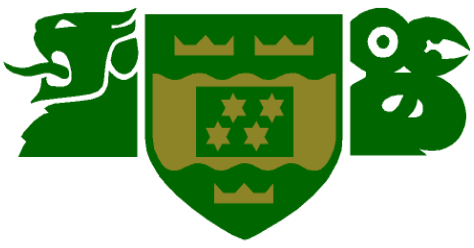
Network properties of arboreal plants

K.C. Burns

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI



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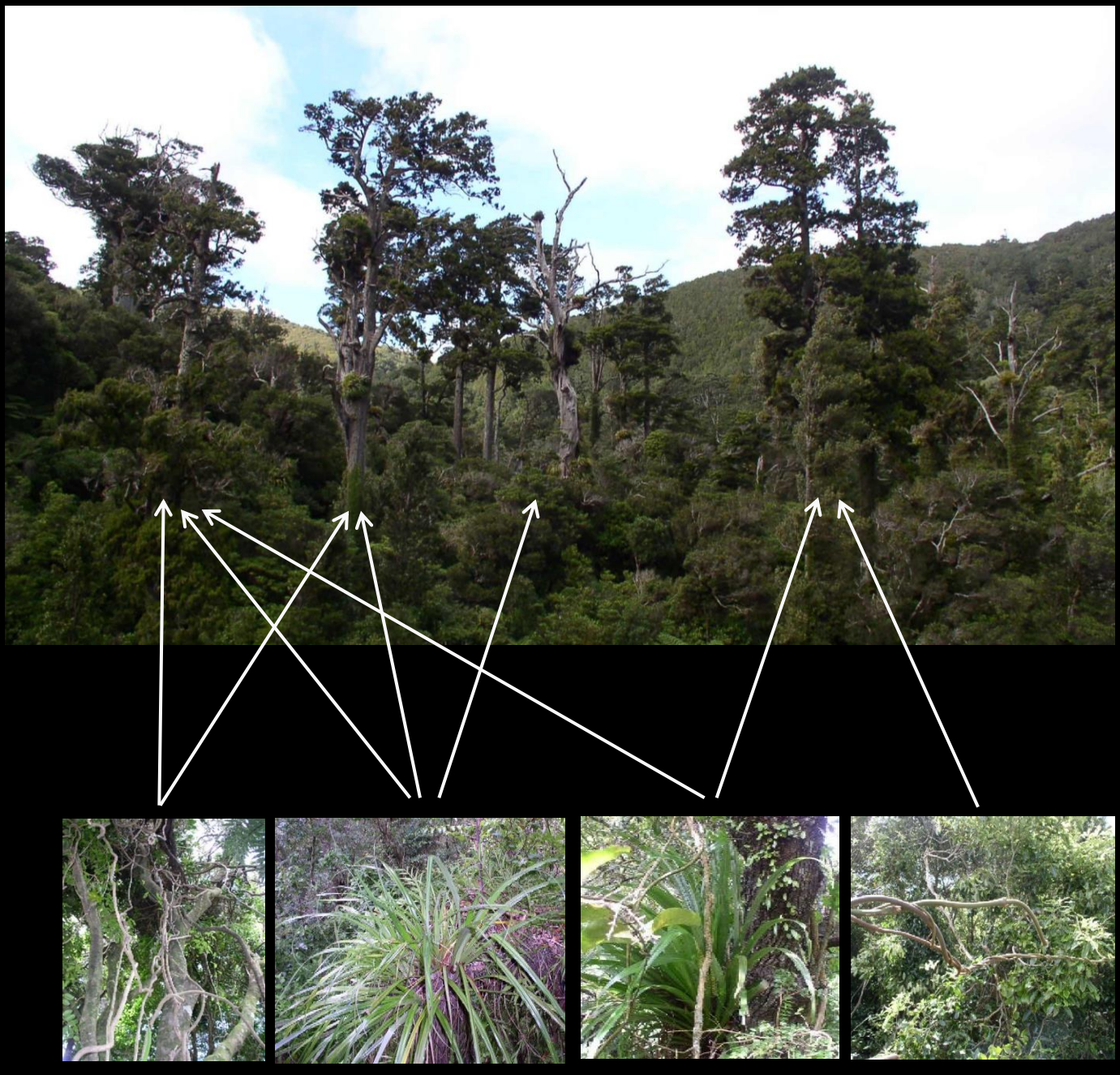
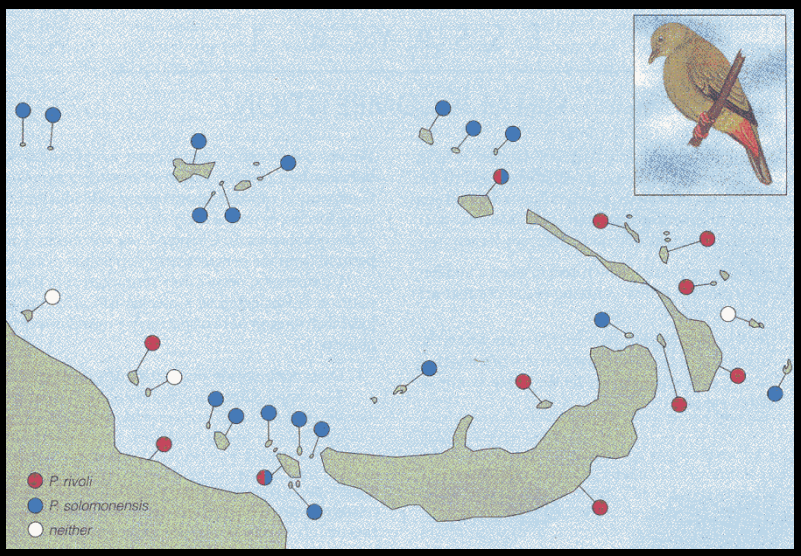
How do you characterise epiphyte communities?

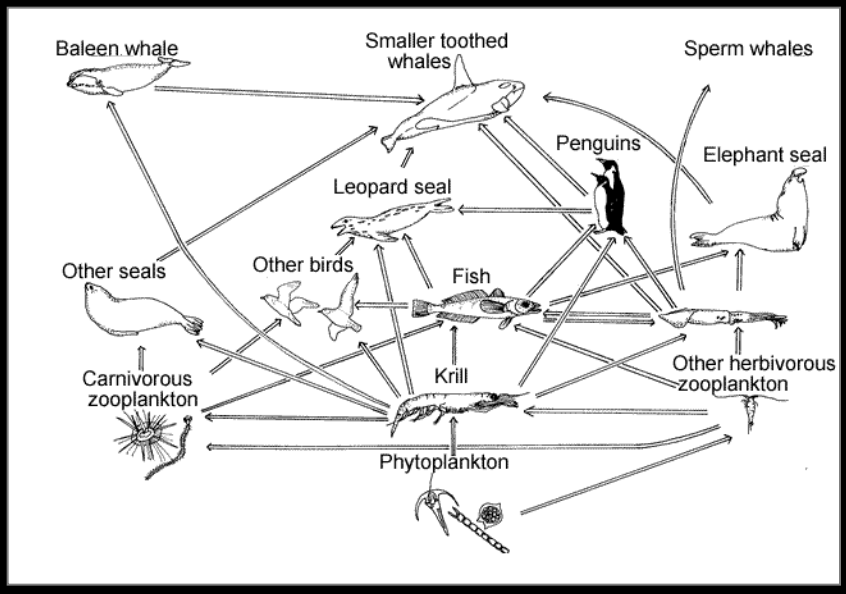


Island Theory



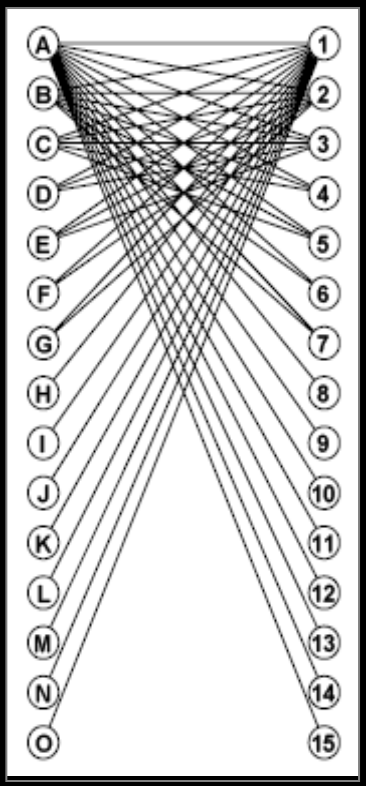
P. rivoli	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
P. solomonensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1

Network theory

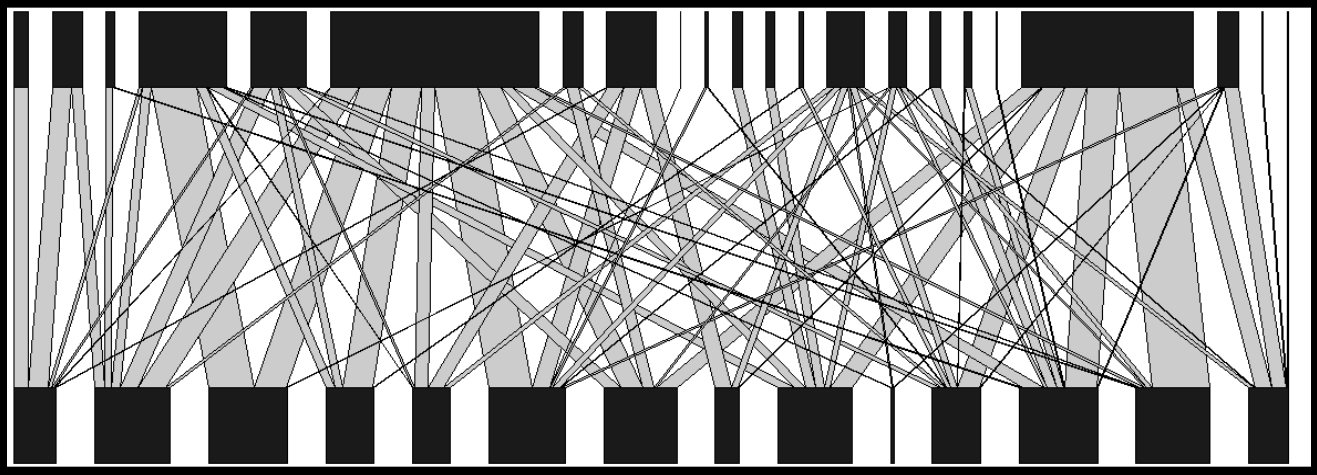


hosts

epiphytes



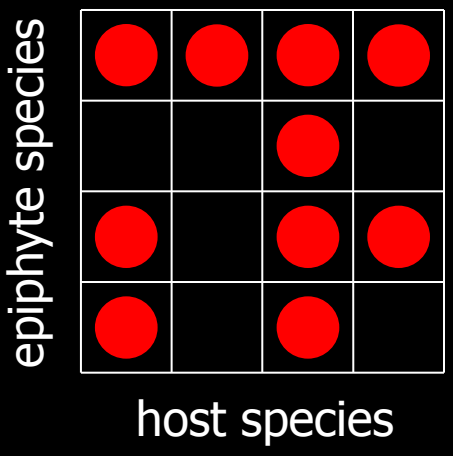
Aren’t they basically the same?



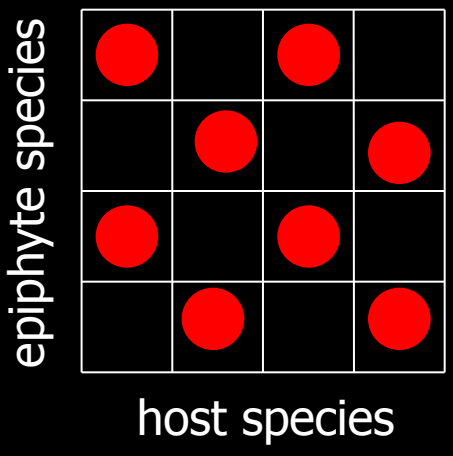
	Island 1	Island 2	Island 3	Island 4	Island 5	Island 6	Island 7	Island 8	Island 9	Island 10	
Species 1	0	0	0	0	0	16	23	0	0	0	**39**
Species 2	7	33	0	1	32	65	57	2	69	214	**480**
Species 3	0	0	0	0	0	0	0	0	7	34	**41**
Species 4	11	11	0	0	7	150	154	5	76	1	**415**
Species 5	1	0	0	0	0	0	2	0	56	78	**137**
Species 6	0	0	0	0	0	31	50	1	0	0	**82**
Species 7	0	0	0	0	0	1	0	0	0	0	**1**
Species 8	0	0	6	3	0	3	0	0	62	1	**75**
Species 9	2	5	3	0	0	27	5	0	4	84	**130**
Species 10	0	21	0	0	0	0	319	6	0	4	**350**
	21	**70**	**9**	**4**	**39**	**293**	**610**	**14**	**274**	**416**	

Patterns in network structure

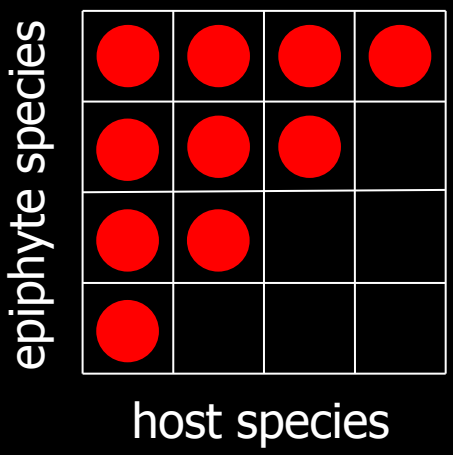
Random →



Negative co-occurrences →



Positive co-occurrences →



How do discern network patterns?

1. Calculate an index that characterises pattern in the observed matrix

$C\text{-}score = (O_i - S)(O_j - S)$

O_i = number of host species occupied by arboreal plant species i.

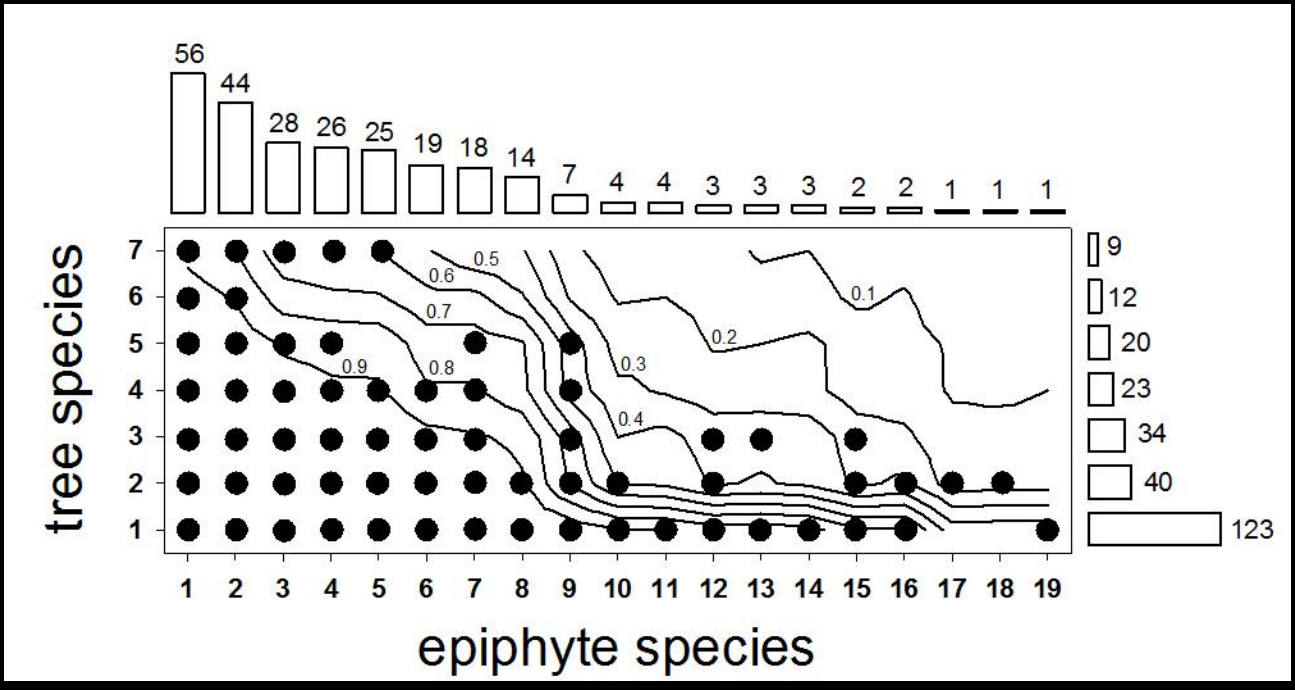
O_j = number of host species occupied by arboreal plant species j.

S = Number of host species occupied by both species i & j.

2. Randomly shuffle occurrences in the observed matrix and recalculate the c-score.

3. Iterate the procedure to get the probability of obtaining the observed c-score value by chance.

Could patterns in network structure result from random interactions between differentially abundant species?

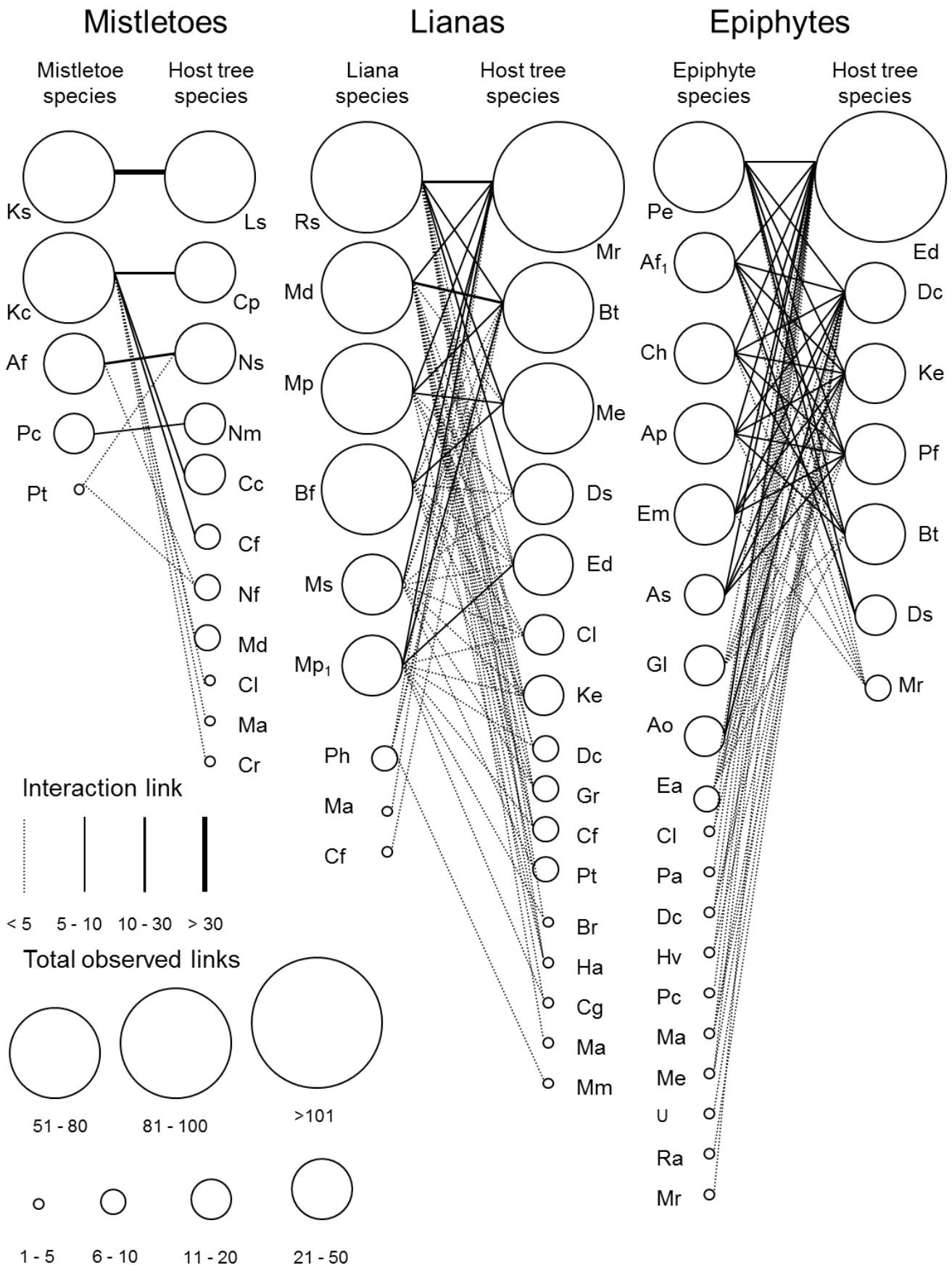


Null models should randomise individuals, not species.

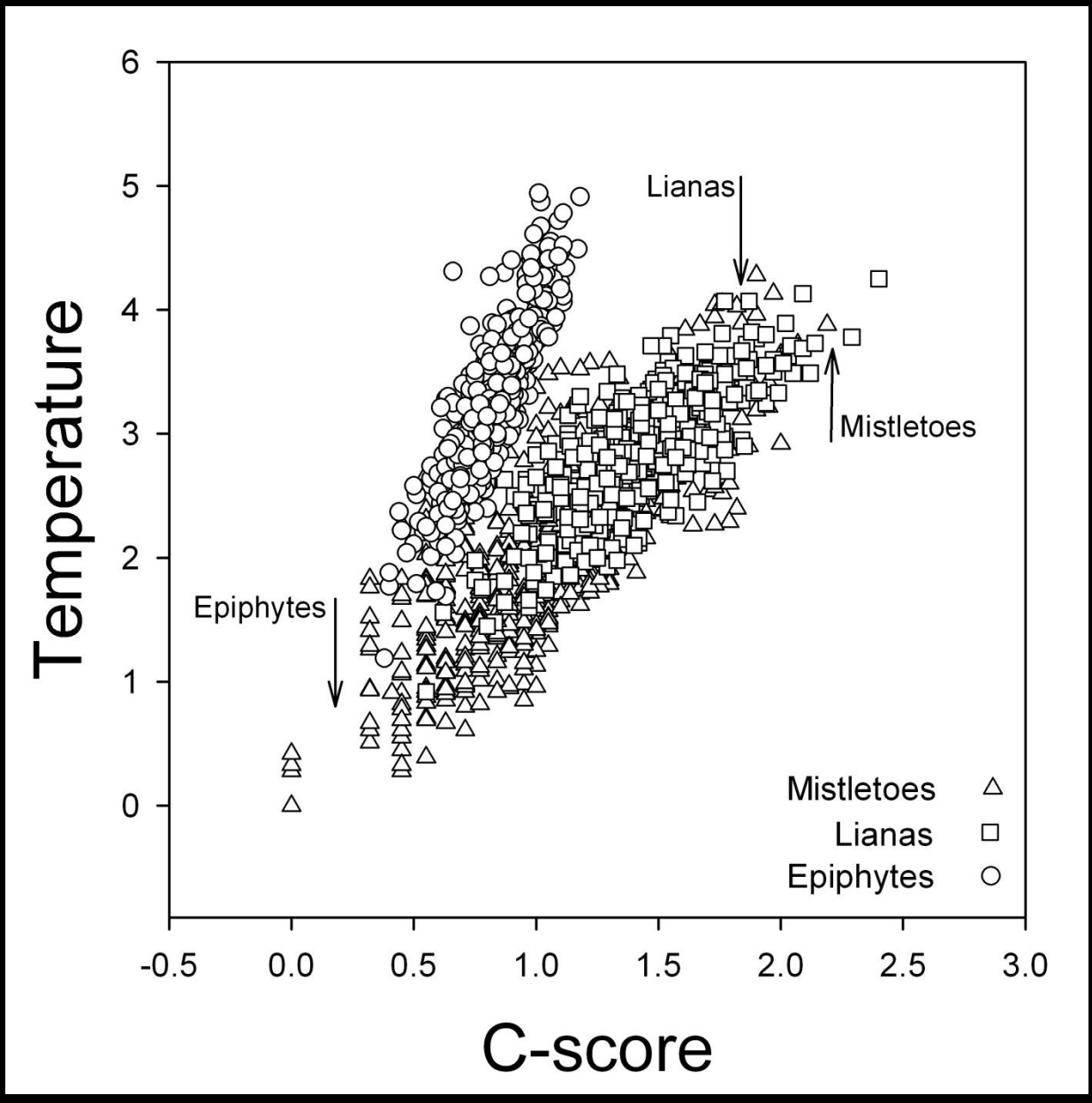
Field Methods

Visual searches for mistletoes, lianas and epiphytes along a series of footpaths in two study sites

Individual-based null model tests for non-random patterns in arboreal plant distributions


Mistletoes
Lianas
Epiphytes
Mistletoe species
Host tree species
Liana species
Host tree species
Epiphyte species
Host tree species
Ks
Ls
Kc
Cp
Af
Ns
Pc
Nm
Pt
Cc
Cf
Nf
Md
Cl
Ma
Cr
Rs
Md
Mp
Bf
Ms
Mp1
Ph
Ma
Cf
Mr
Bt
Me
Ds
Ed
Cl
Ke
Dc
Gr
Cf
Pt
Br
Ha
Cg
Ma
Mm
Pe
Af1
Ch
Ap
Em
As
Gl
Ao
Ea
Cl
Pa
Dc
Hv
Pc
Ma
Me
U
Ra
Mr
Ed
Dc
Ke
Pf
Bt
Ds
Mr
Interaction link
< 5
5 - 10
10 - 30
> 30
Total observed links
51 - 80
81 - 100
>101
1 - 5
6 - 10
11 - 20
21 - 50

Results


Temperature
C-score
Lianas
Mistletoes
Epiphytes
Mistletoes
Lianas
Epiphytes
6
5
4
3
2
1
0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0

Conclusions

- Mistletoes and lianas have specialized preferences for particular host species, leading to negative co-occurrence patterns.

    + Competitive displacement?

- Epiphytes are distributed oppositely, exhibiting positive (i.e. 'nested') distributional patterns.

    + Facilitation?

What's next?

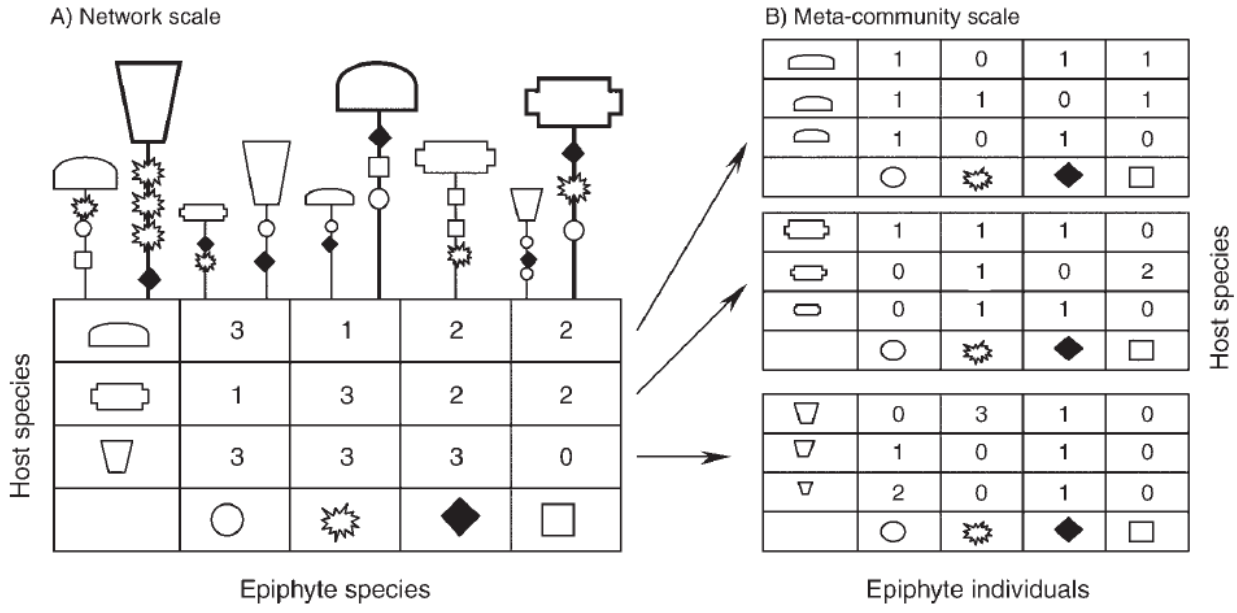


FIG. 1. Schematic illustrating the meta-network analytical framework. (A) An epiphyte–host species interaction network, with an illustration of a hypothetical forest composed of three host species, each of which is represented by three trees that are inhabited by four epiphyte species. Below the forest diagram is the corresponding interaction matrix whose entries are the interaction frequencies of each species pair. (B) The three host-specific epiphyte meta-communities, which are amalgamated into single rows in the epiphyte–host interaction network.

- exploring hierarchies of scale