

Comparative analysis of morphological and ecological traits between sexual and parthenogenetic chalcid wasps.

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Supervised by Casper Van Der Kooi



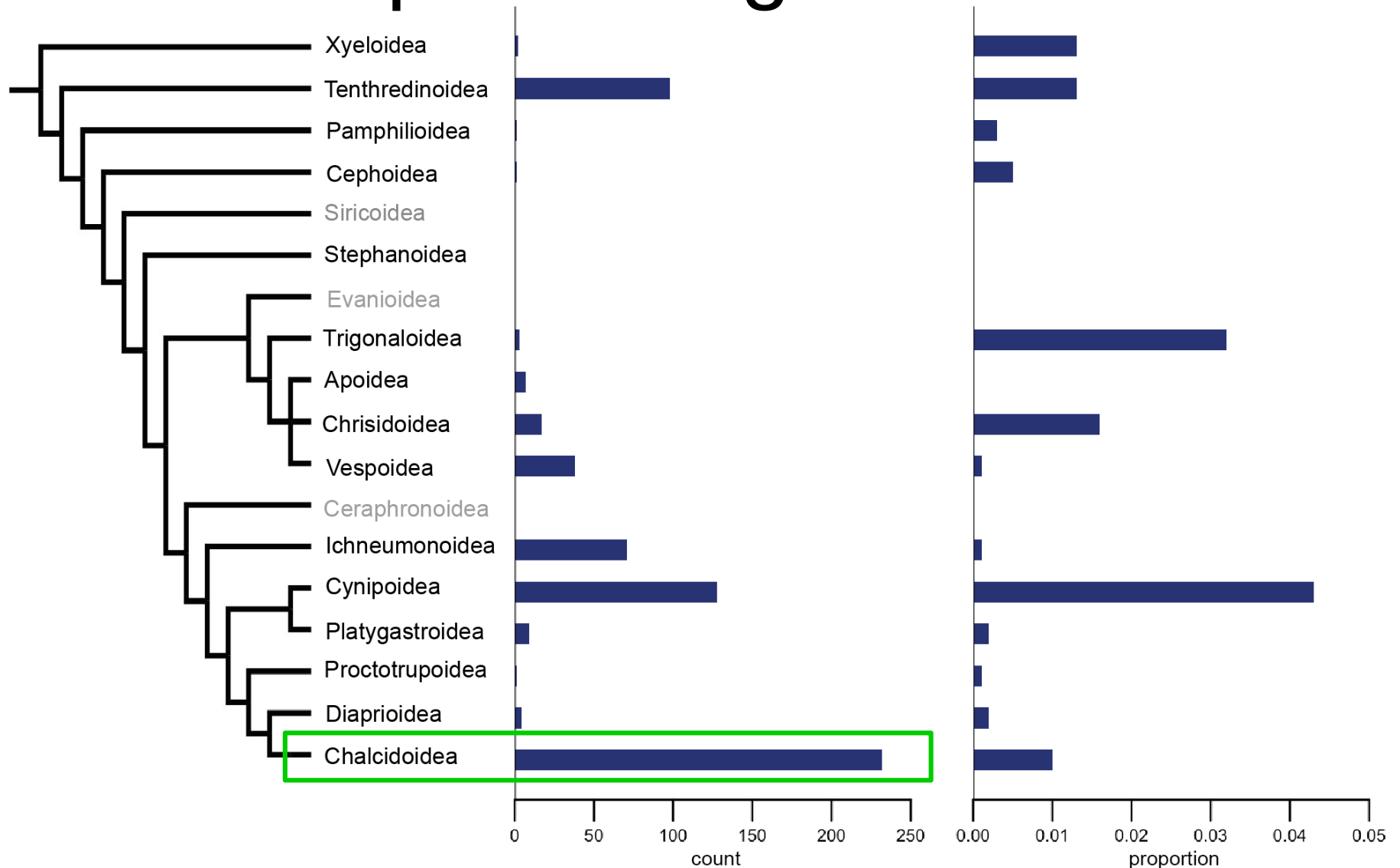
The study

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

Why Chalcidoidea ?

- Many parthenogenetic species
- Lots of studies, many species relevant for biocontrol.
- Great database available!

Chalcidoidea has many parthenogens



From Casper's review on parthenogenesis

NHM database

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

The screenshot shows the homepage of the Natural History Museum's Universal Chalcidoidea Database. The header features the museum's logo and navigation links: Visit, Discover, Take part, Support us, Shop, Schools, and Our science. A search bar is located on the right. Below the header, the page title "Universal Chalcidoidea Database" is displayed, followed by a link to the "Index to families". A list of families is provided, including Agaonidae, Aphelinidae, Chalcididae, Encyrtidae, Eucharitidae, Eulophidae, Eupelmidae, Eurytomidae, Leucospidae, Mymaridae, Ormyridae, Perilampidae, Pteromalidae, Rotoitidae, Signiphoridae, Tanaostigmatidae, Tetracampidae, Torymidae, and Trichogrammatidae. The page also includes a footer with the date "Last updated 19-Aug-2003" and the name "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 Mymarommatalidae

Last updated 19-Aug-2003 Dr B R Pitkin

Two separate studies

- "Manual dataset"

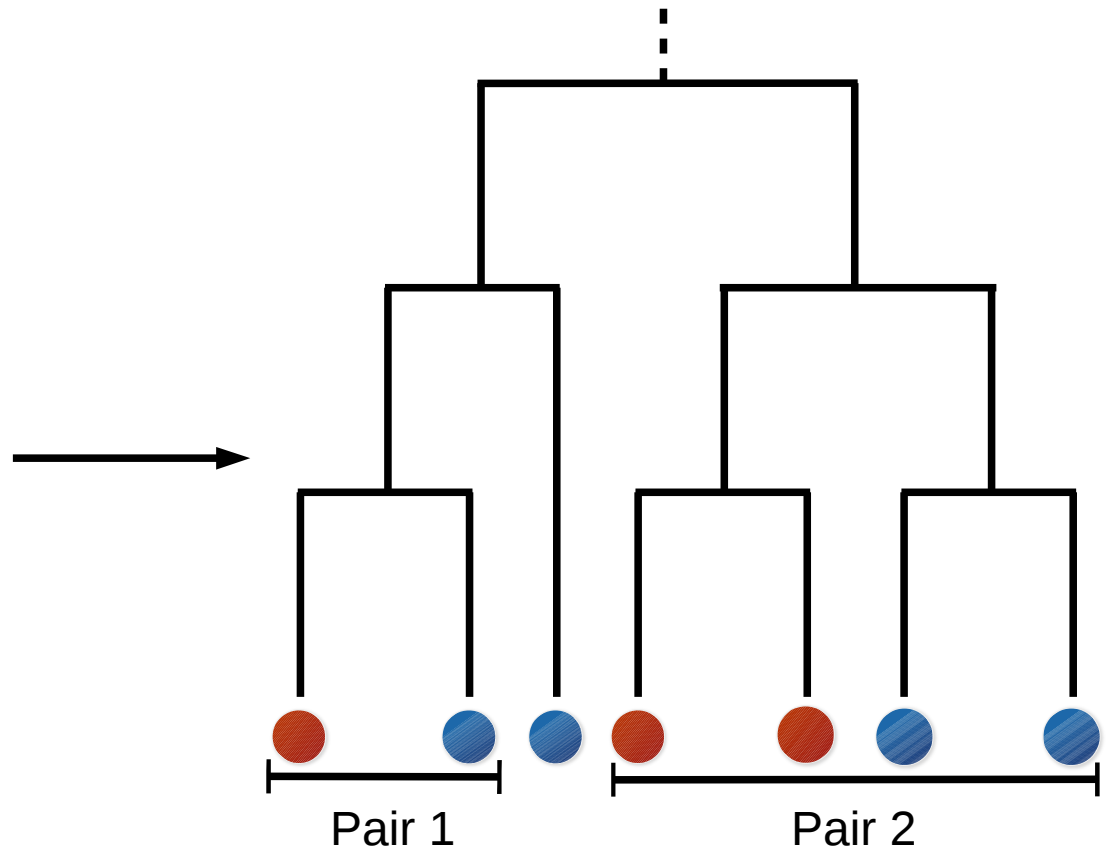
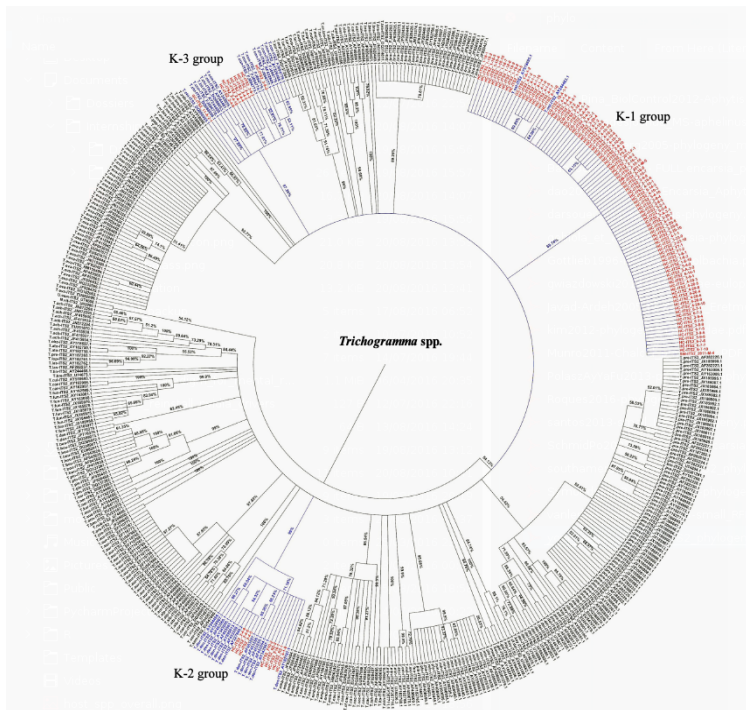
- Gathered by hand in literature
- More variables
- Fewer species
- Using asex/sex pairs for comparison

- "Automated dataset"

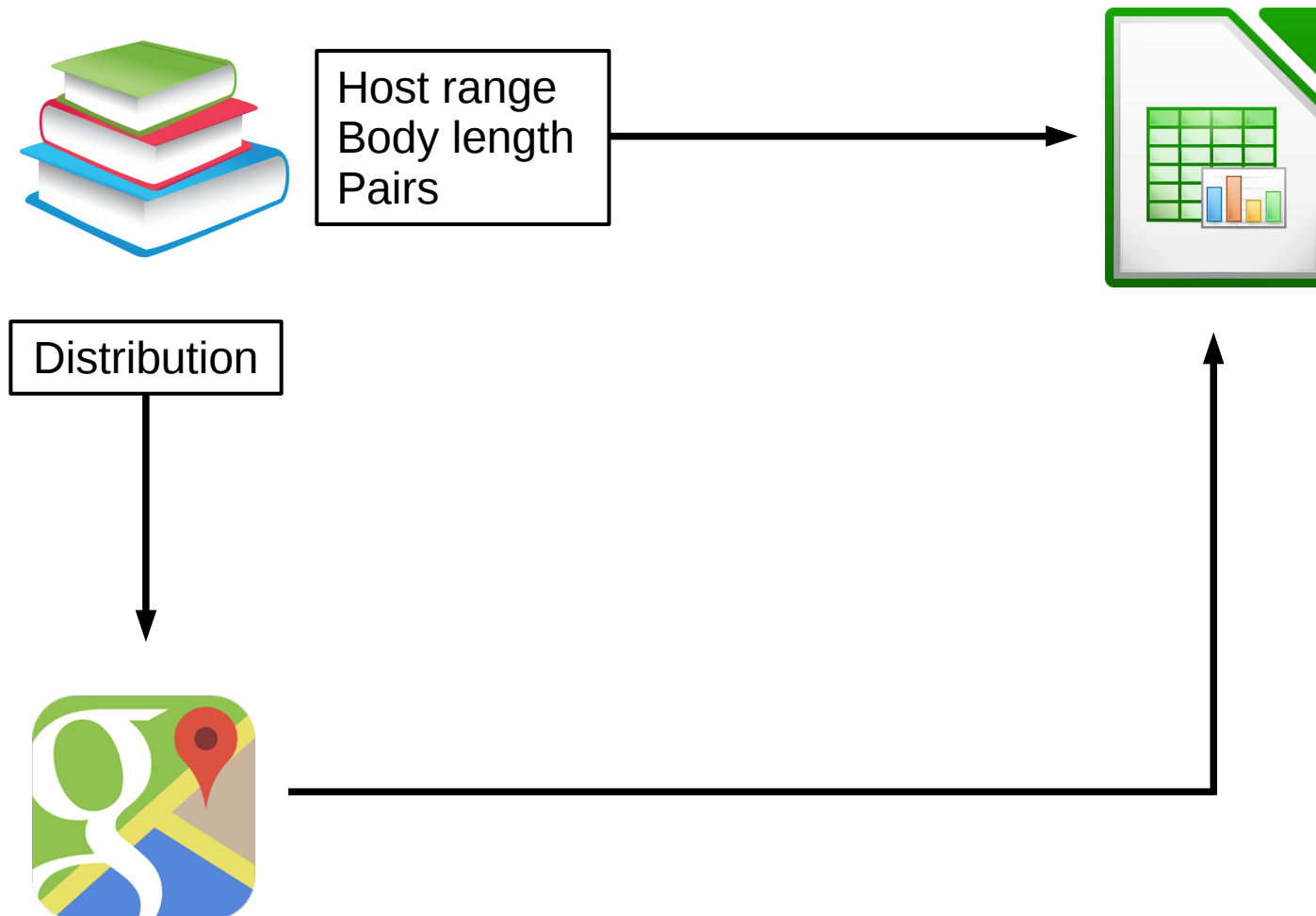
- All data from the same database.
- Only distribution and host range
- Much more species
- Using genera for comparison

Manual dataset: Pairs

- Comparison sex vs asex between the most closely related species.



Manual dataset: flowchart



Data

Species used for comparisons:

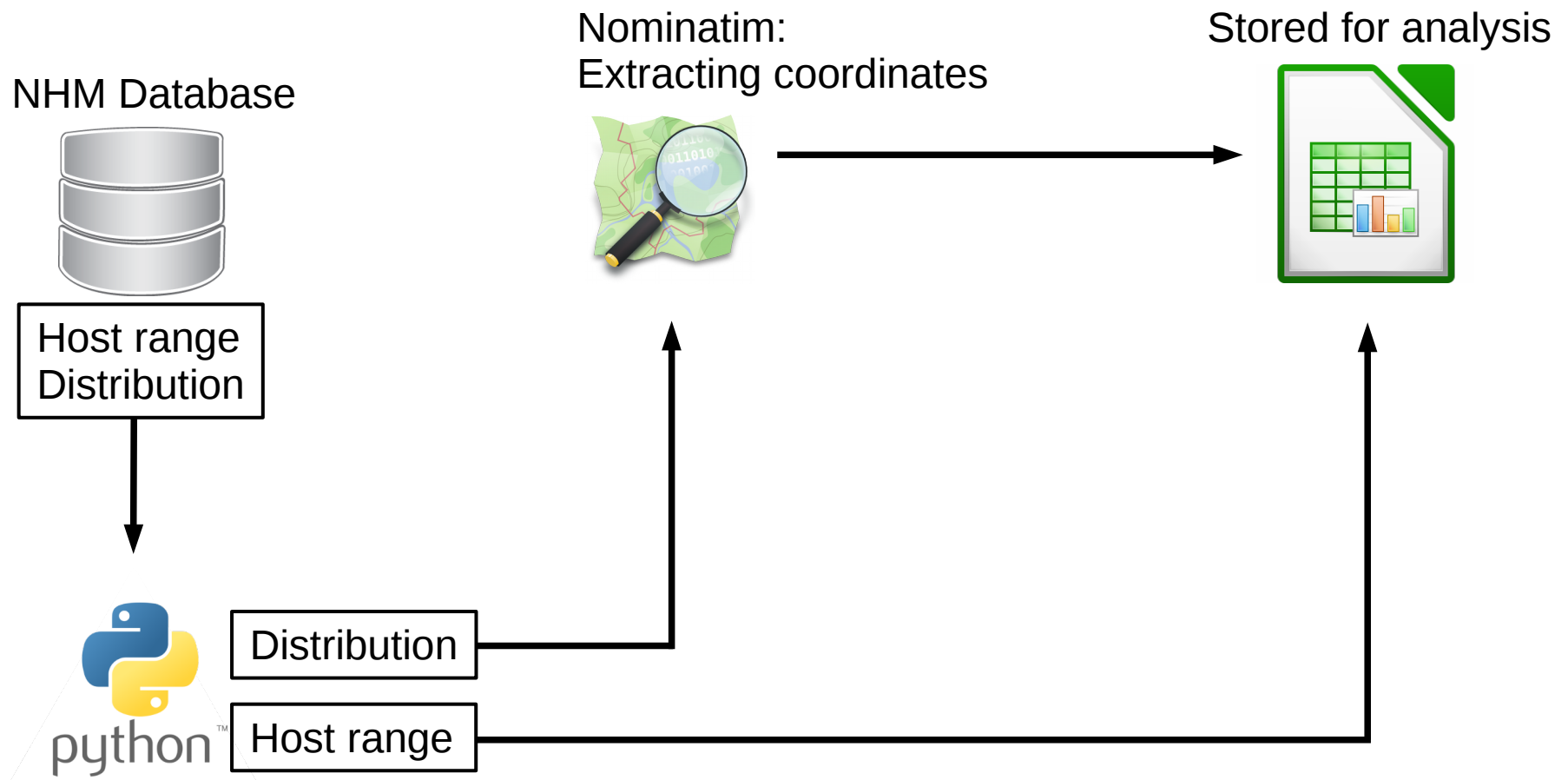
Manual dataset:

- 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.



Data:

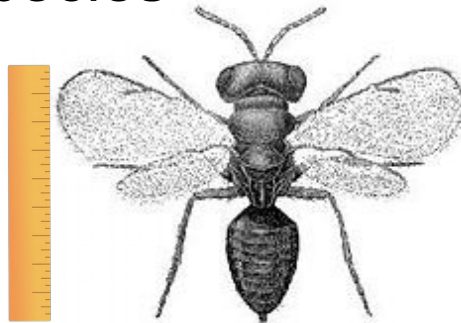
Automated dataset:

- 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

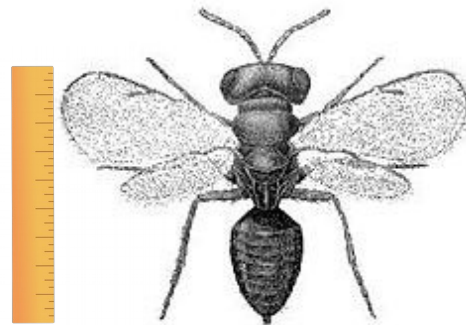
Variables studied

- Do asexuals differ from sexuals in size ?
 - Many parthenogens are small (i.e. whiteflies, thrips)
 - Body length
- Do asexuals tend to have more host species ?
 - Successful asexuals are often generalist.
 - Number of host species



Variables studied

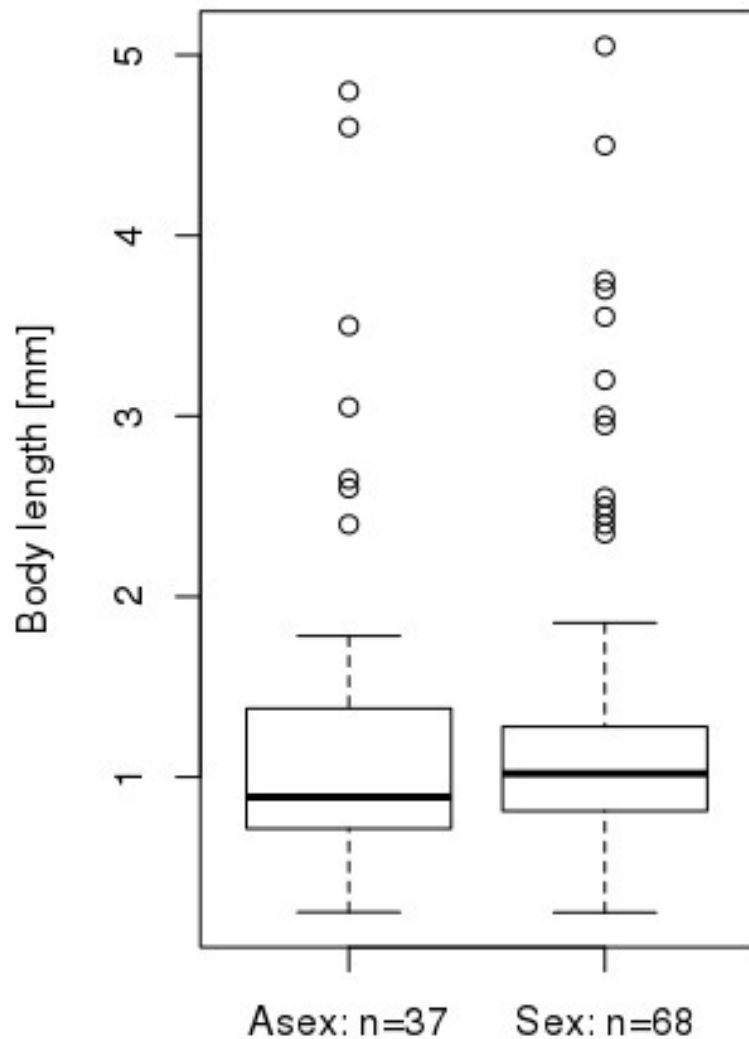
- Do asexuals tend to occupy different /larger regions than sexuals ?
 - Number of countries/states
 - Latitude, (longitude): Median, absolute, range



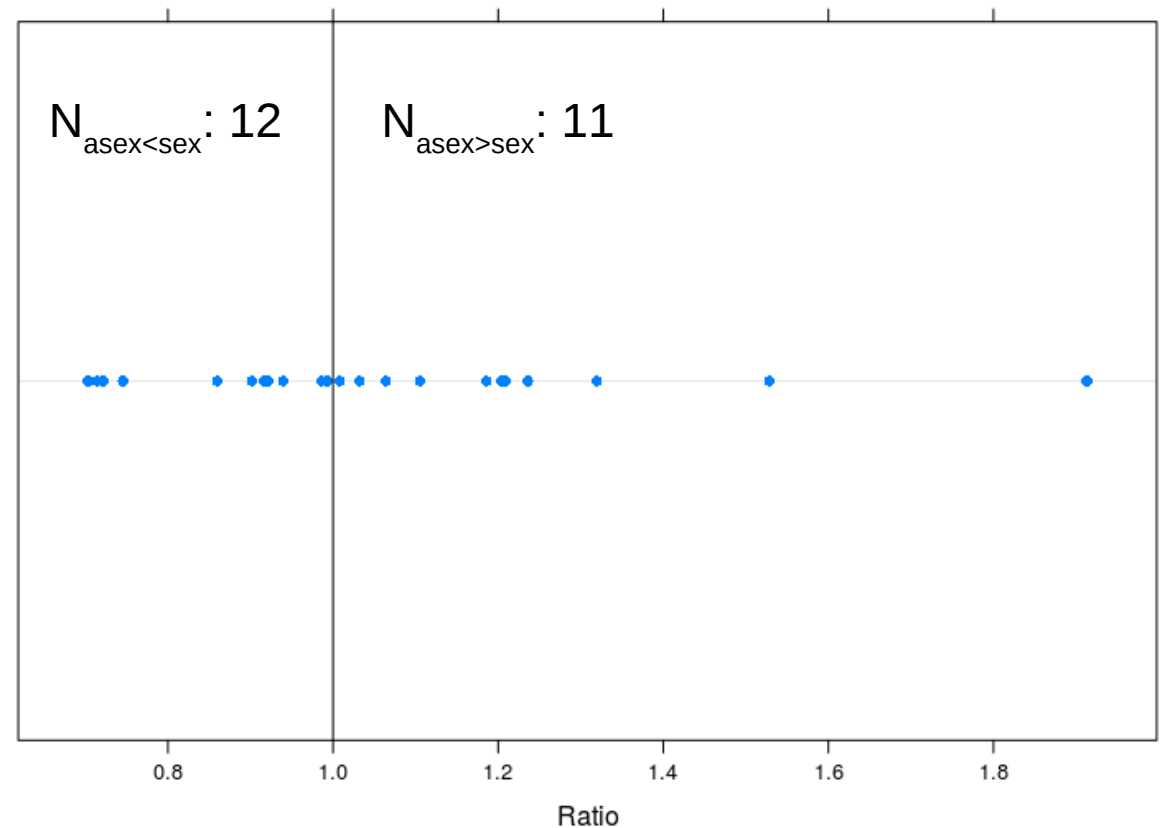
Do asexuals differ from sexuals in length ?

Manual dataset

Body length by
Reproductive mode: Overall



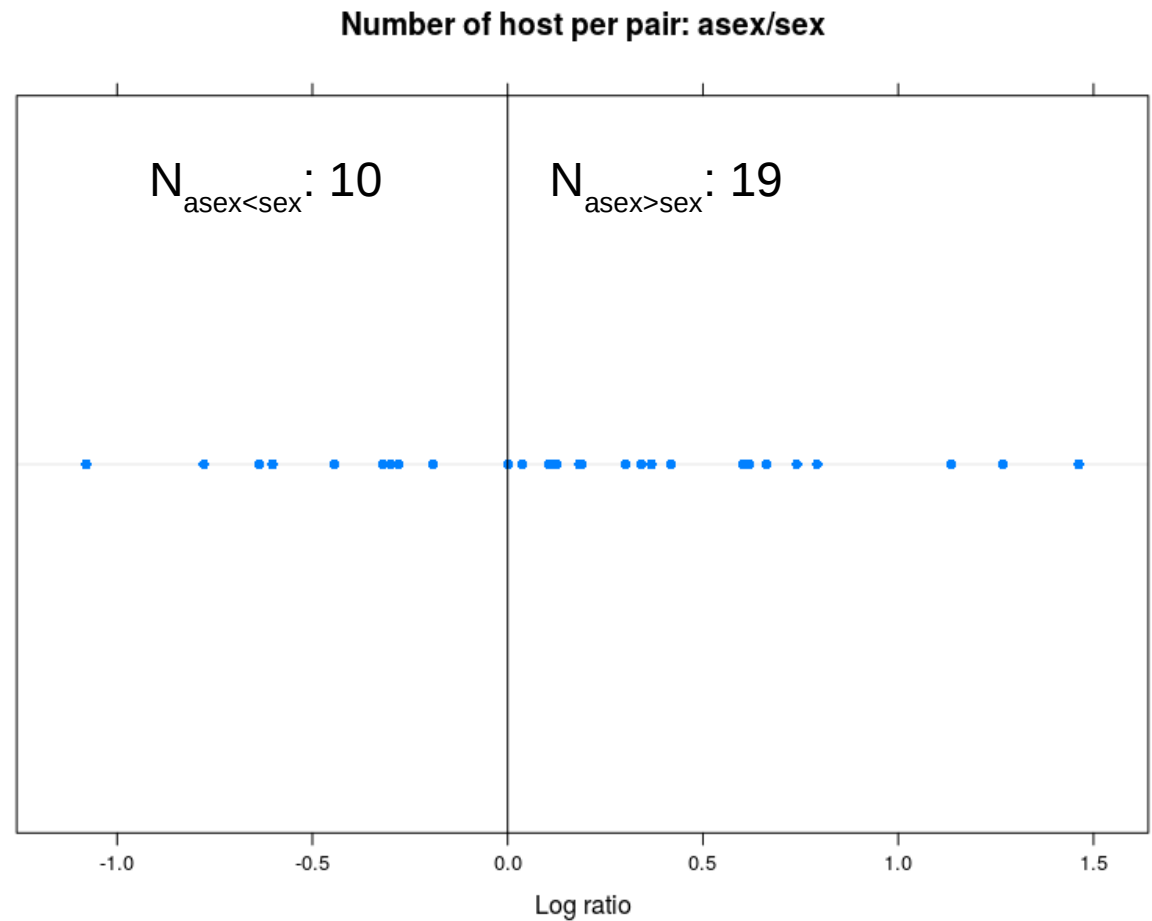
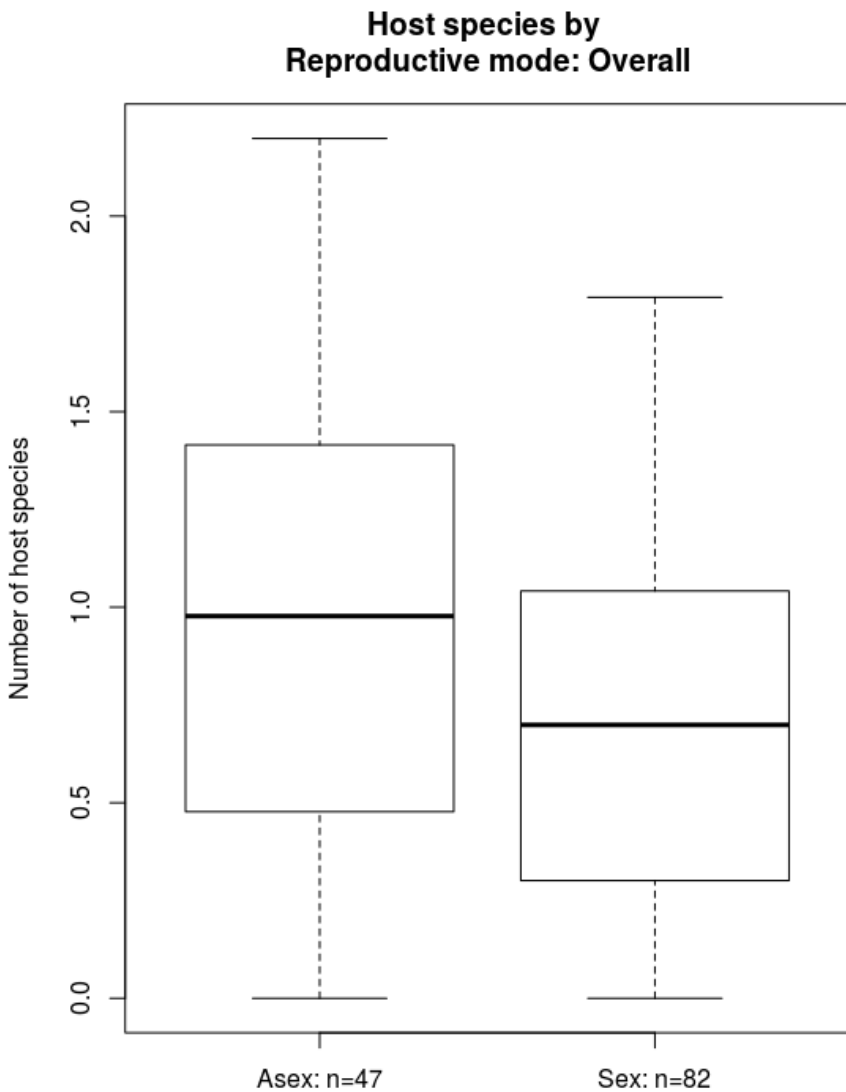
Ratio of body length per pair: asex/sex



--> No significant difference

Do asexuals have more host species?

Manual dataset

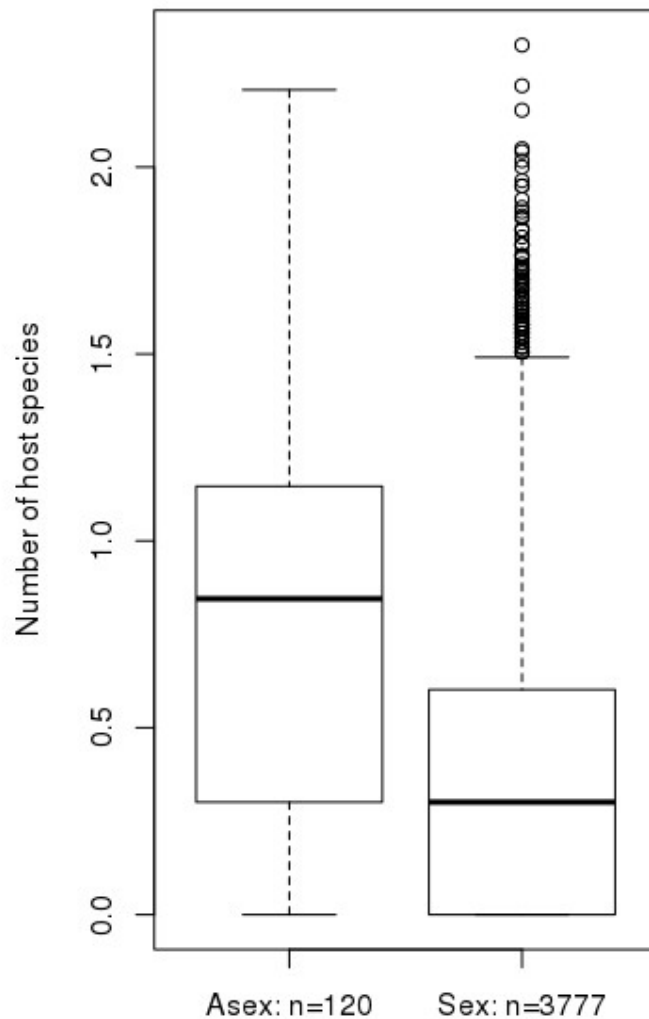


--> Asex seem to have more host species

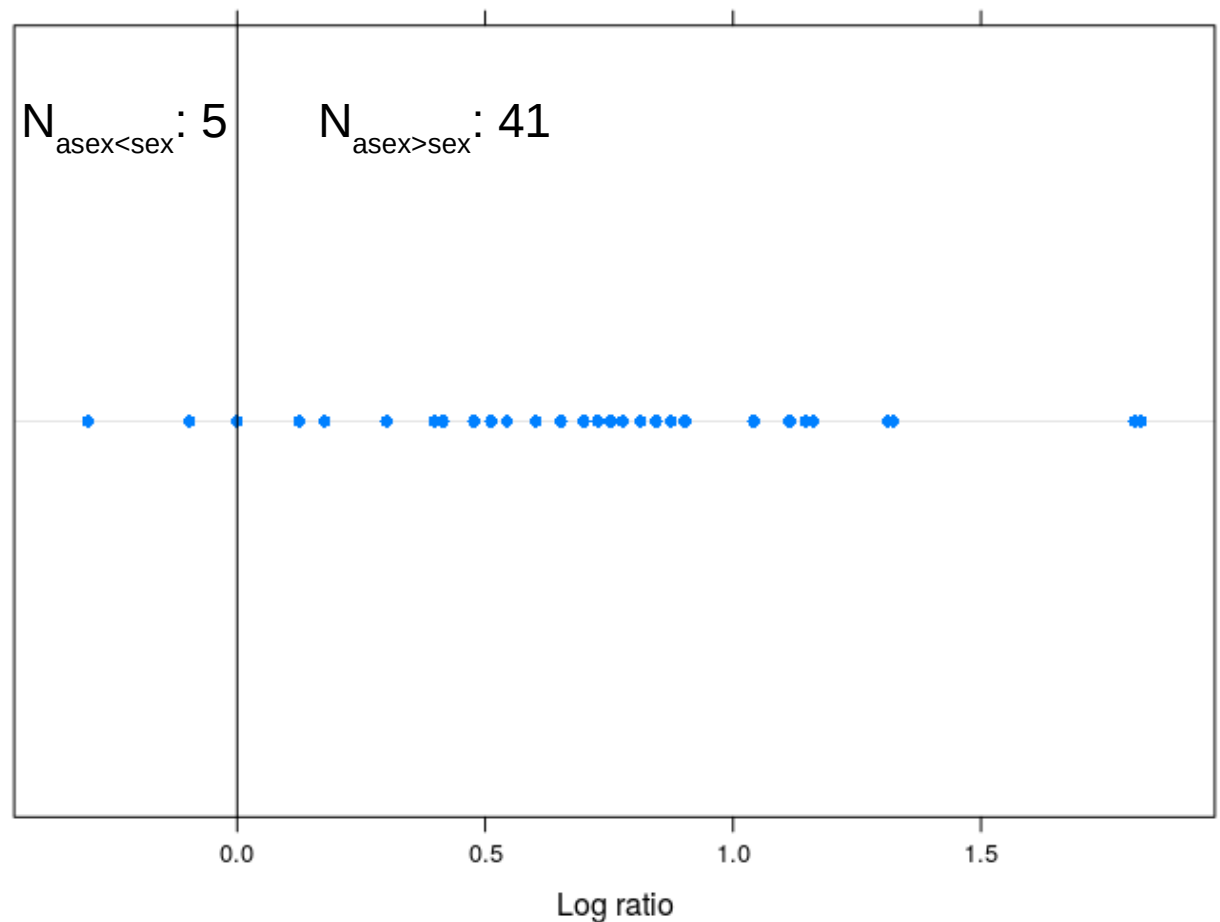
Do asexuals have more host species?

Auto dataset

Log10 host species: Overall



Log ratio (sex/asex) of number of host species

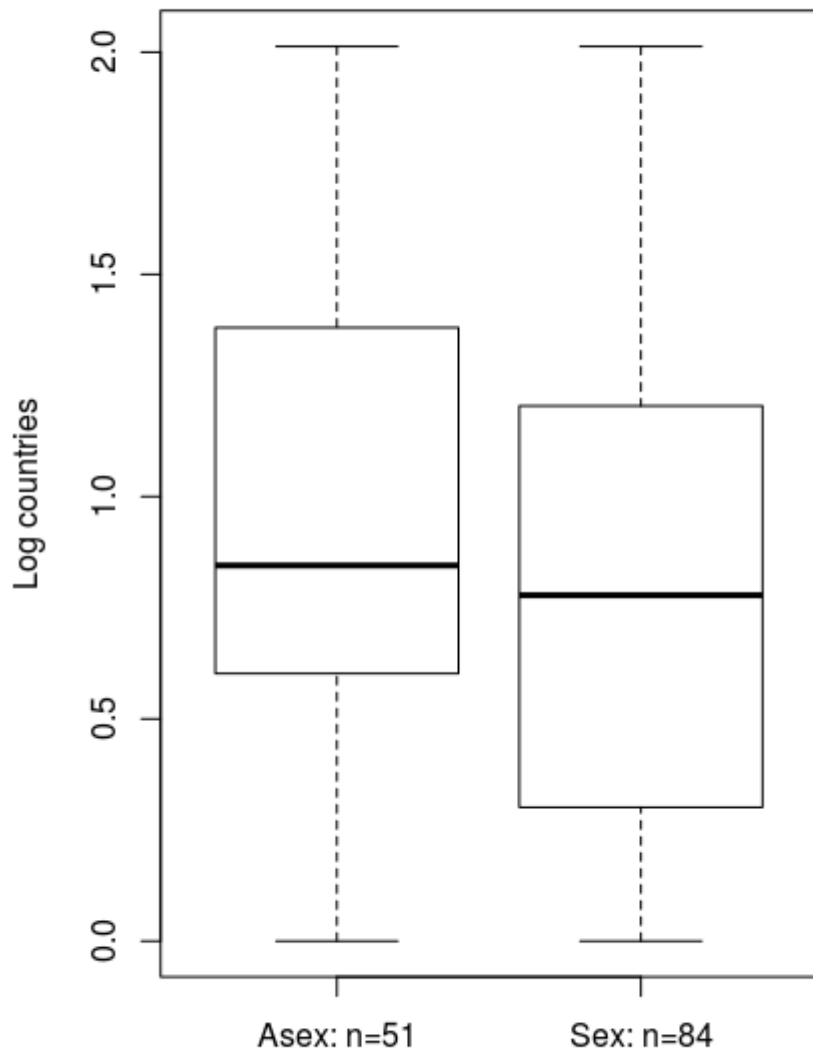


--> The effect looks much stronger.

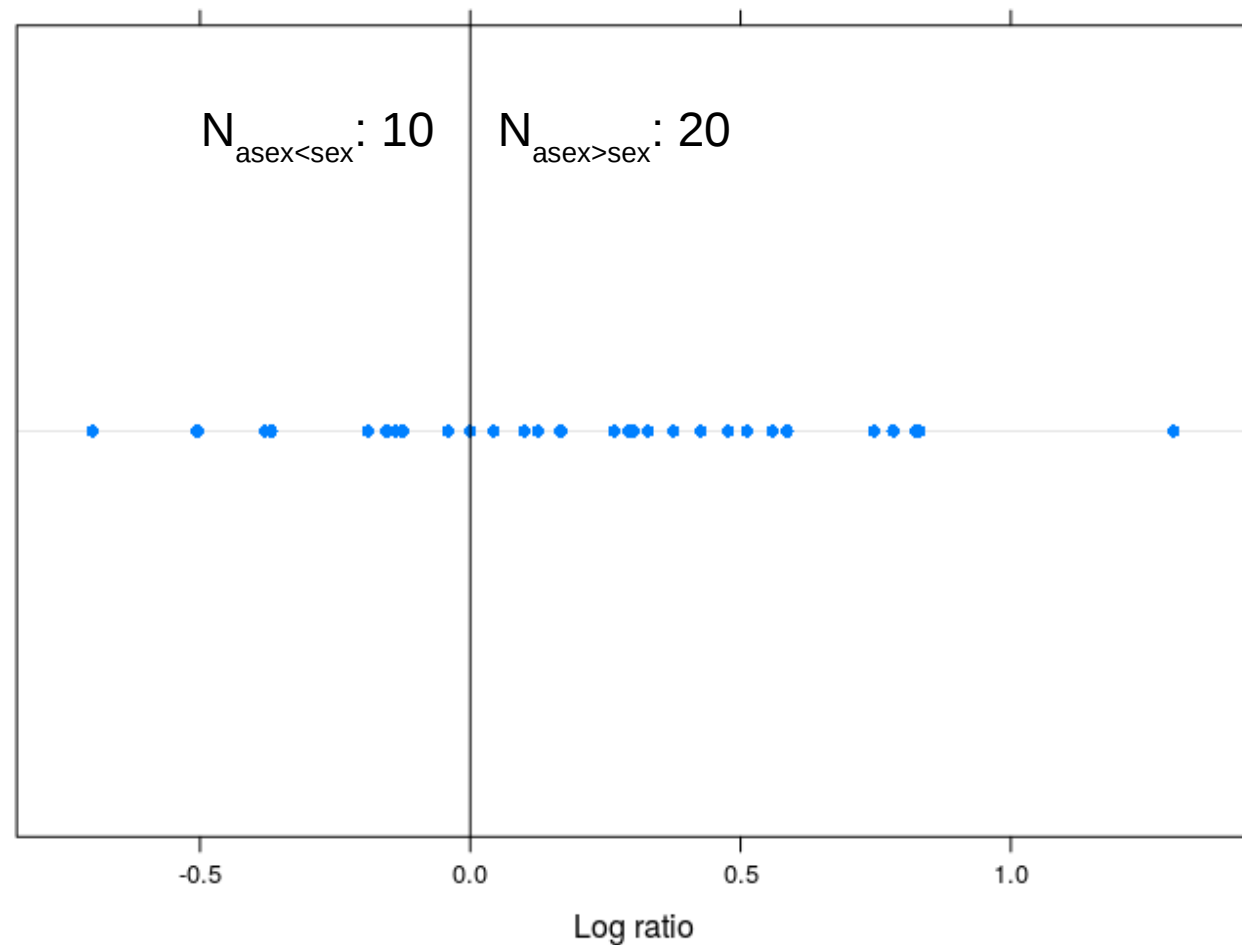
Are asex found in more countries?

Manual dataset

Number of countries by reproductive mode: Overall



Number of locations: asex/sex in each pair

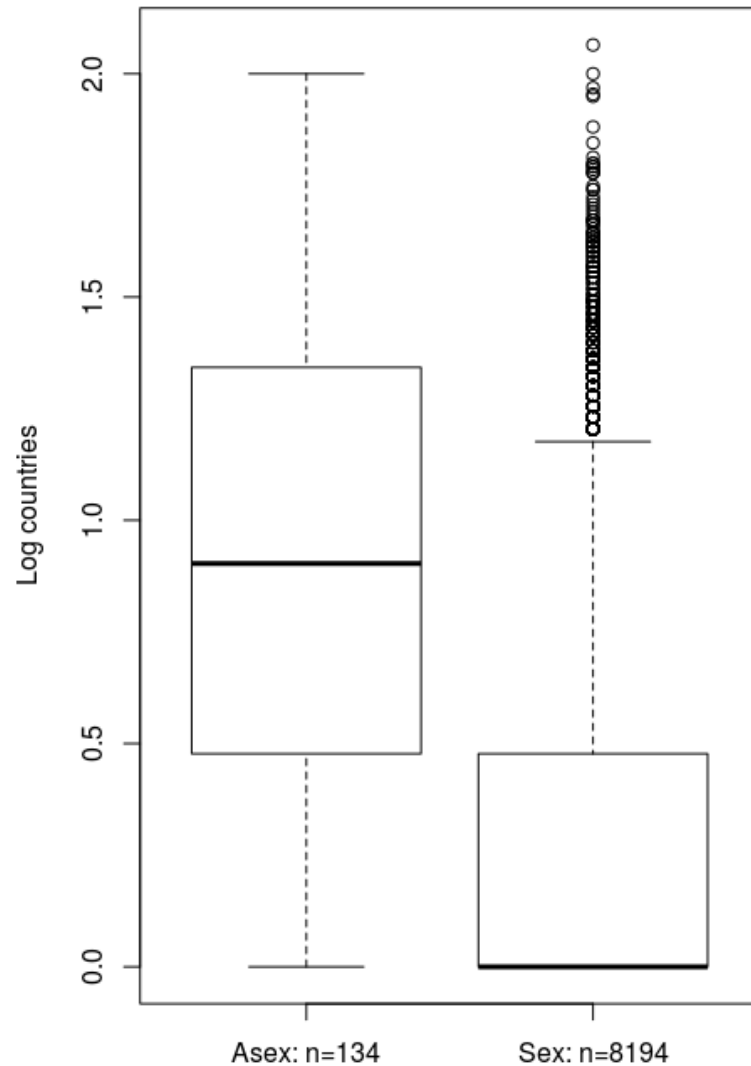


--> Weak effect ?

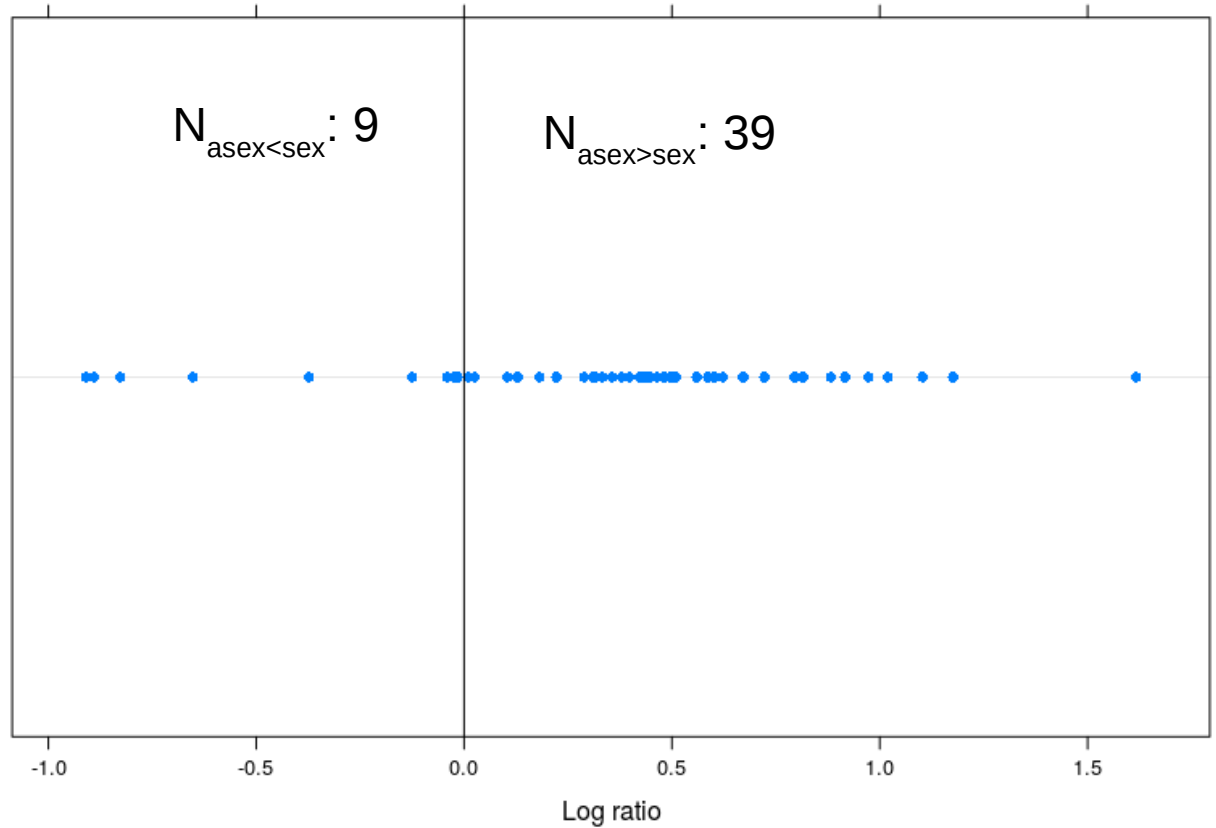
Are asex found in more countries?

Auto dataset

Number of countries by
reproductive mode: Overall



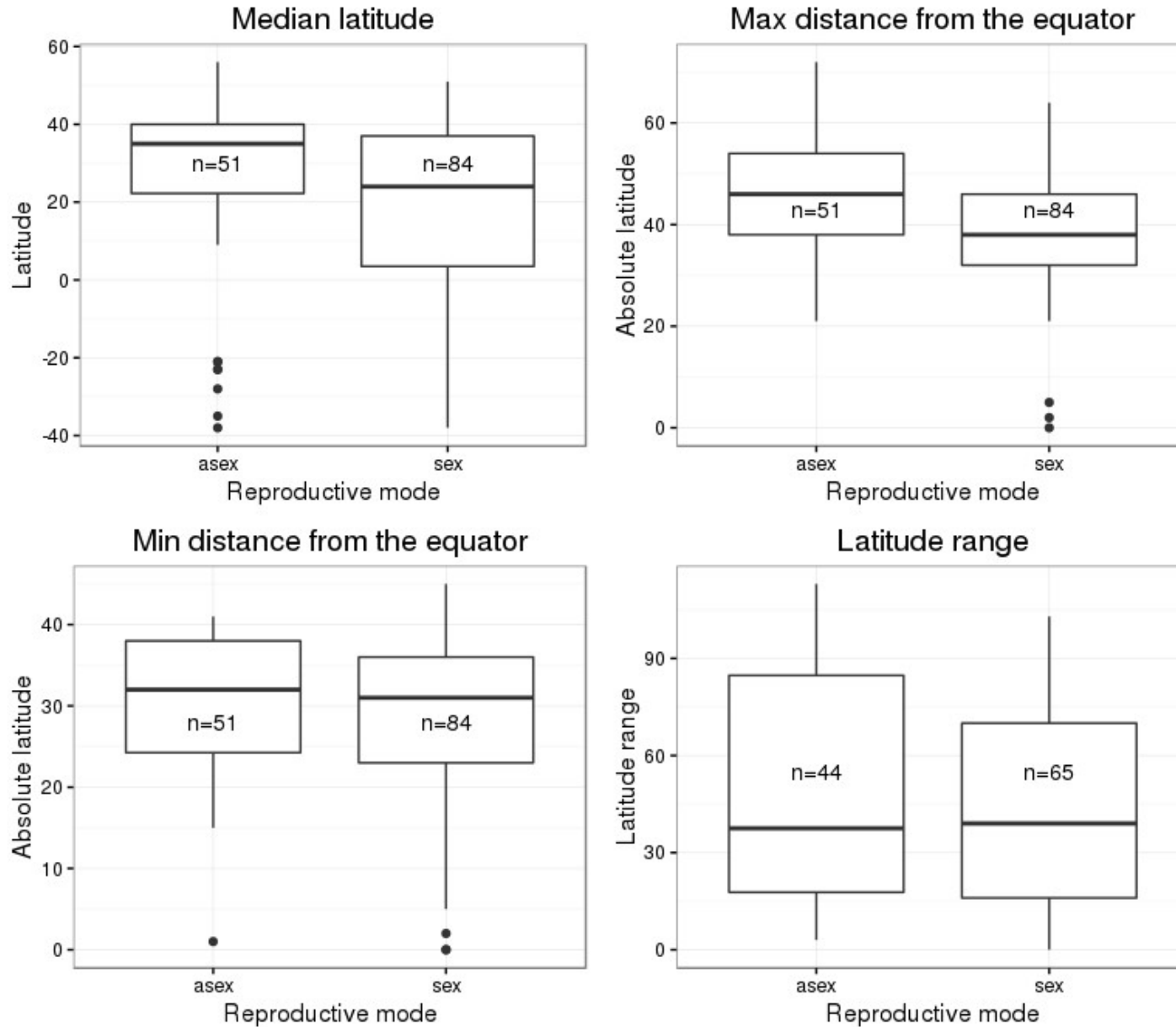
Ratio of number of countries per genus: asex/sex



--> The effect looks much stronger.

Asexuals are found further from the equator

Manual dataset



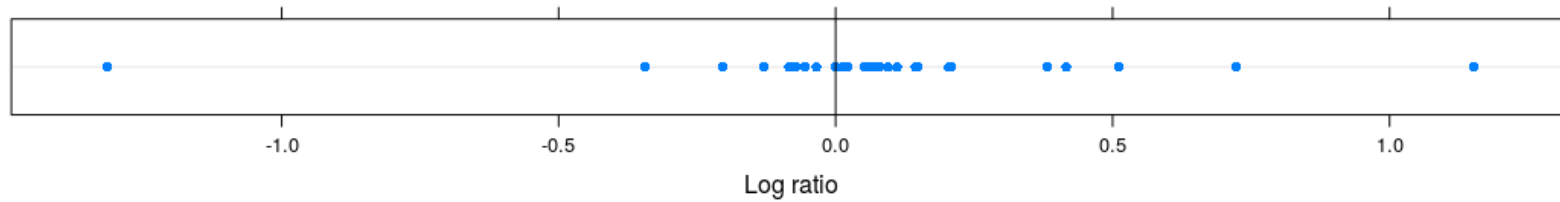
Asexuals are found further from the equator

Manual dataset

$N_{\text{asex} < \text{sex}}$

12

Ratio of median distance from equator per pair: asex/sex

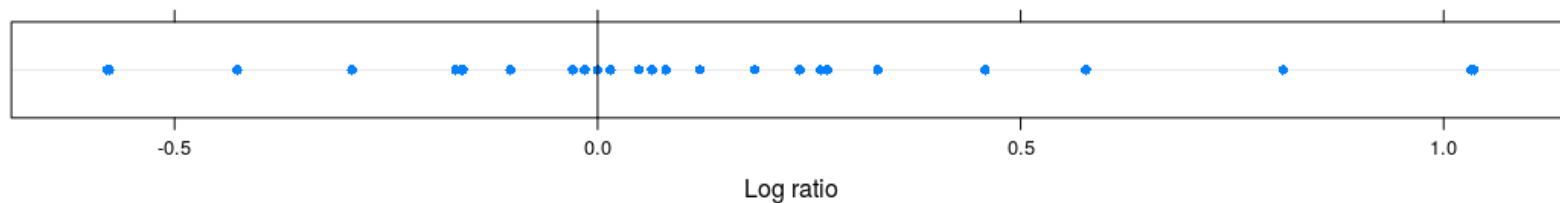


$N_{\text{asex} > \text{sex}}$

17

Ratio of latitude ranges per pair: asex/sex

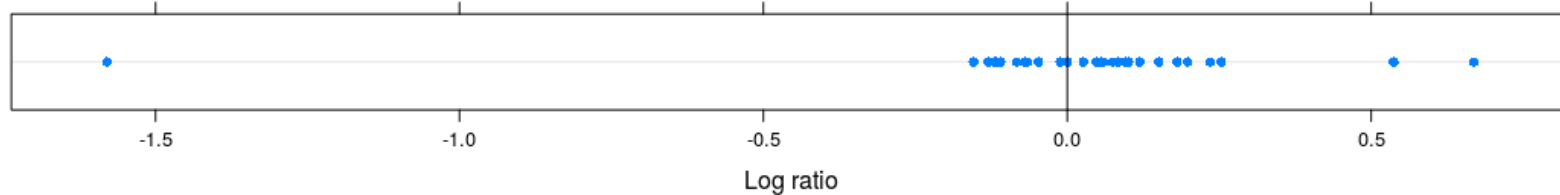
10



15

Ratio of minimum distance from the equator per pair: asex/sex

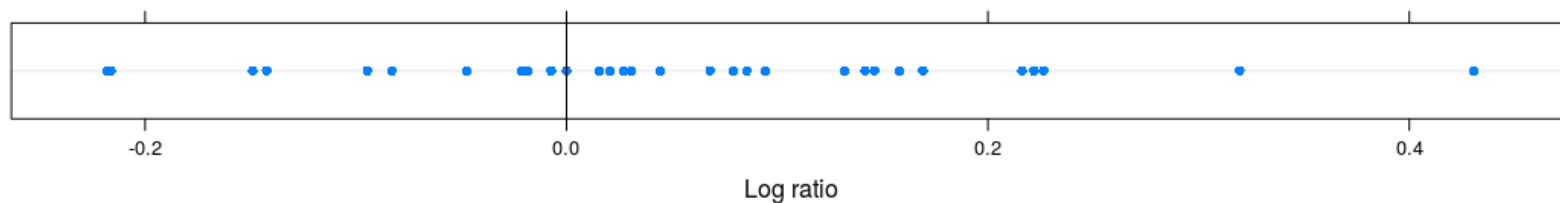
11



19

Ratio of maximum distance from equator: asex/sex

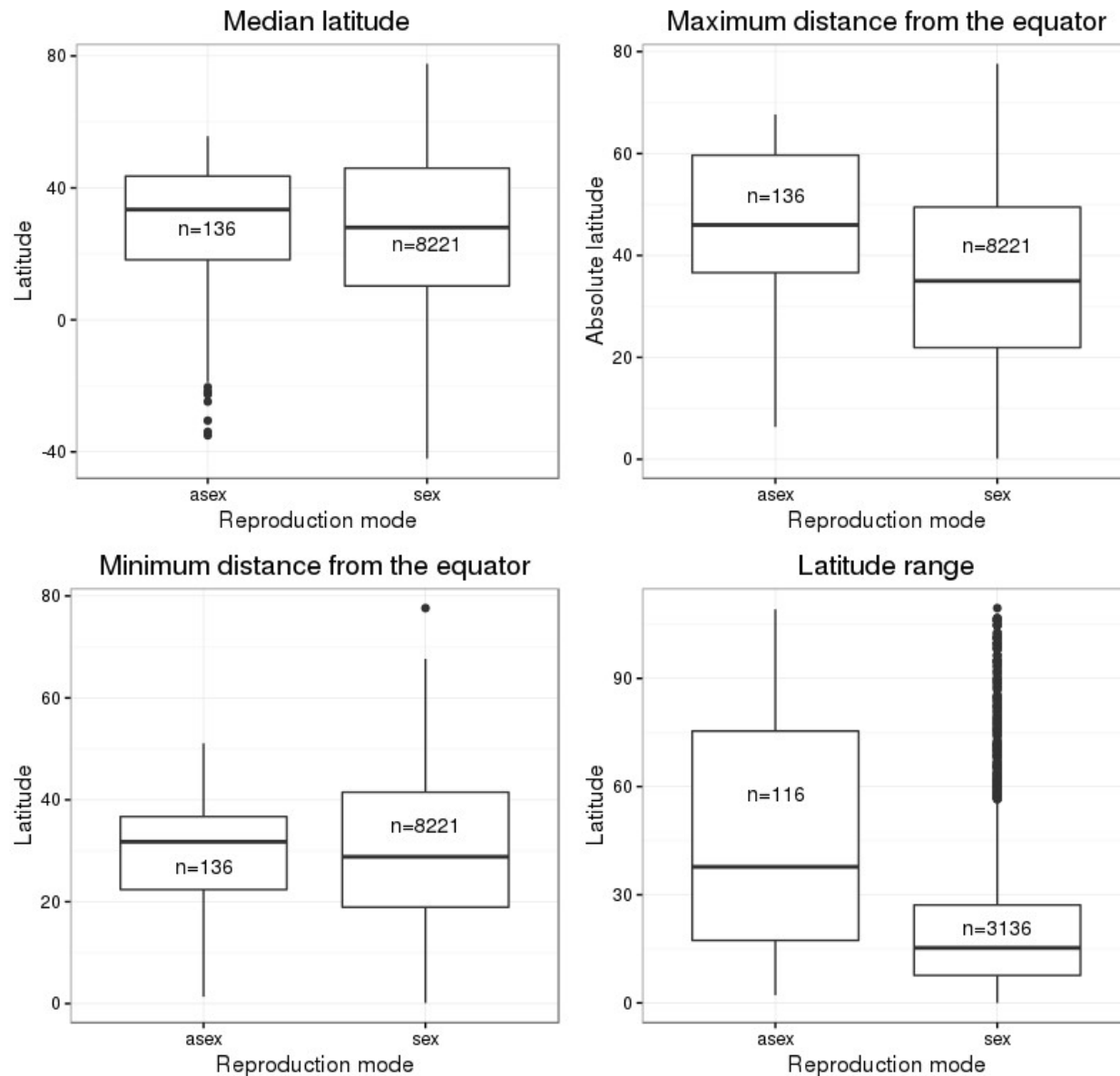
11



20

Asexuals are found further from the equator

Auto dataset



Asexuals are found further from the equator

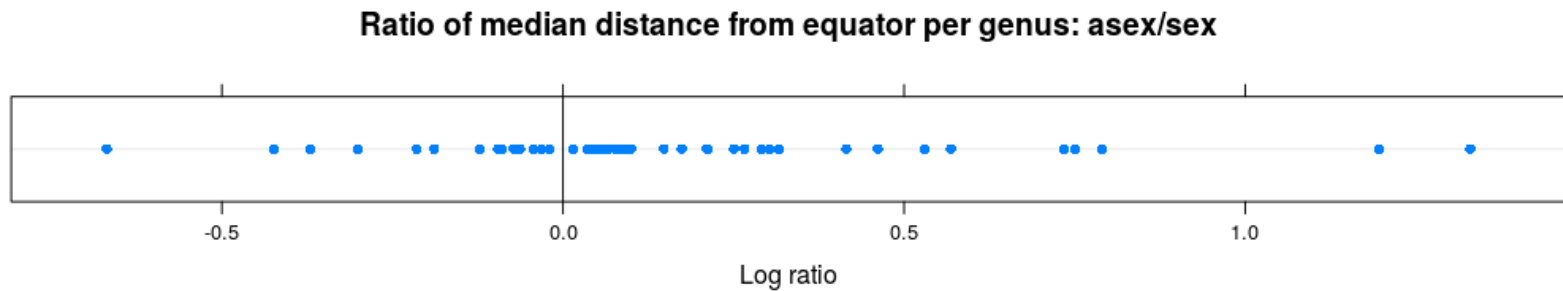
Auto dataset

$N_{\text{asex} < \text{sex}}$

$N_{\text{asex} > \text{sex}}$

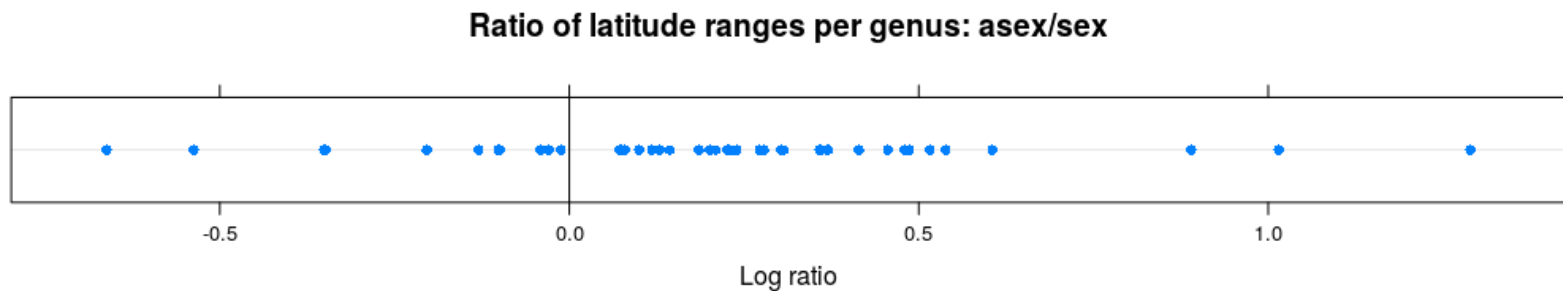
17

31



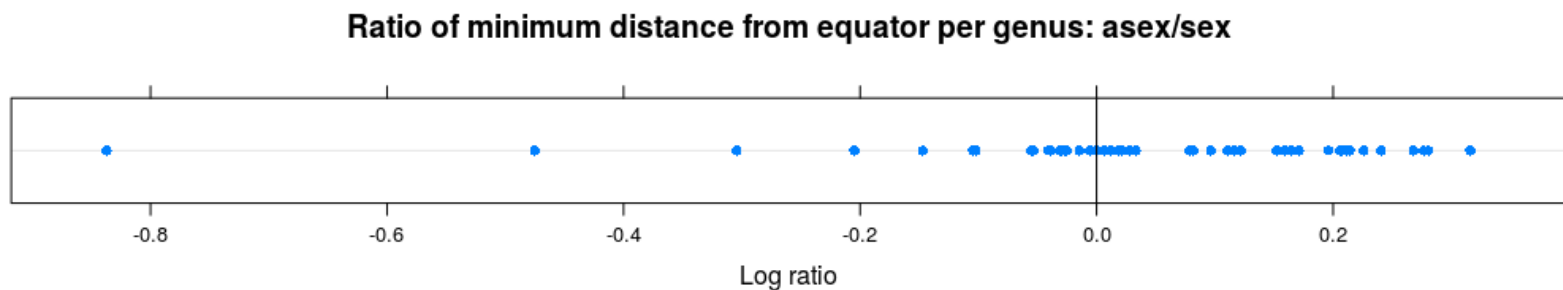
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32



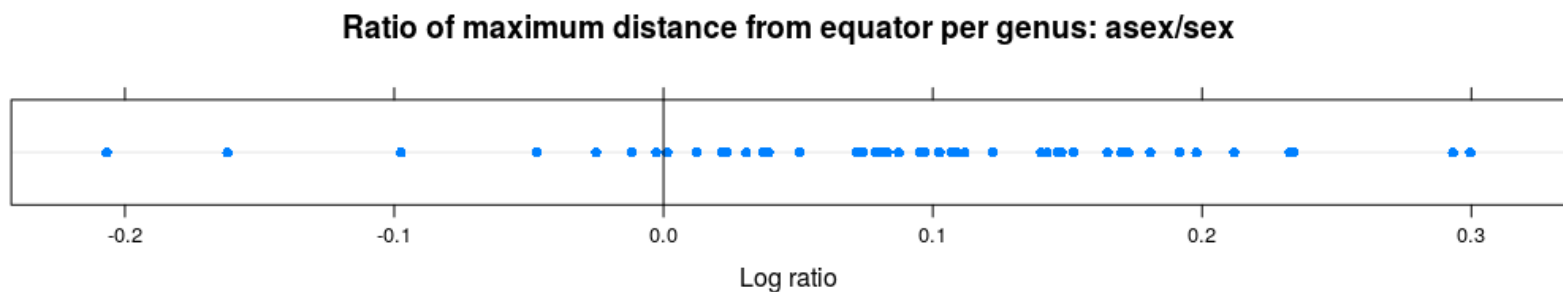
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27



7

41



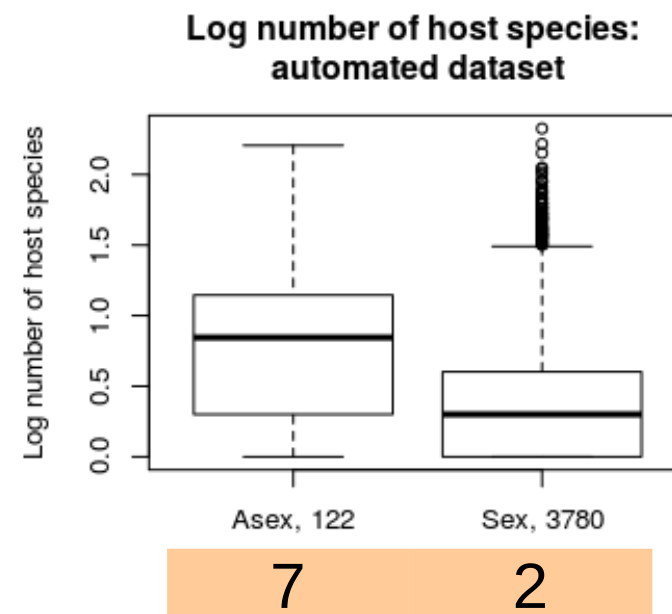
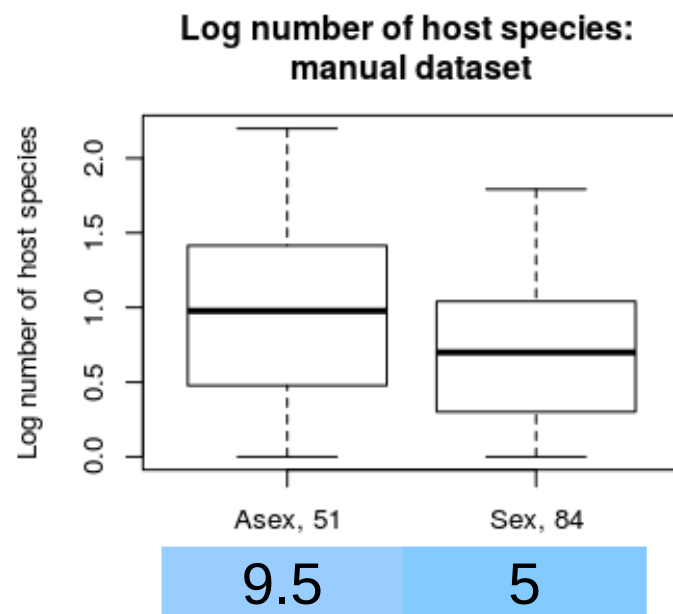
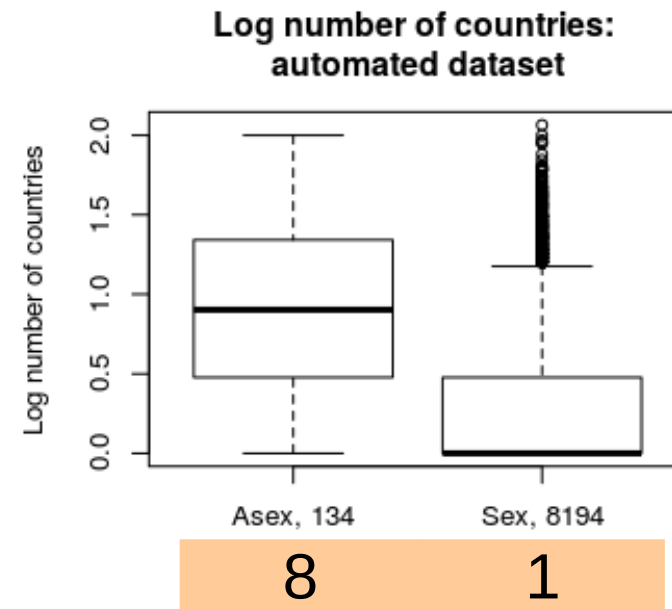
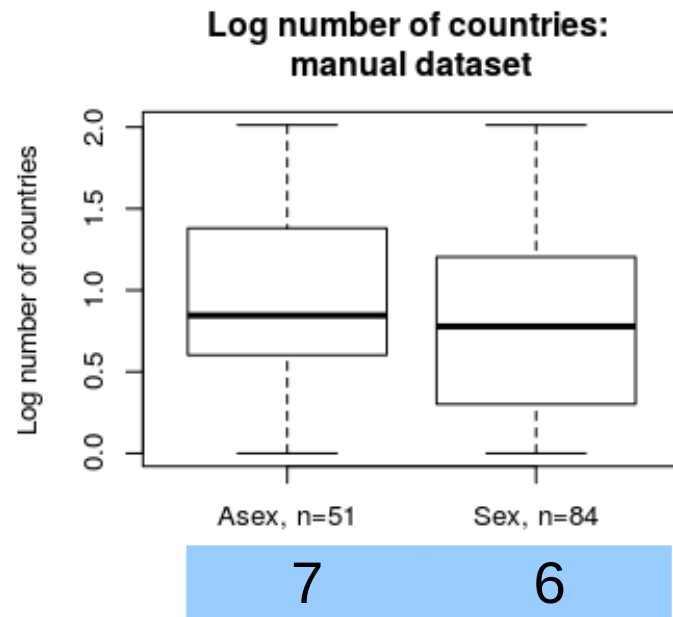
Results: pairwise (or per genera) statistical analysis

Using a generalized linear mixed model:

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

Variable	Asex vs sex manual	Manual (pairs)	Asex vs sex automated	Automated (genera)
Number of countries	21.9 vs 10.2	p=0.01	17.0 vs 1.8	p<0.001
Number of hosts	20.8 vs 7.9	p=0.01	14.0 vs 2.3	p<0.001
Max distance from equator	45.1 vs 39.8	p=0.01	45.2 vs 33.8	p<0.001
Median latitude	25.1 vs 17.48	p=0.03	28.4 vs 22.9	p<0.001
Latitude range	53.1 vs 42.1	p=0.3	47.8 vs 20.8	p<0.001
Body length	1.3 vs 1.2	p=0.42	-	-

Study bias in the automated dataset ?



Study bias

- Species are considered asexual only if we know they are.
- unknown biology → considered sexual
- There are many poorly studied species on the database, those have been sampled fewer times.
- Many of these species may be asexual.
 - High number of locations biased towards asexual species (more studied).

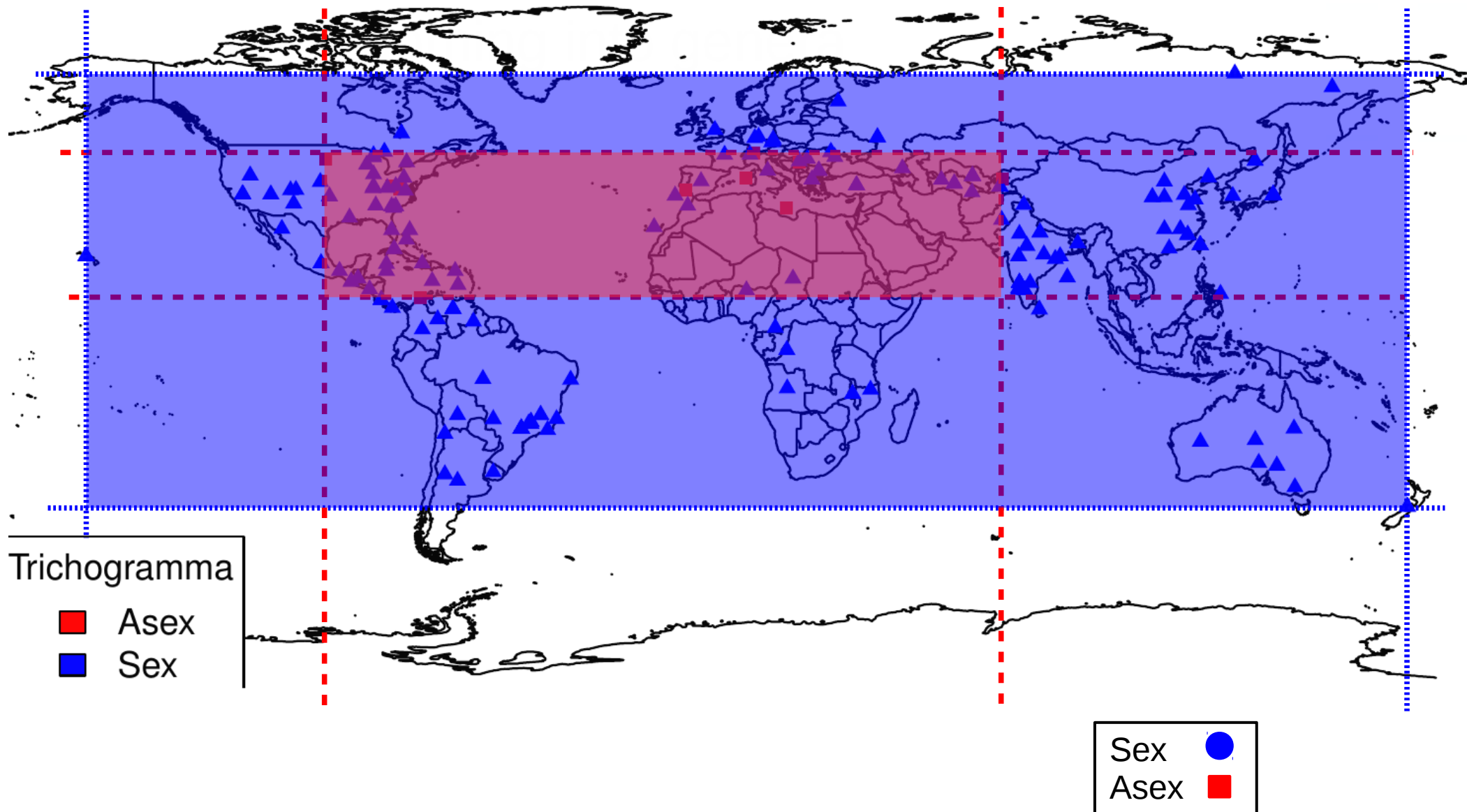
Results: biased variables

- Variables which depend on the number of observations are probably biased in the automated dataset.
- For these variables, one should consider only the manual dataset

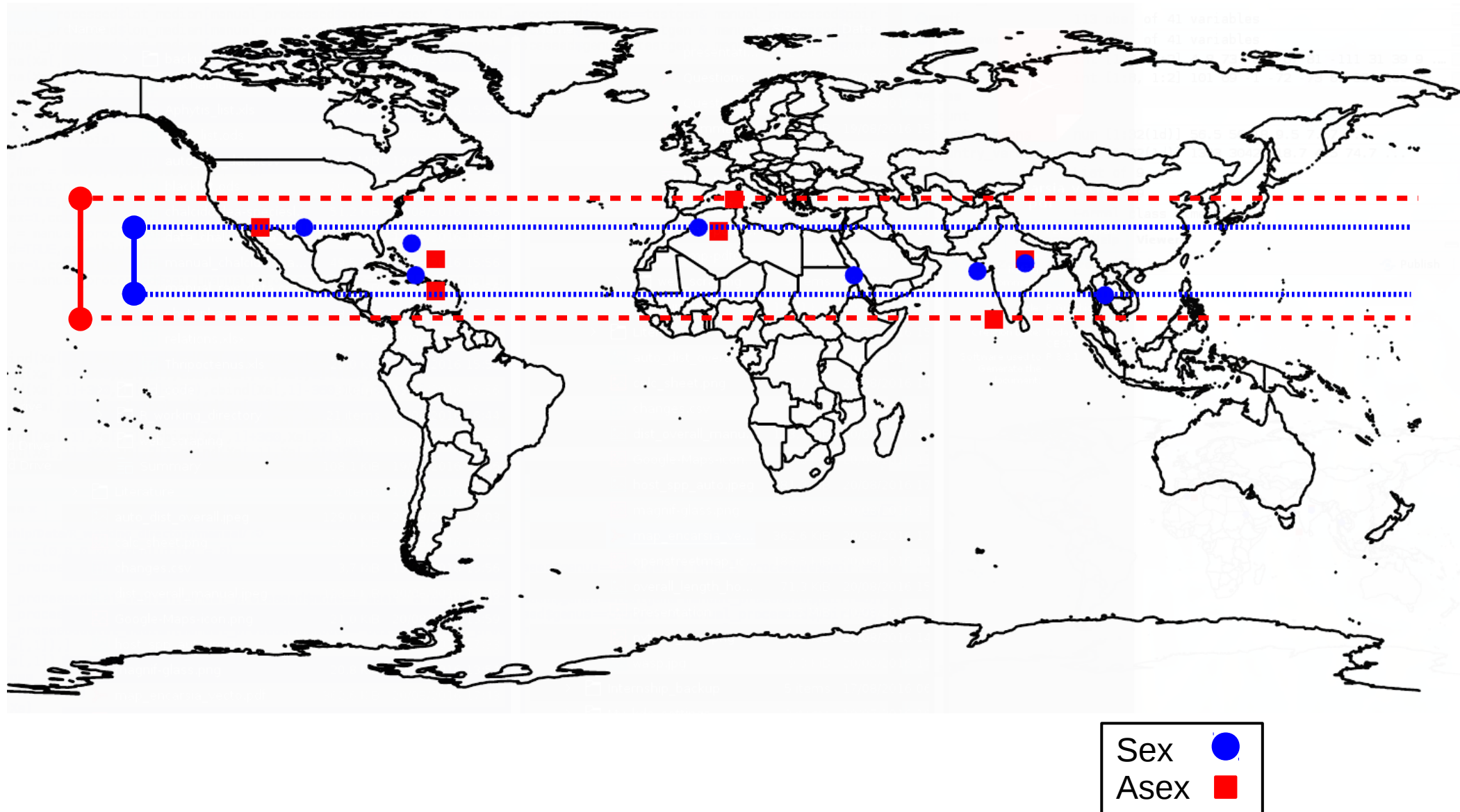
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Extra slides

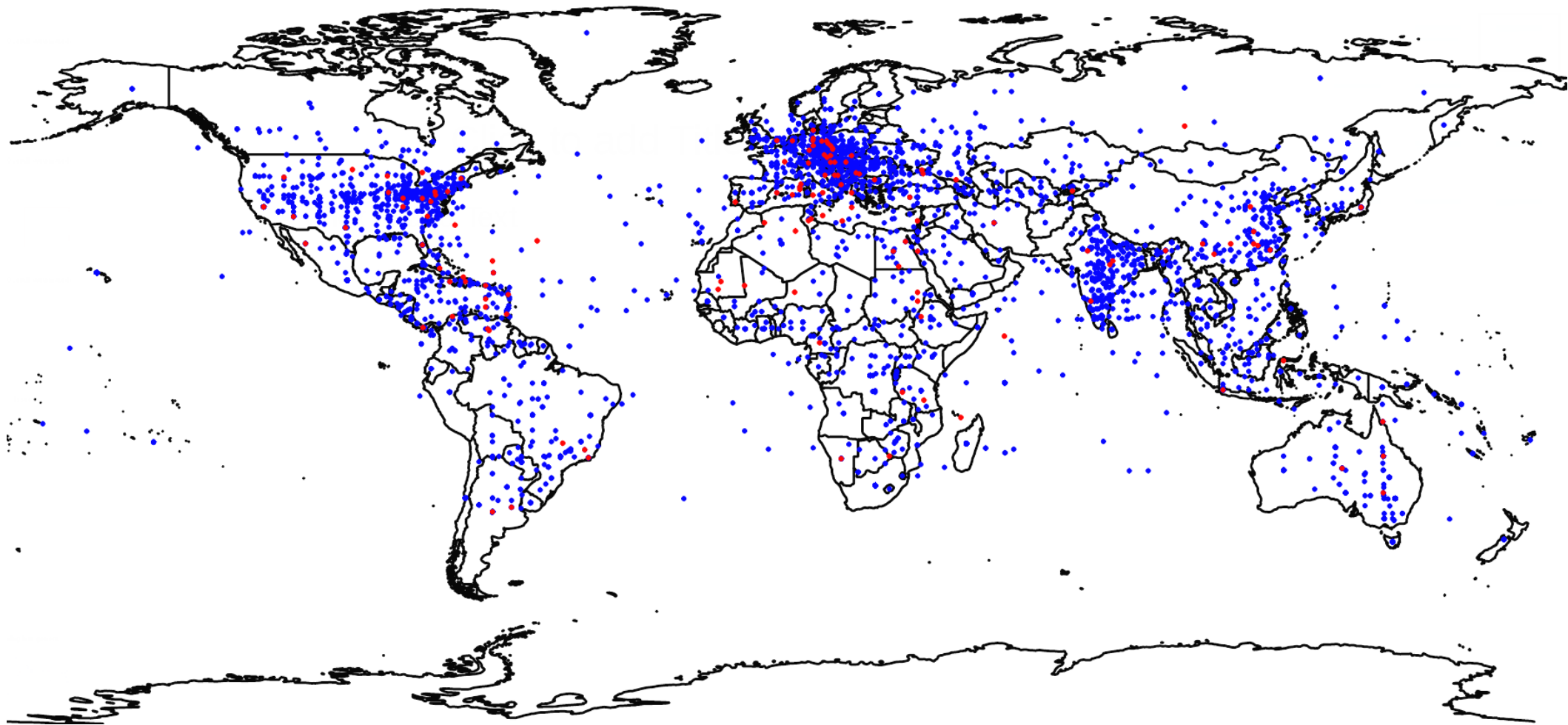
What's next: distribution area



Latitude range

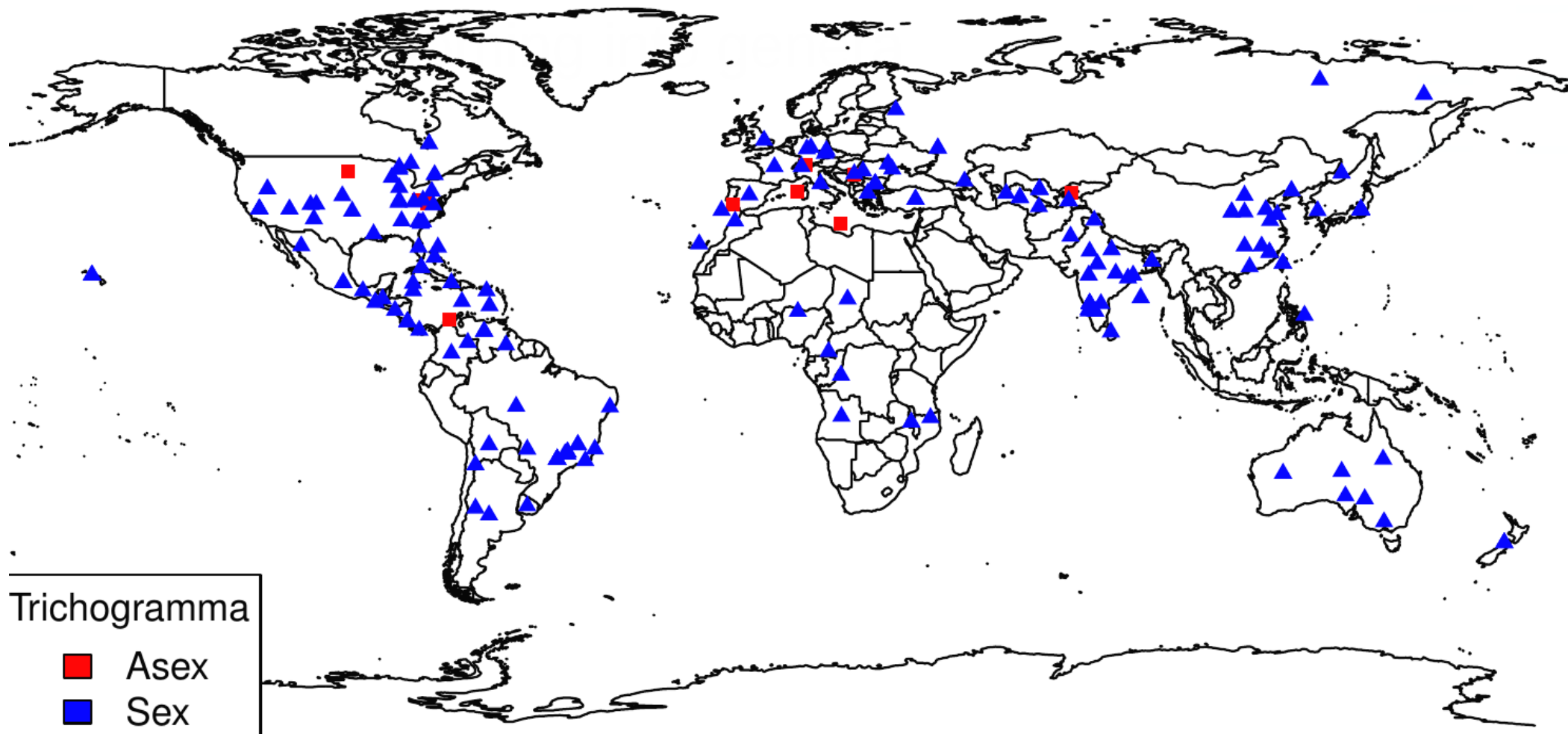


Reproductive mode is masked by genera



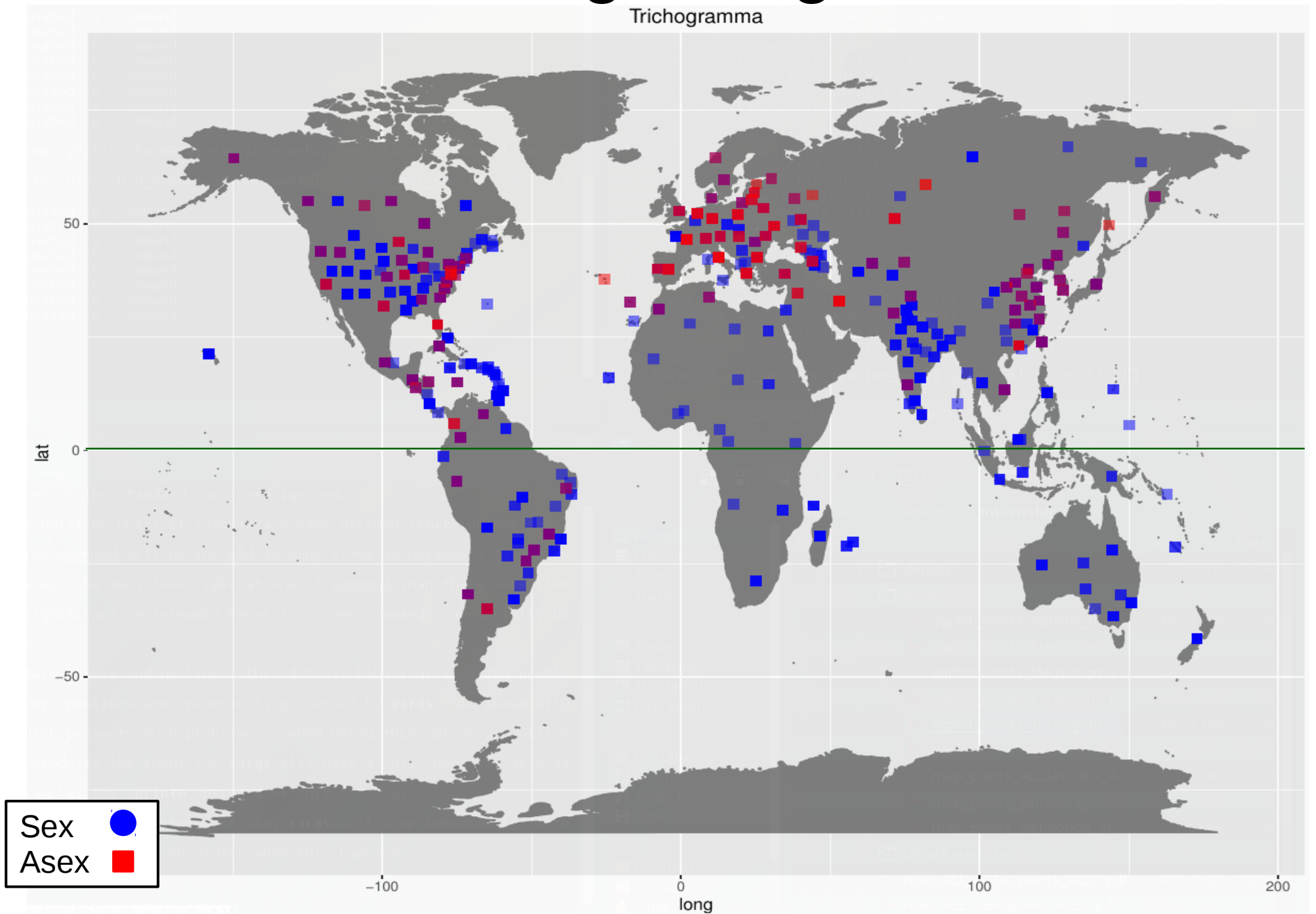
(Each point corresponds to the median coordinates of a species)

Zooming into genera

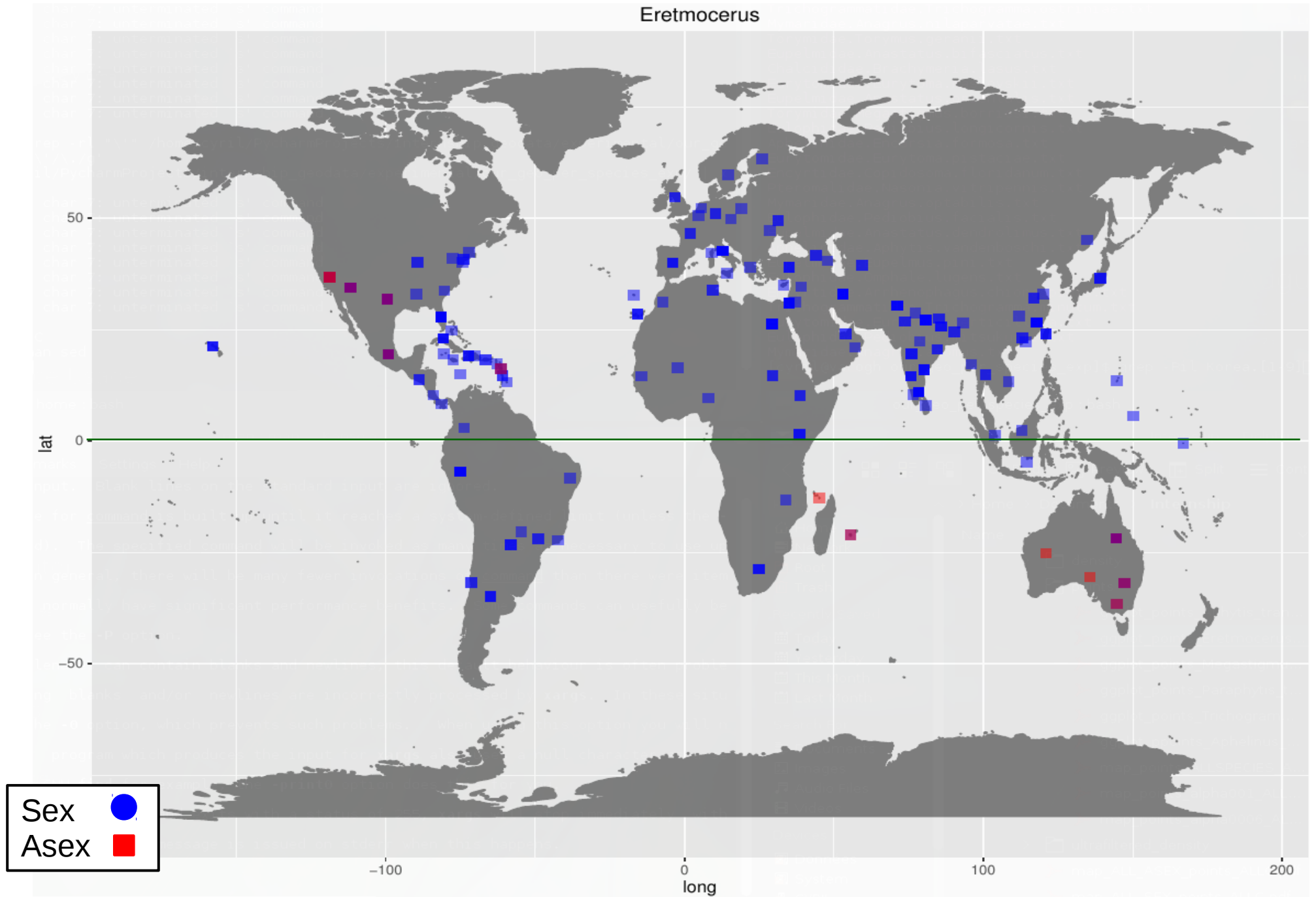


(Each point corresponds to the median coordinates of a species)

Zooming into genera



Zooming into genera



Note: estimation methods used

- Manual:

- Ncountries: MCMC
- Nhosts: Laplace
- Body length: Laplace
- Median latitude: MCMC
- Max dist eq: PQL
- Latitude range: Laplace

- Automated:

- Ncountries: MCMC
- Nhosts: MCMC
- Body length: ---
- Median latitude: MCMC
- Max dist eq: PQL
- Latitude range: PQL