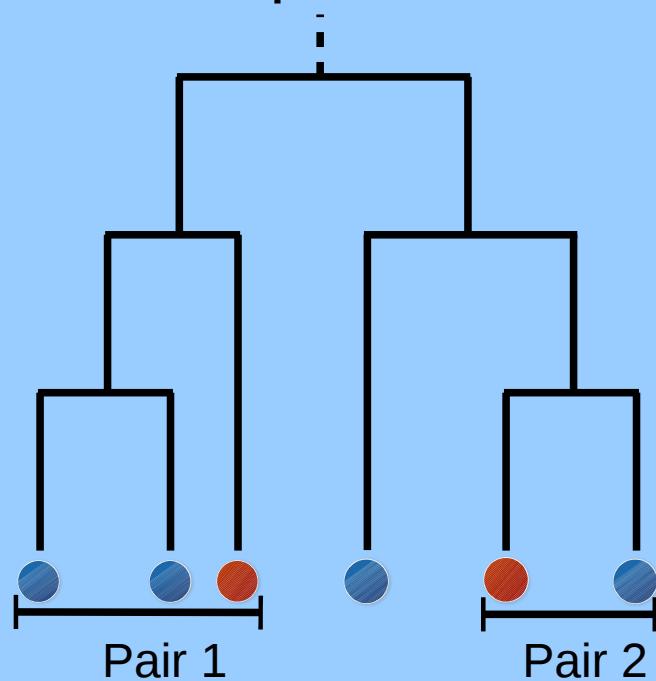
- Many (240) parthenogenetic species
- Well studied, many species relevant for biocontrol.
- Great database available!

The screenshot shows the homepage of the Natural History Museum's Universal Chalcidoidea Database. The top navigation bar includes links for Visit, Discover, Take part, Support us, Shop, Schools, Our science, and a search function. A banner at the top right offers 'Admission free' and 'Become a Member'. Below the banner, a black navigation bar contains the text 'Home / Our science / Data / Universal Chalcidoidea Database'. The main content area features a green header 'Universal Chalcidoidea Database' and a sub-header 'Index to families'. A sidebar on the left lists various chalcidoid families: Chalcidoidea, Agaonidae, Aphelinidae, Chalcididae, Encyrtidae, Eucharitidae, Eulophidae, Eupelmidae, Eurytomidae, Leucospidae, Mymaridae, Ormyridae, Perilampidae, Pteromalidae, Potteridae, Signiphoridae, Tanaostigmatidae, Tetracampidae, Torymidae, Trichogrammatidae, Mymarommatidae, and Mymarommatoidea. At the bottom of the page, a note states 'Last updated 19-Aug-2003 Dr B R Pitkin'.

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

Manual dataset

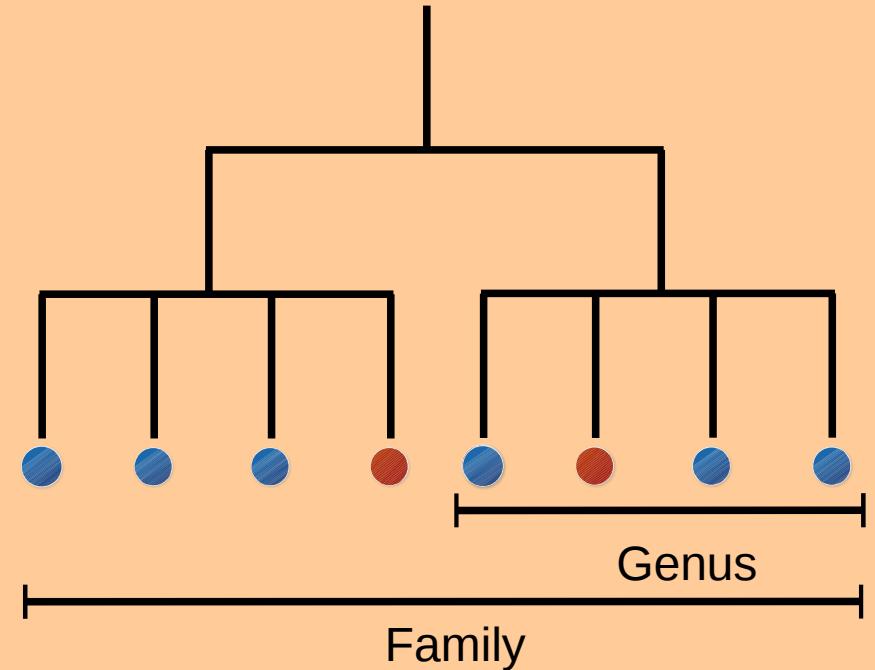
- Gathered by hand in literature
- Comparison sex vs asex between the most closely related species.



→133 species across 32 pairs
50 asexuals, 83 sexuals

Automated dataset

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

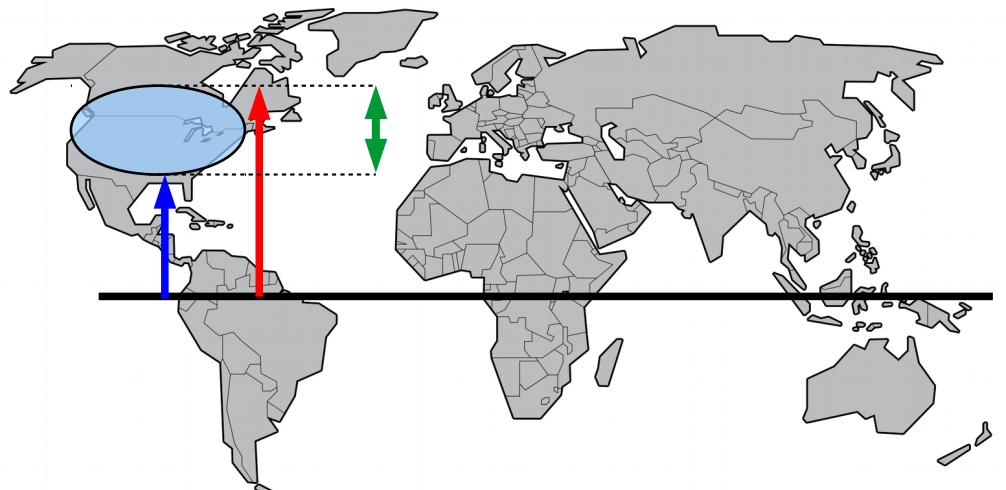


→8357 species across 66 genera
136 asexuals, 8221 sexuals

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.

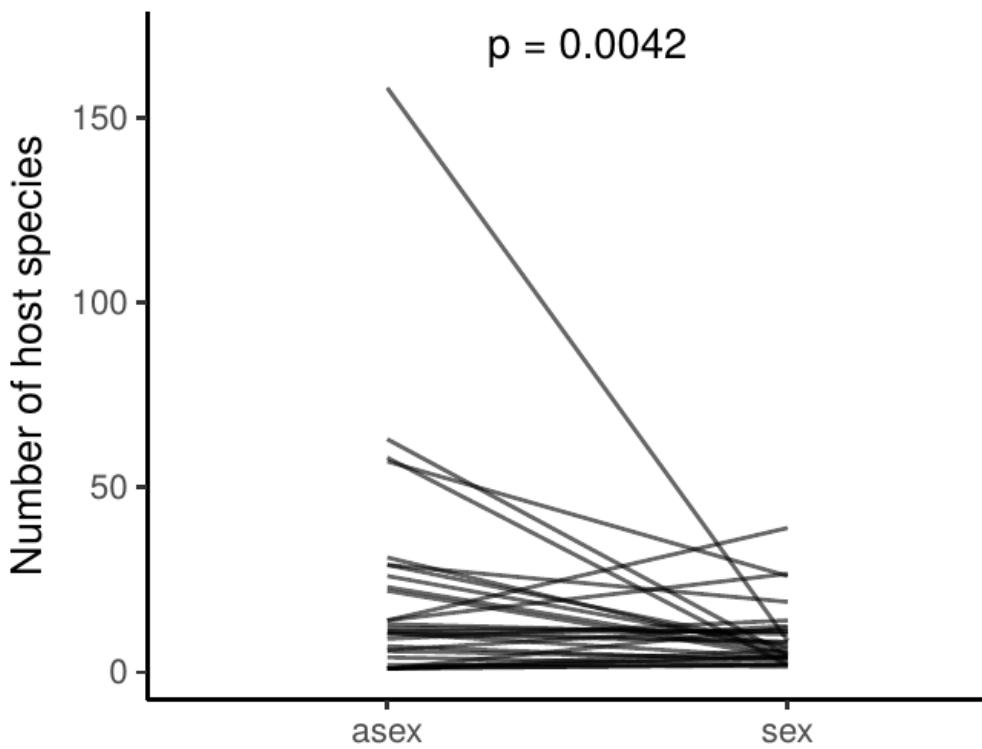
- Max distance from equator.
- Min distance from equator
- Latitude range



Results: Host species

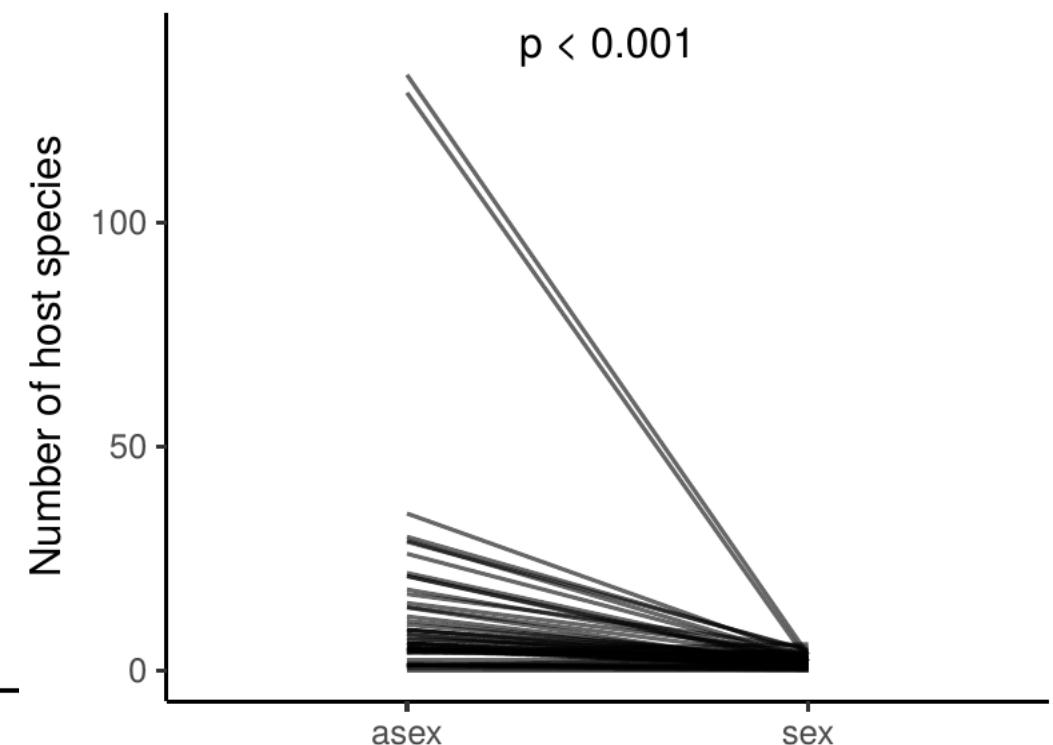
Manual dataset:

- Values per pair



Automated dataset

- Values per genus



Generalized linear mixed models:

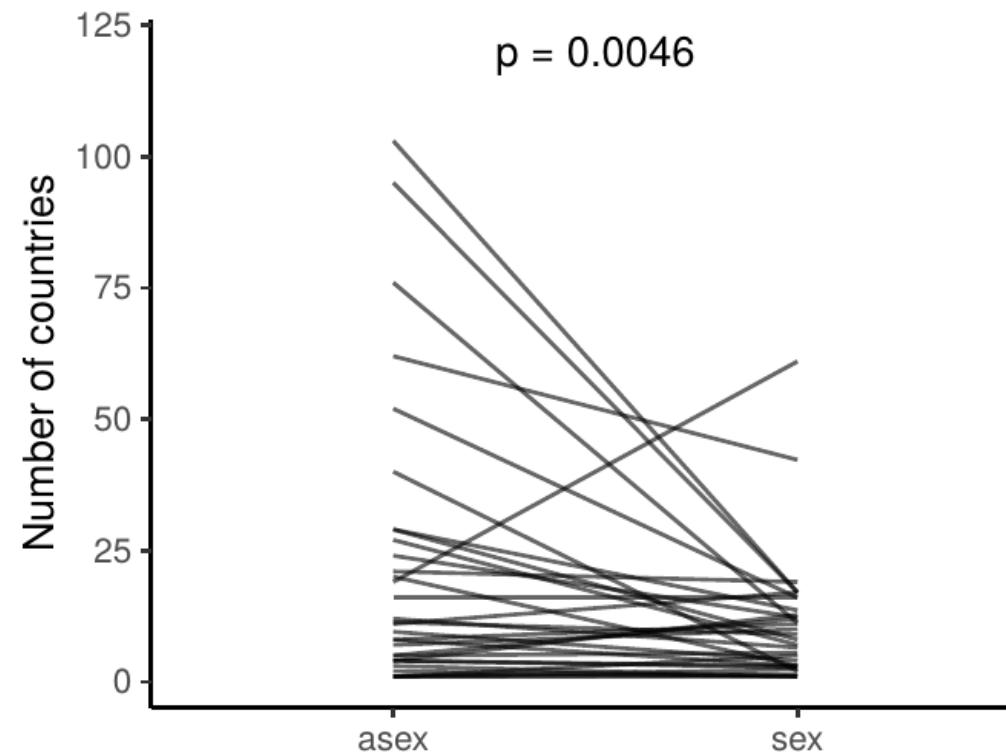
$n.hosts \sim \text{mode} + (1| \text{genus / pair})$

$n.hosts \sim \text{mode} + (1| \text{genus})$

Results: Number of countries

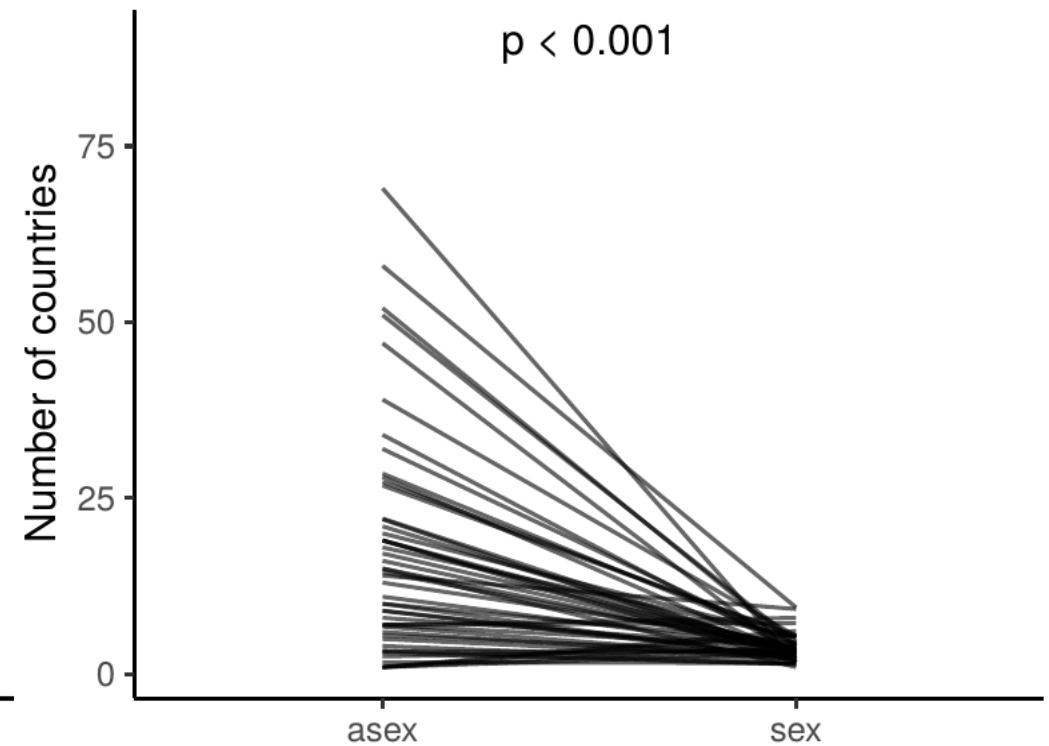
Manual dataset:

- Values per pair



Automated dataset

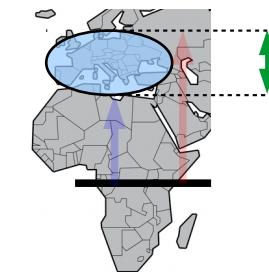
- Values per genus



Generalized linear mixed models:

$n.\text{countries} \sim \text{mode} + (1 | \text{genus} / \text{pair})$

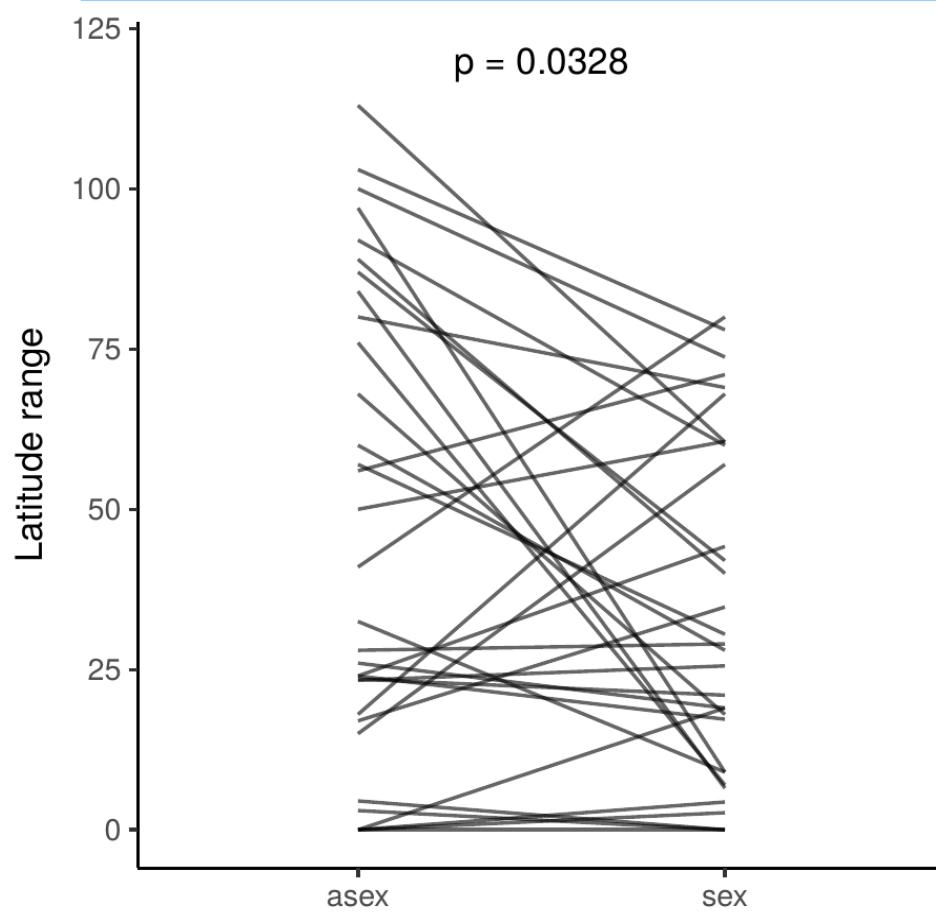
$n.\text{countries} \sim \text{mode} + (1 | \text{genus})$



Results: Latitude range

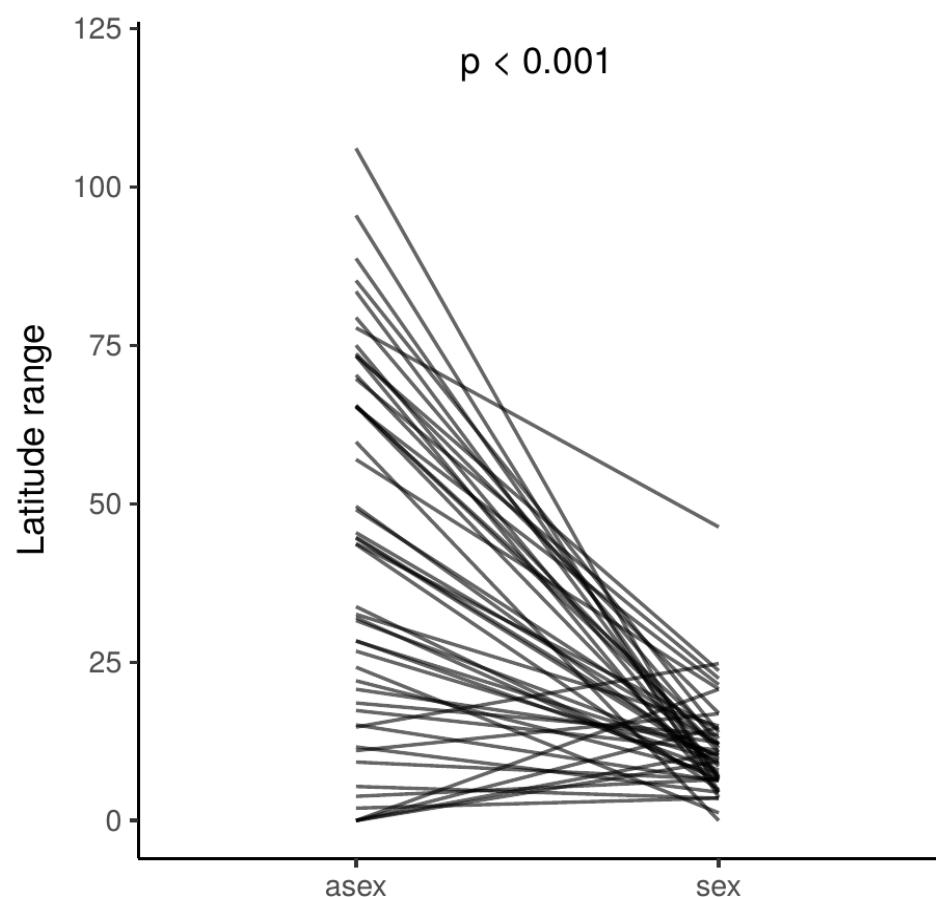
Manual dataset:

- Values per pair



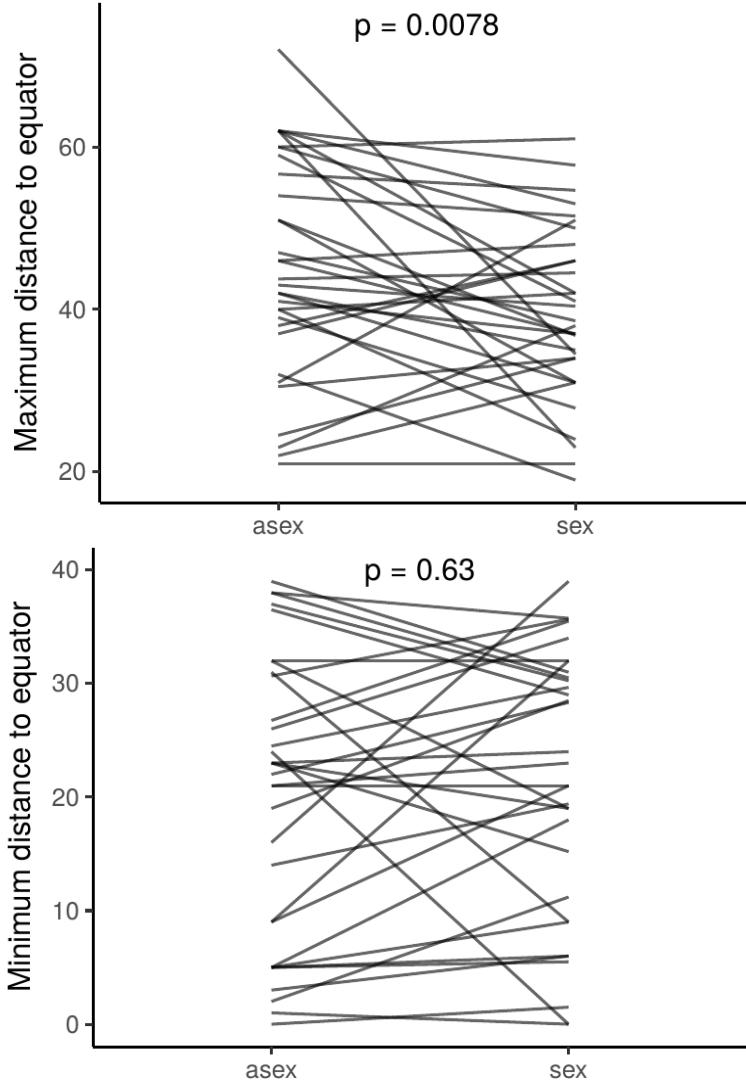
Automated dataset

- Values per genus

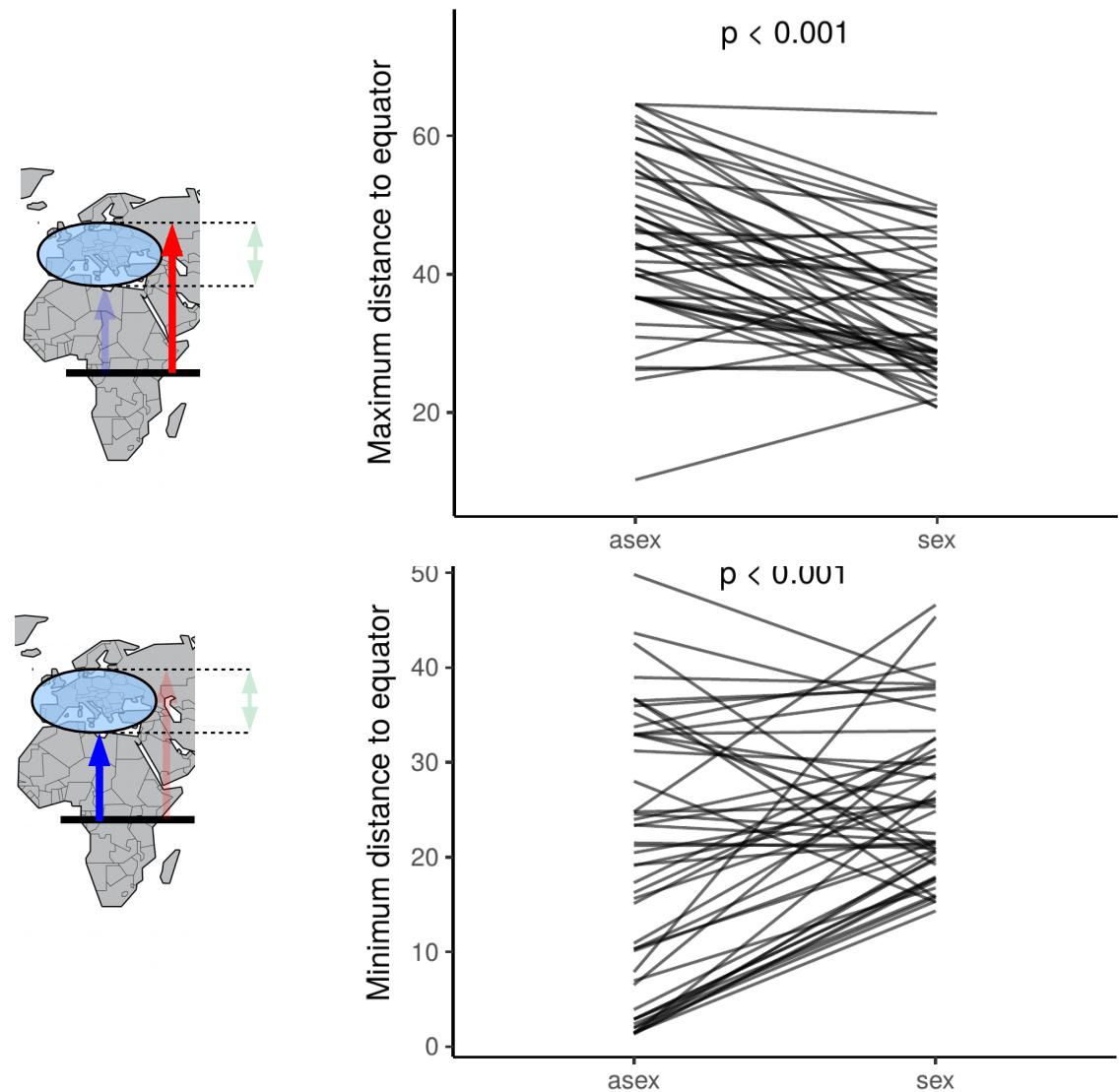


Results: Direction of expansion

Manual dataset:

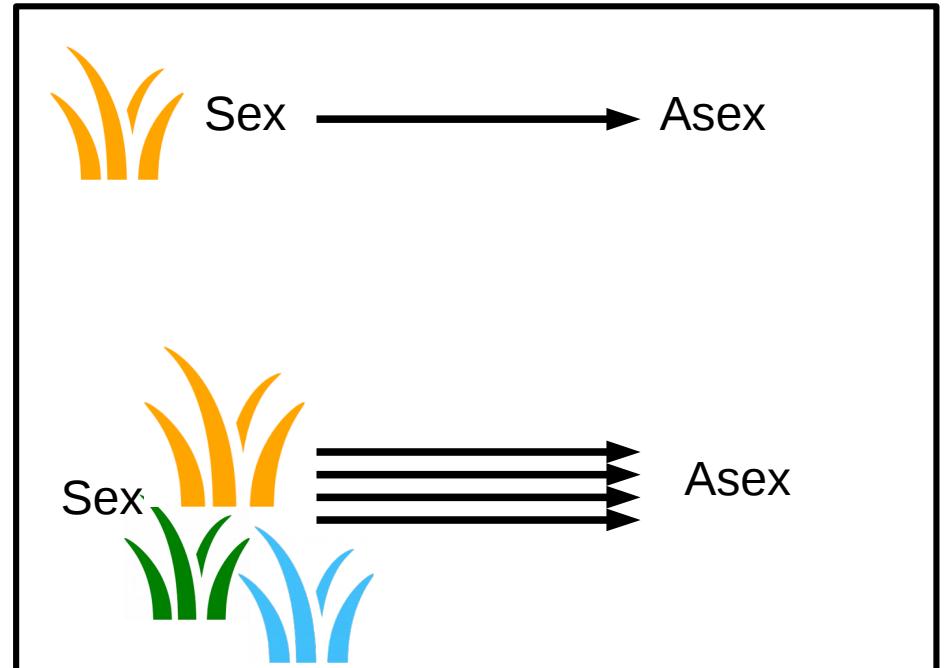
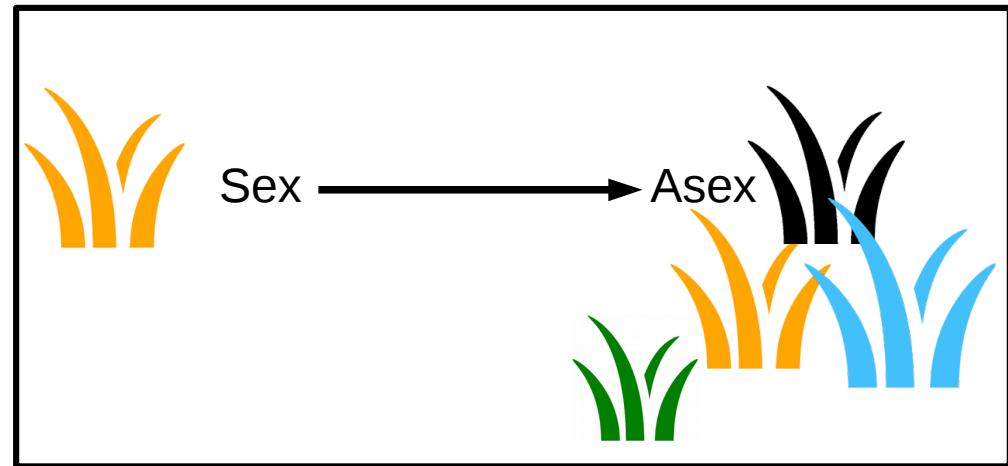


Automated dataset:



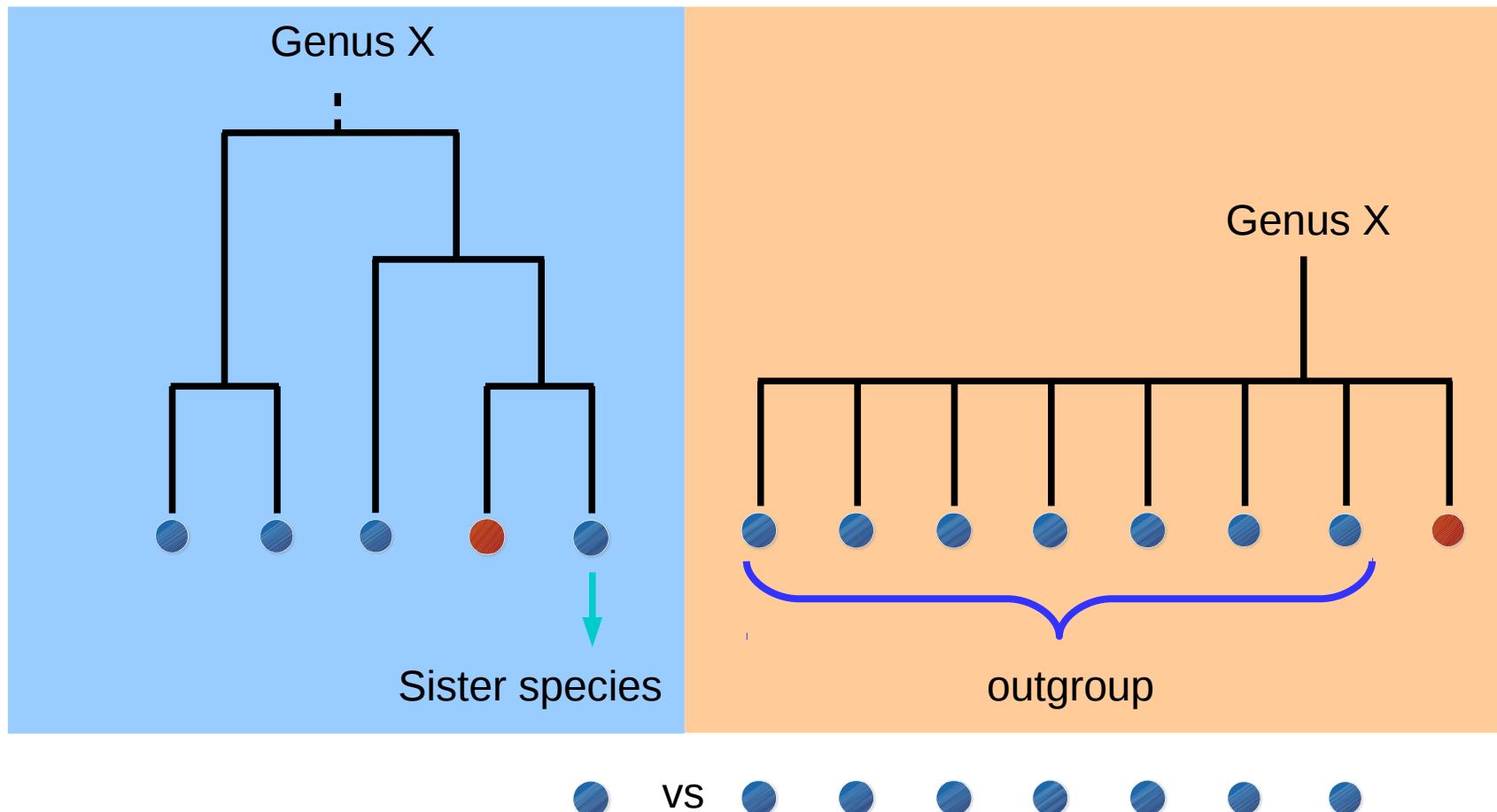
Arrow of causality

- Does the broad niche evolve after transition to asexuality?
- Or are sexuals with broad niche more likely to give rise to asexuals?



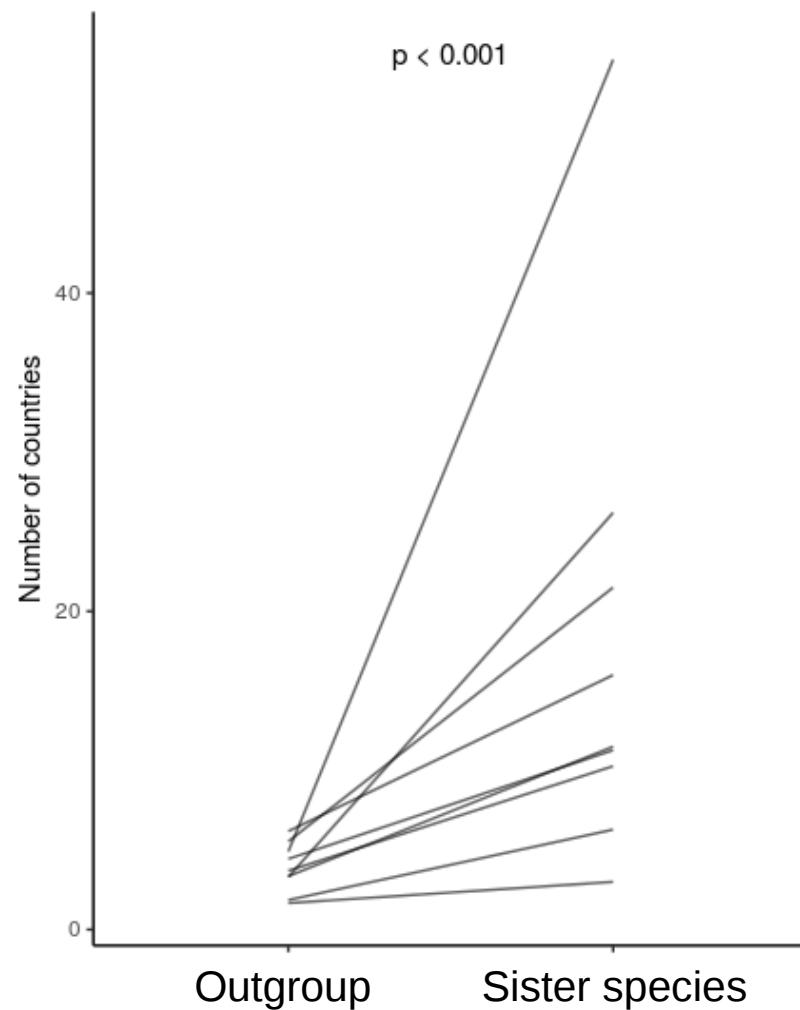
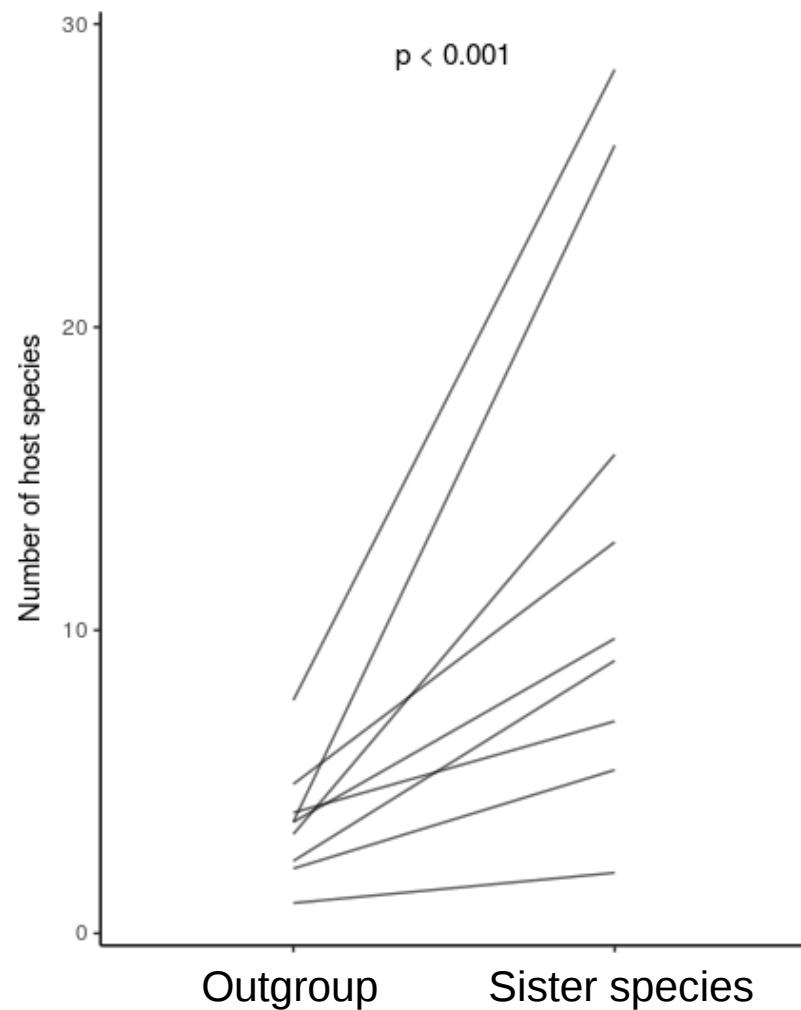
Arrow of causality

- Combining manual and automated datasets



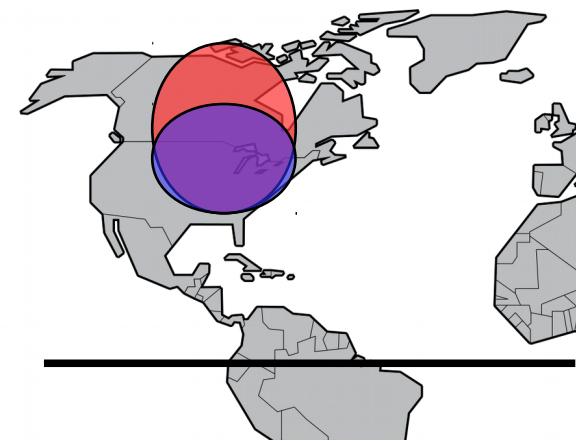
- Comparing number of host species and countries between sister species and outgroups in each genera

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



Conclusions

- 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.



● Asexual
● Sexual

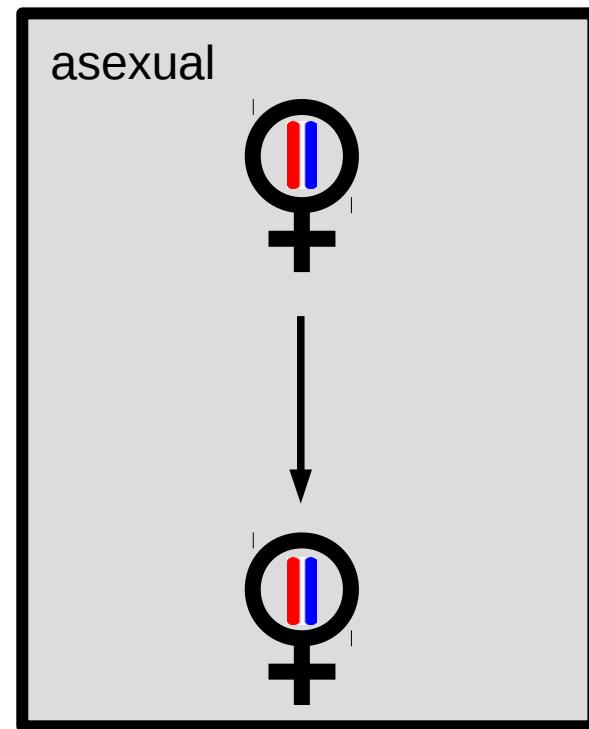
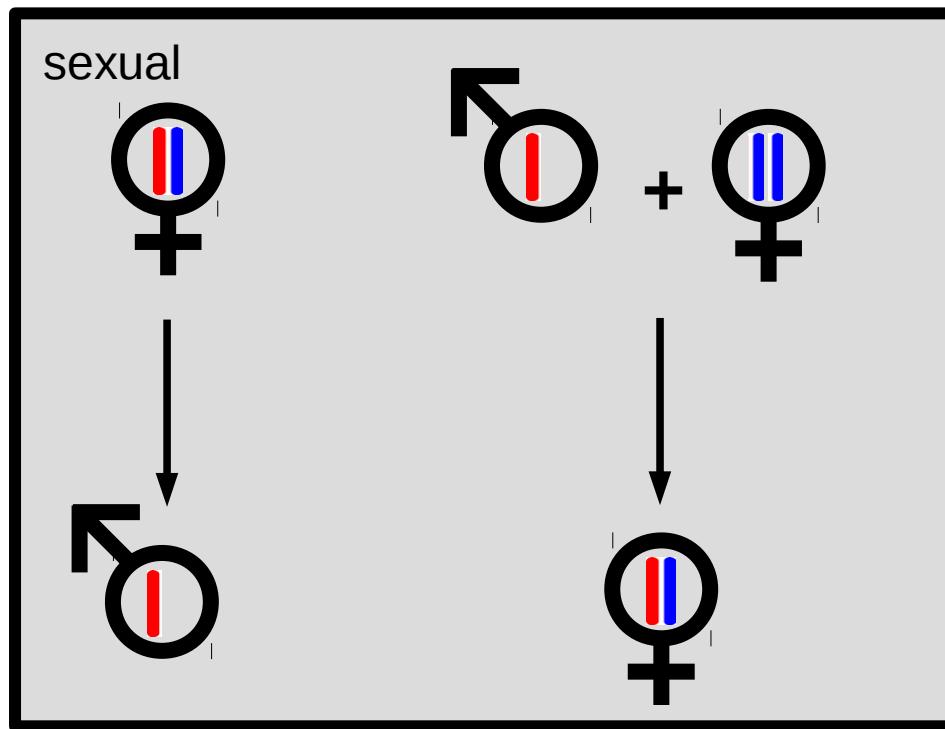
Thank you !

Questions ?

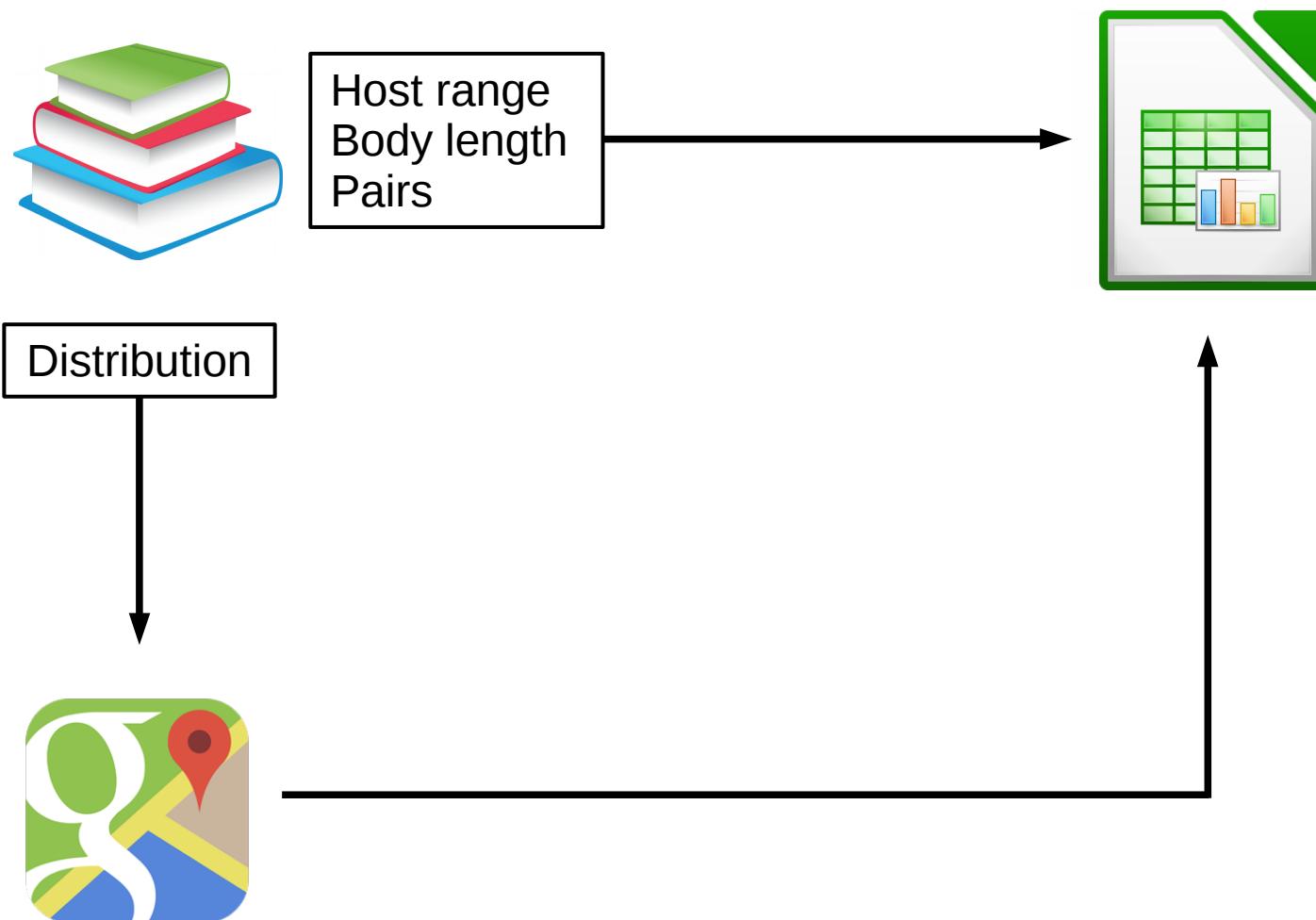
Supplementary slides

Haplodiploid arthropods

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



Manual dataset: flowchart



Manual dataset: Data

Species used for comparisons:

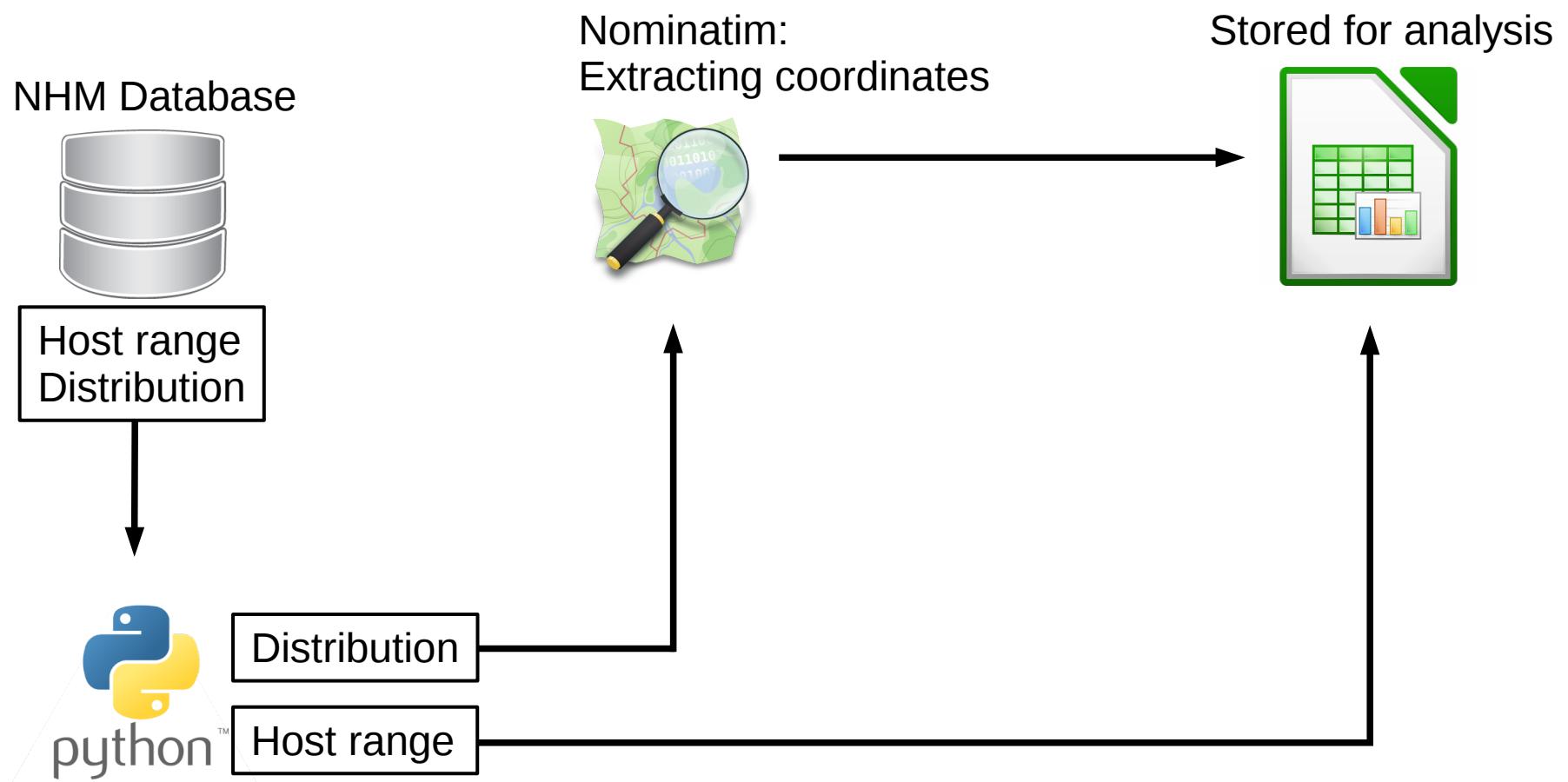
Manual dataset:

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

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

Automated dataset: flowchart

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



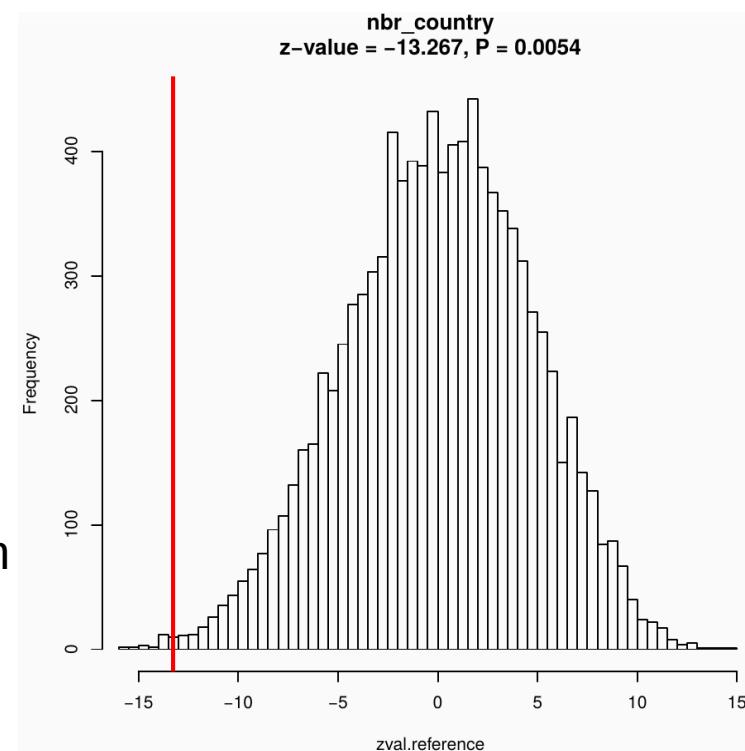
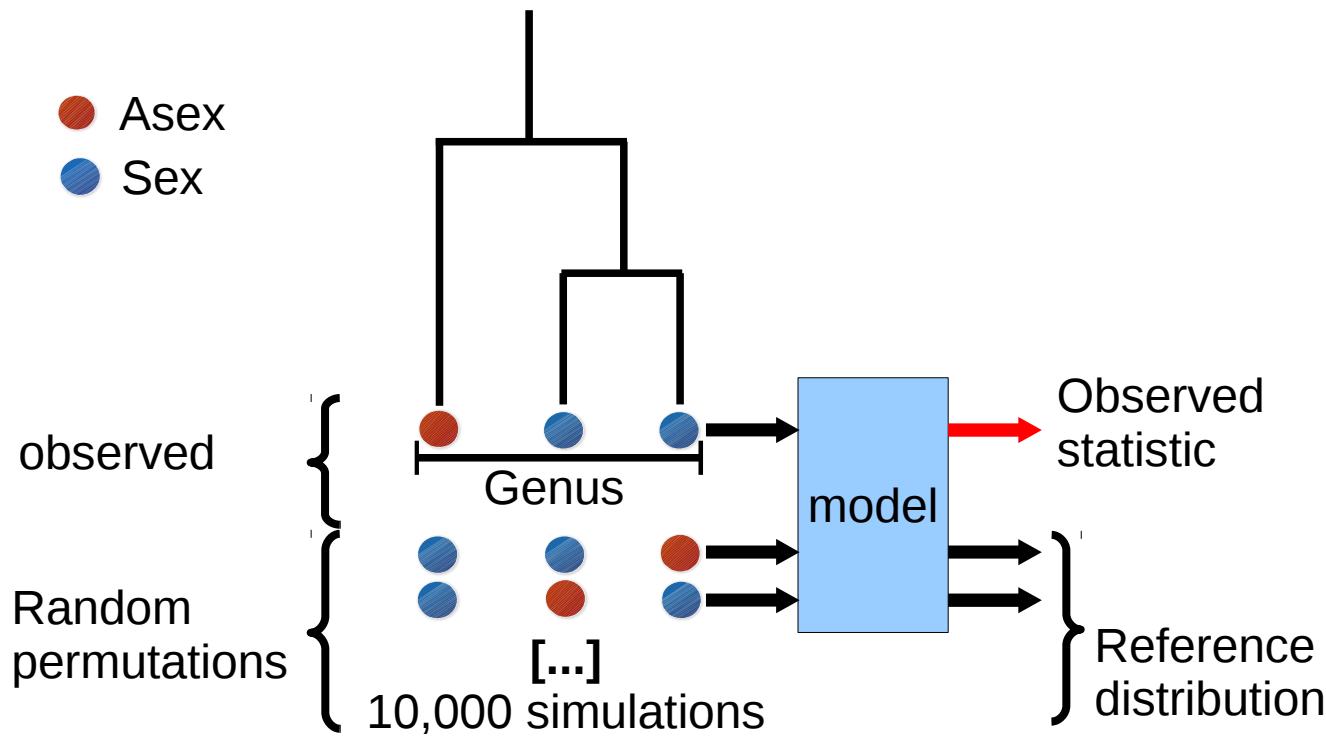
Automated dataset: Data

Automated dataset:

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

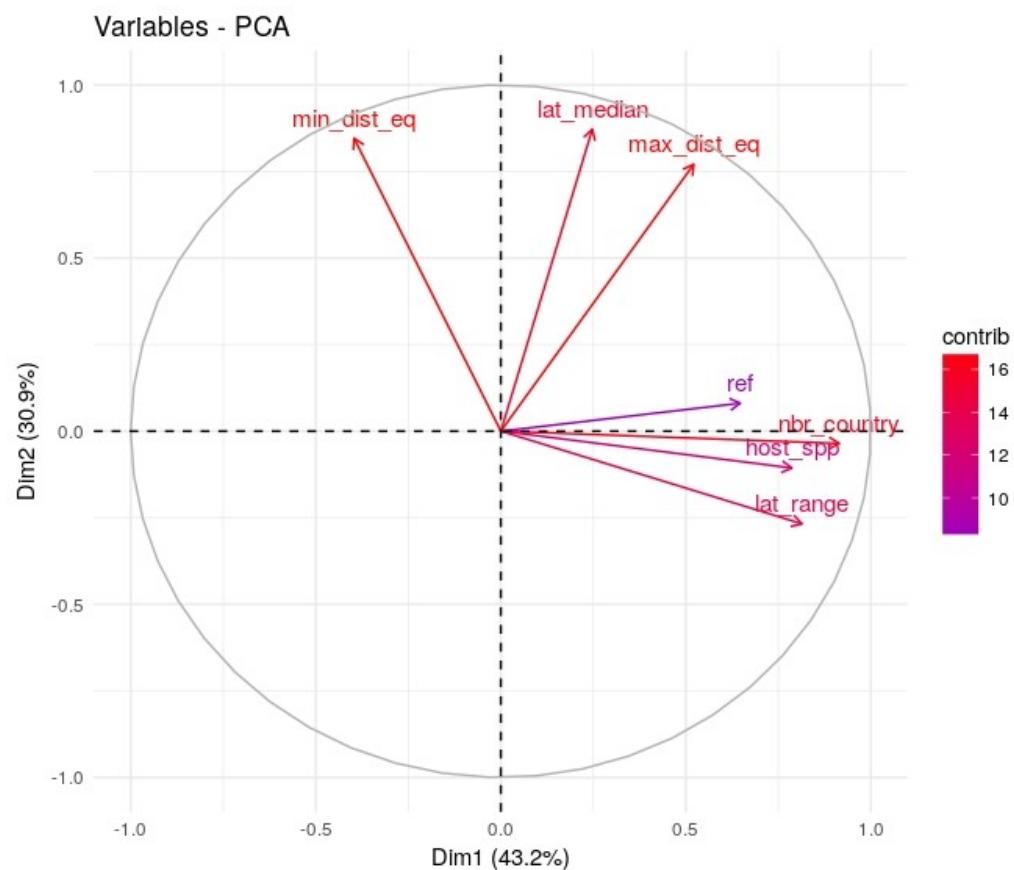
Family	Asexual	Sexual	Total
Aphelinidae	46	1006	1052
Chalcididae	1	304	305
Encyrtidae	22	1314	1336
Eulophidae	22	2148	2170
Eupelmidae	1	481	482
Eurytomidae	3	879	882
Leucospidae	1	117	118
Mymaridae	12	528	540
Pteromalidae	6	680	686
Torymidae	8	517	525
Trichogrammatidae	14	247	261

GLMM with permutation approach



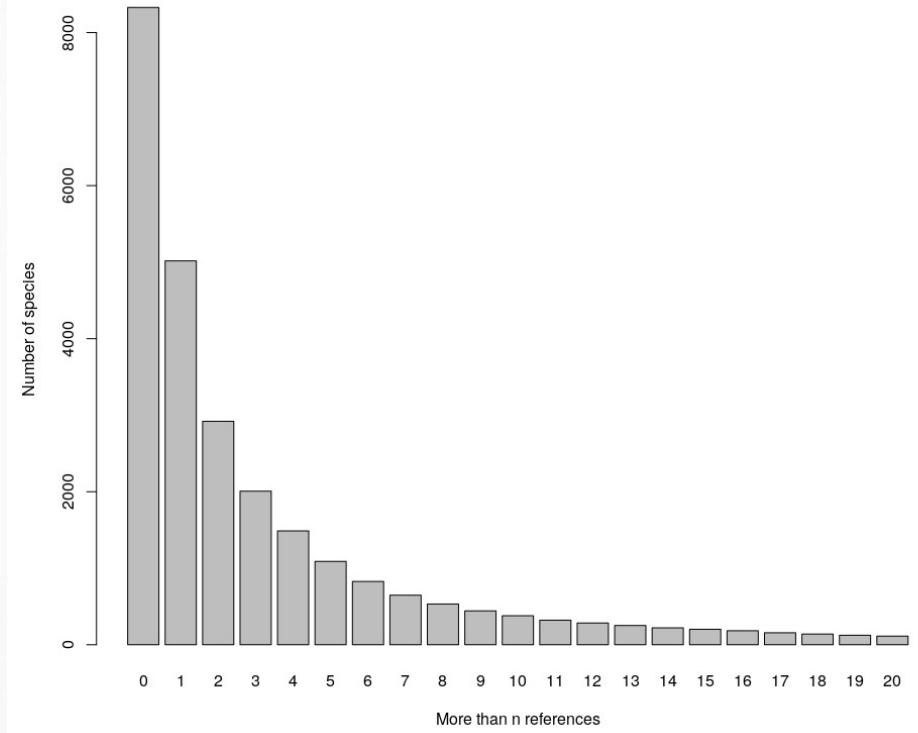
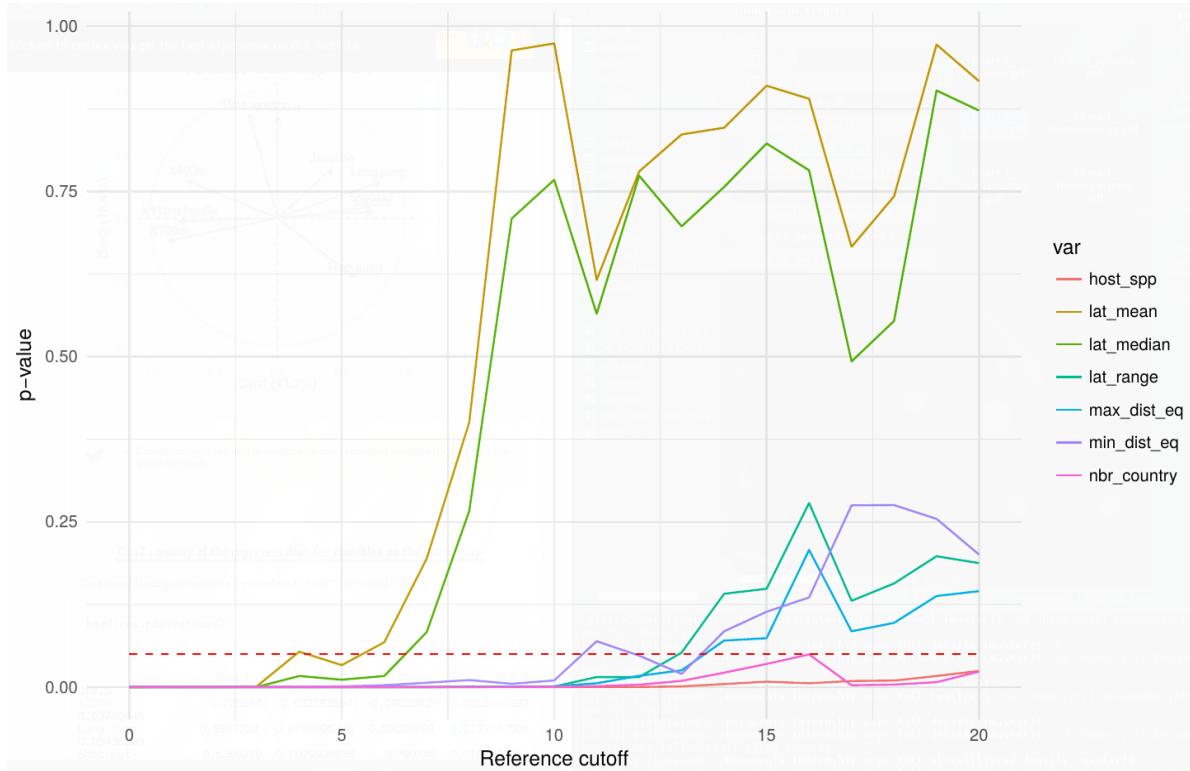
Automated dataset: Publication bias

- 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



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)

