TELL ME ABOUT THE FOREST

Into the Labyrinth Dead Can Dance

INNOVATIVE APPROACHES TO TEACHING PALEONTOLOGY WORKSHOP
ON THE CUTTING EDGE
JUNE 2104

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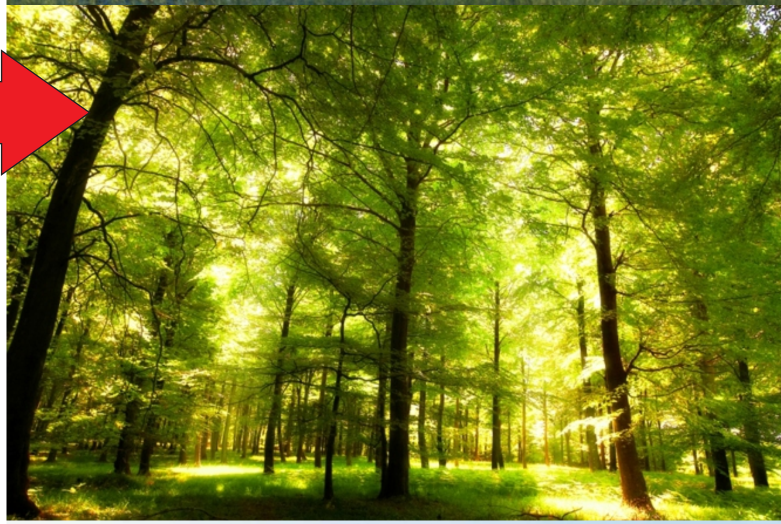
Colby College

- Most students entering university have some experience with trees growing in a forest ecology
- Most student perspectives are that of a northern hemisphere chauvenist
- Several other forest structures now exist
- Although the "present is key to the past," deep-time fossil communities have not always been the same



ACTIVITY GOALS

- Introduce quantitative ecological measures to fossil benthic (autochthonous) assemblages
- Test assemblage relationships using diversity measures, correlation coefficients, and simple multivariate statistical analyses
- Reconstruct an autochthonous fossil community in space, demonstrating that ancient community structure differs from the Recent

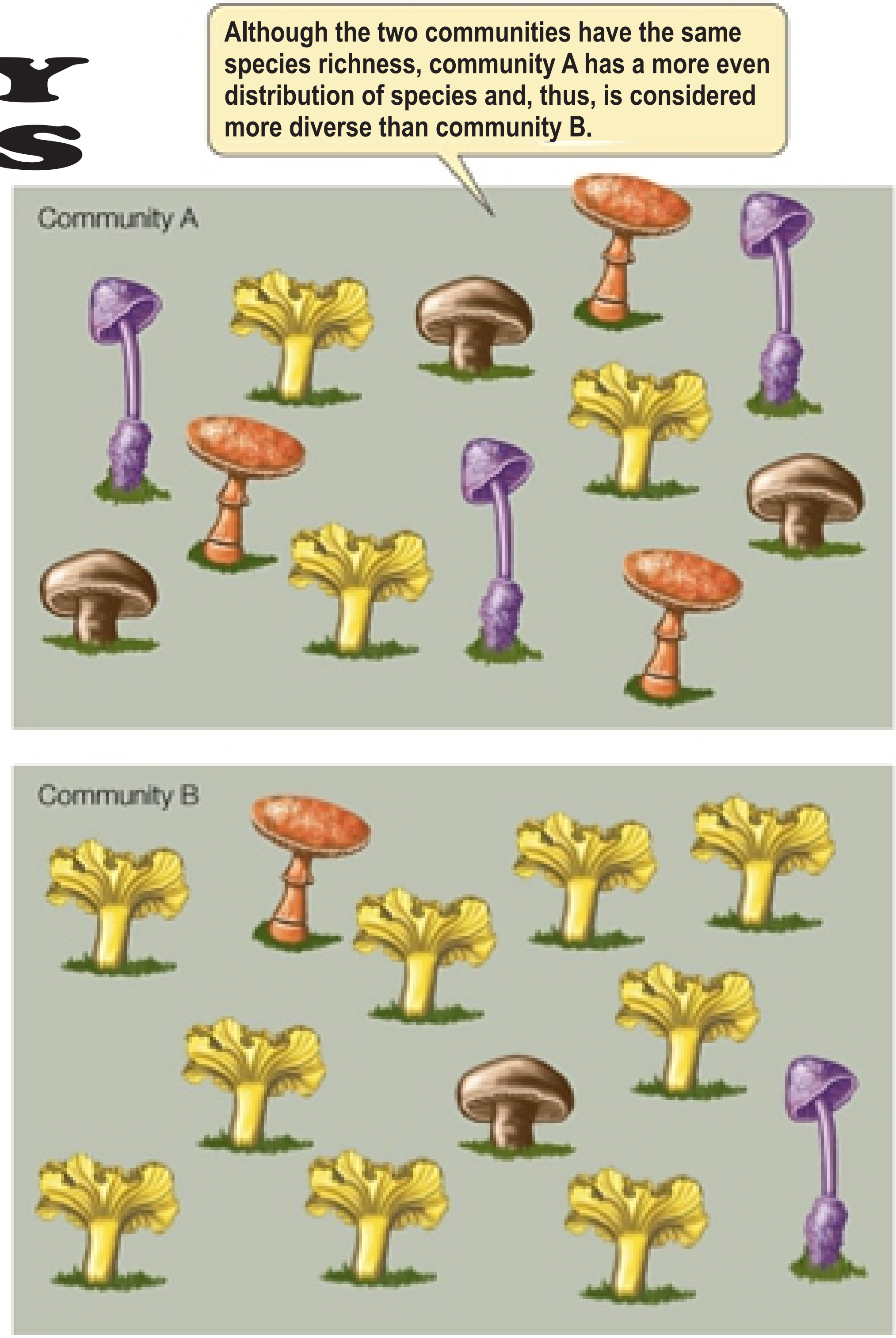
BASIC DIVERSITY MEASURES

Introduction to:

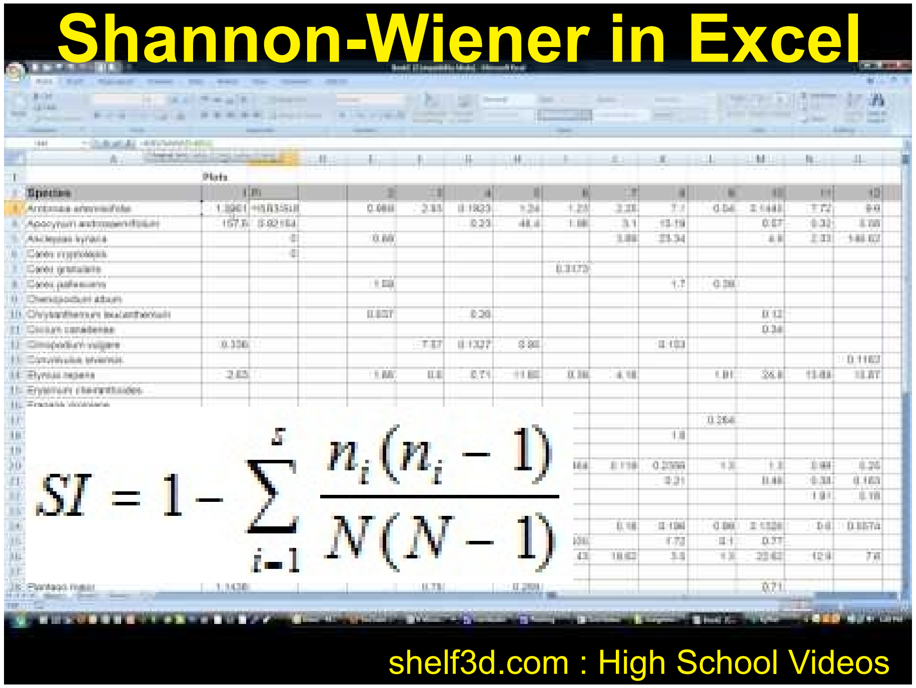
- α-diversity (richness)
- β-diversity (compositional change along gradient)
- γ-diversity (regional)

Prelude to:

- Eveness
- Diversity Indices



SHANNON-WIENER, SIMPSON & MARGALEF INDICES



where n = # individuals/sp; N = total # individuals

Simpson's Index

Calculating Species Diversity

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

Species	Numbers (n)	n(n - 1)
A	10	
B	18	
C	16	
D	2	
E	8	
	$\sum n(n-1)$	

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- Step one: Calculate N
- Step two: Calculate N(N - 1)
- Step three: Calculate n(n - 1)
- Step four: Calculate $\sum n(n-1)$
- Step four: Divide N(N-1) by $\sum n(n-1)$

shelf3d.com : High School Videos

Margalef Index

D = (S-1)/Log N

- Relates diversity to the number of species (S) to the number of individuals (N).
- Attempts to account for sampling size and effort

SIMILARITY INDICES

	J 	
I 	(+) (+) a	(+) (-) b
	(-) (+) c	(-) (-) d

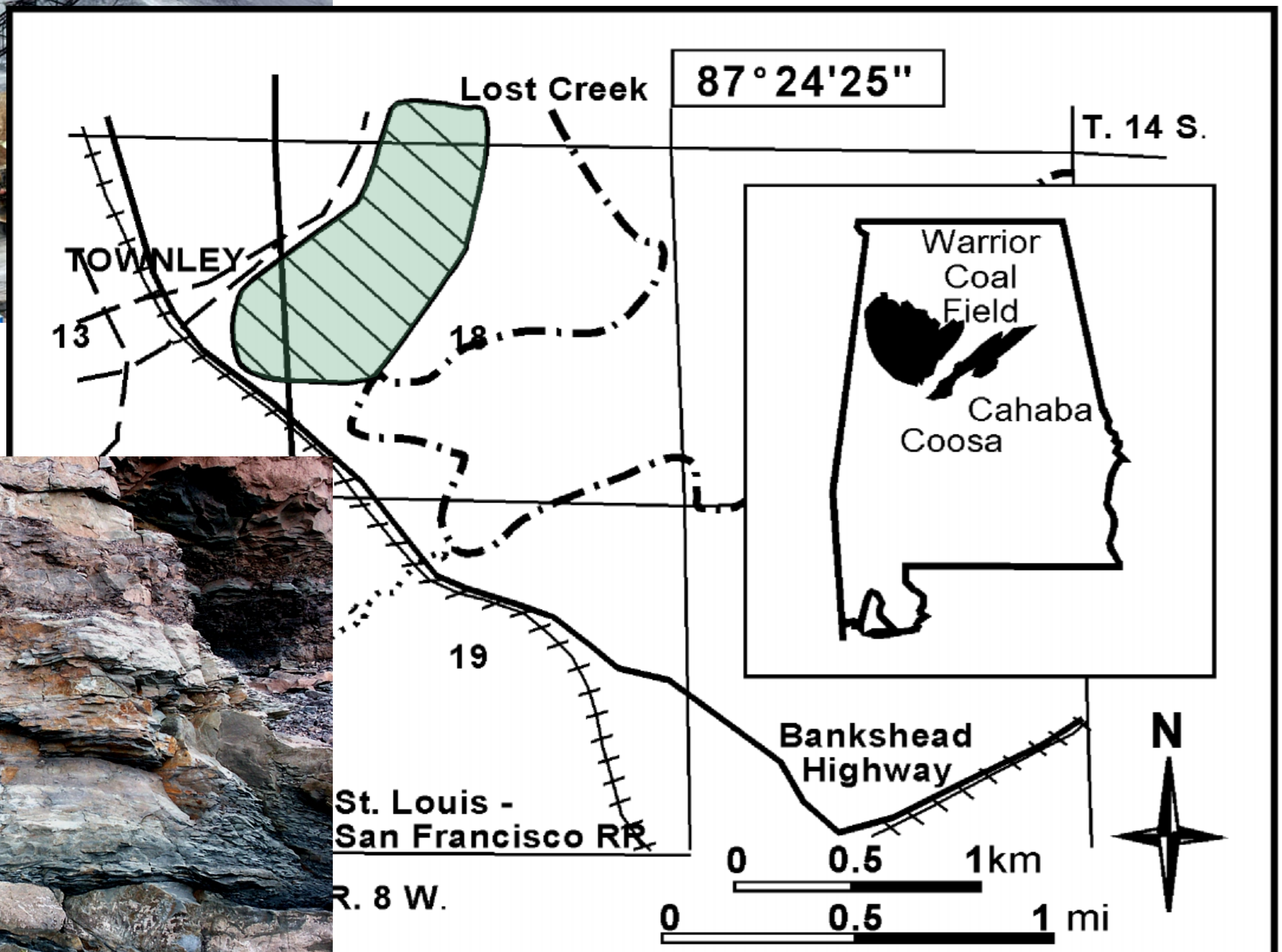
$$SC_{ij} = \frac{2a}{b + c}$$

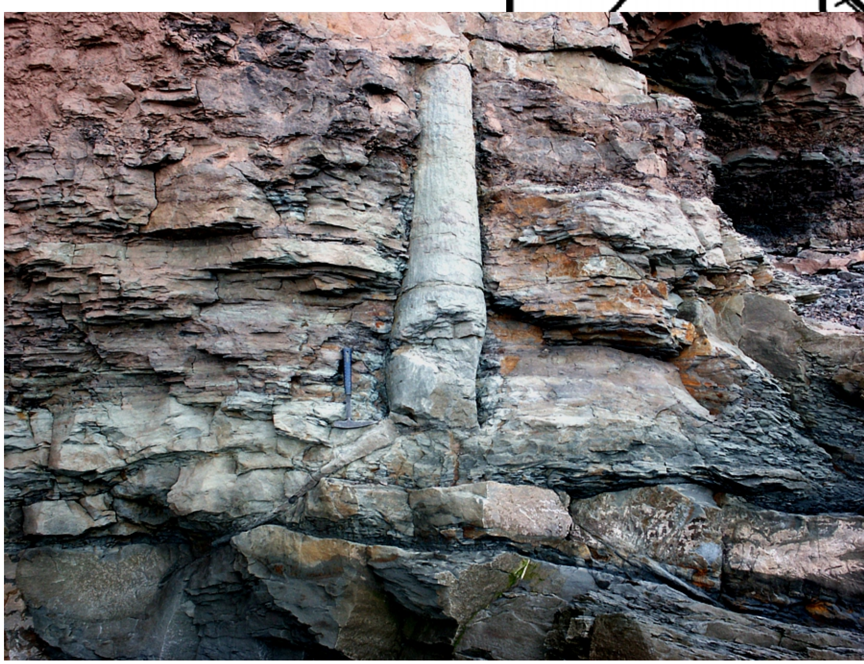
- Sørenson's (shared/number in I & J)
- Jaccard (finds incidence where both values=1).
- Simple Matching

$$JC_{ij} = \frac{a}{a + b + c}$$

$$SM_{ij} = \frac{a + d}{a + b + c + d}$$

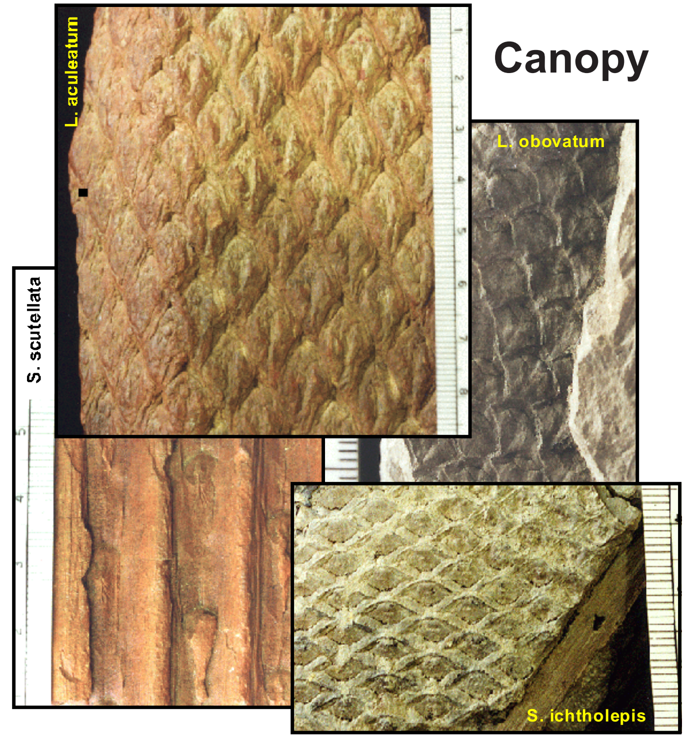
Lost Creek Mine

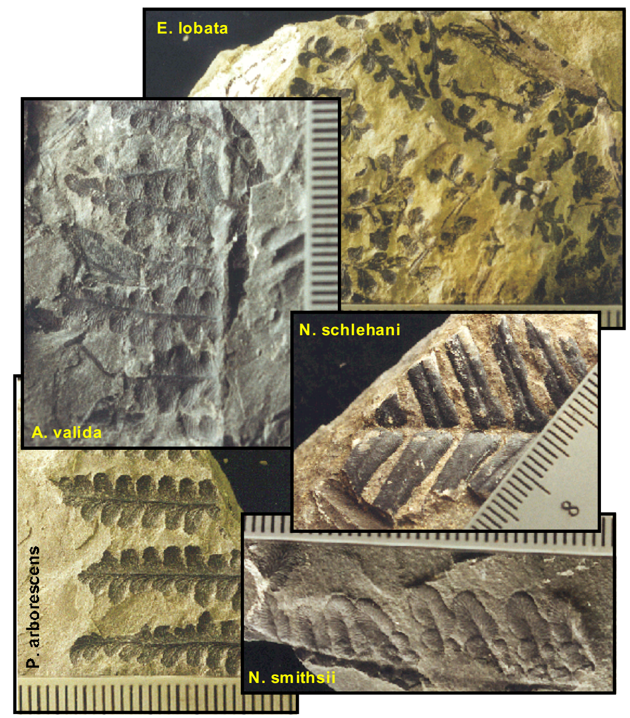




Latitude	8725.113	8725.334	8725.486	8725.512	8725.287	
Longitude	3349.291	3349.57	3349.671	3349.654	3349.224	
Blue Creek Forest	Locality1	Locality6	Locality8	Locality13	Locality14	
Lepidodendron aculeatum	12	0	44	46	8	CANOPY
Lepidodendron obovatum	0	0	38	18	0	
Lepidophloios laricinus	25	45	0	37	99	
Sigillaria elegans	0	8	6	7	0	
Sigillaria ichthyolepis	0	8	6	9	0	
Sigillaria scutellata	0	16	0	9	0	
Calamites cisti	10	7	20	28	45	
Calamites suckowi	0	20	8	28	10	
Artisia	1	0	0	1	0	
Pecopteris arborescens	7	0	4	2	3	UNDER STORY
Cardiopteridium	8	1	0	0	0	
Eremopteris Rhodea type	0	0	0	0	2	
Eremopteris sp.	0	1	0	0	1	
Eusphenopteris lobata	0	2	2	3	3	
Sphenopteris brongniarti	8	5	7	11	5	
Alethopteris cf. valida	0	7	0	0	0	
Alethopteris lonchitica	0	7	7	13	0	
Neuralethopteris elrodi	3	0	81	13	0	
Neuralethopteris pocahontas	23	0	18	51	8	
Neuralethopteris schlehani	12	0	7	0	0	
Neuralethopteris smithsii	5	0	0	2	0	
Neuropteridium	8	0	0	0	0	
Alloiopteris	0	5	0	0	0	GROUND COVER
Diplothmema	2	0	0	0	0	
Lyginopteris hoeninghausii	1	27	24	12	19	
Palmatopteris furcata	0	9	1	13	0	
Sphenophyllum emarginatum	0	6	0	5	0	
Sphenophyllum cuneifolium	1	1	0	0	0	
Sphenopteris cf. schatzlarensis	3	16	0	0	7	
Sphenopteris herbacea	1	0	3	0	2	
Sphenopteris pseudocristata	1	13	0	0	2	

Canopy





Understory

SIMILARITY INDICES & Q-Mode CLUSTER ANALYSIS

- First, similarity indices between each pair of cases is calculated
- Second, similarity Indices entered into the matrix
- Third, scan the matrix to find the pair of cases with the highest similarity (most related); these will cluster most closely together at the calculated value (% similarity)

	locality 1	
locality 6		

	locality 1	
locality 8		

	locality 1	
locality 13		

	locality 1	
locality 14		

	locality 6	
locality 8		

	locality 6	
locality 13		

	locality 6	
locality 14		

	locality 8	
locality 13		

	locality 8	
locality 14		

	locality 13	
locality 14		

Simple Matching Coefficient

	locality 1	locality 6	locality 8	locality 13	locality 14
locality 1					
locality 6					
locality 8					
locality 13					
locality 14					

	LOCALITY 1	
LOCALITY 6	8	11
	8	2

	LOCALITY 1	
LOCALITY 8	9	7
	9	6

	LOCALITY 1	
LOCALITY 13	10	9
	8	4

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Simple Matching Coefficient

	locality 1	locality 6	locality 8	locality 13	locality 14
locality 1		0.344	0.484	0.452	0.613
locality 6			0.452	0.548	0.516
locality 8				0.774	0.613
locality 13					0.516
locality 14					

- The data in these two collections, then, are combined as a new datum (presence of taxon is now considered to be common to the group) and this datum is then used to calculate the similarity coefficients along with the remaining localities.
- Again, find the pair-wise comparison that has the highest similarity coefficient. These ollections are then linked at the next highest level in the analysis.

	locality 1	locality 6	locality 8/13	locality 14
locality 1				
locality 6				
locality 8/13				

	locality 1	locality 6	locality 8/13	locality 14
locality 1		0.323	0.516	0.613
locality 6			0.483	0.516
locality 8/13				0.516

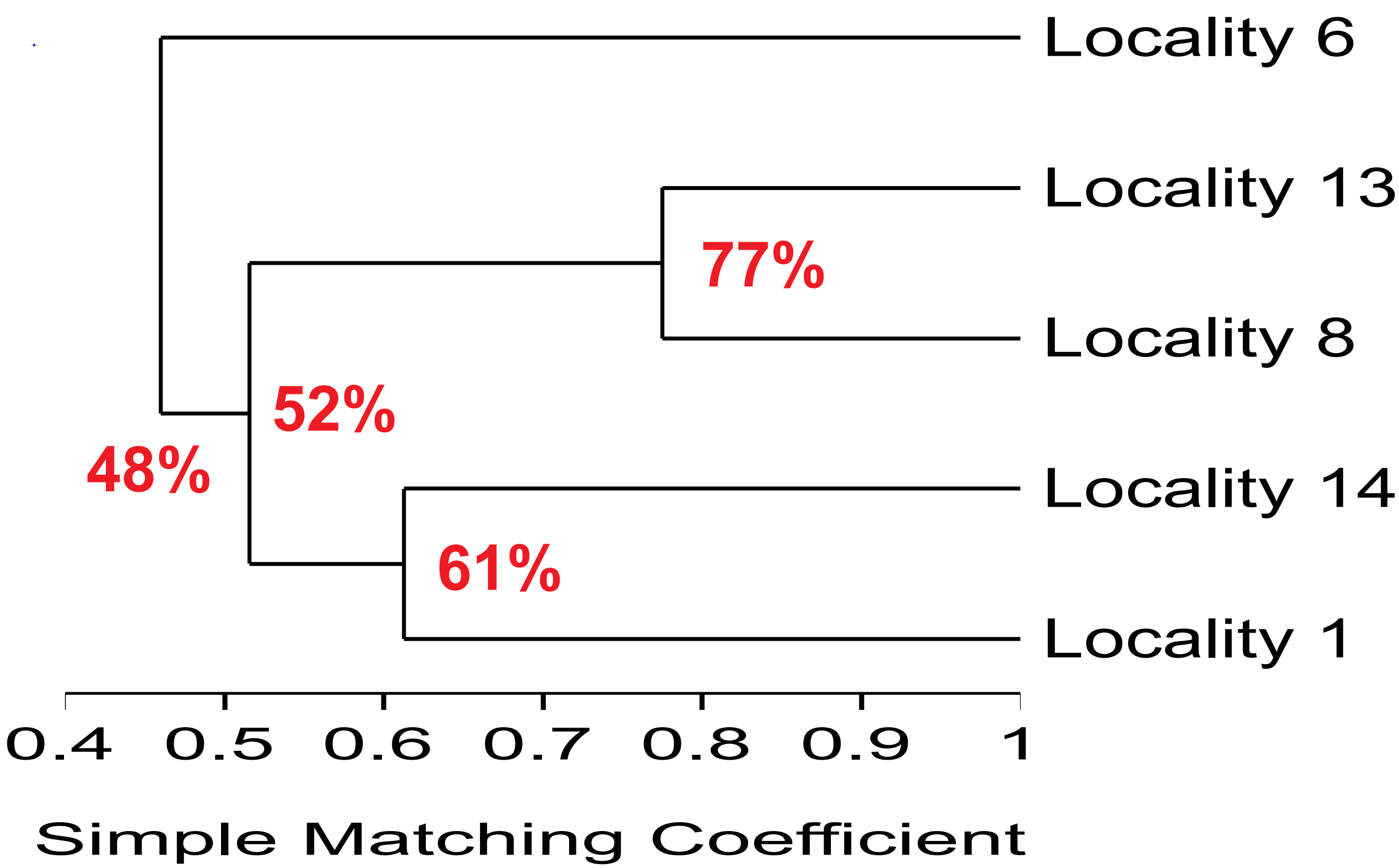
- Again, find the pair-wise comparison that has the highest similarity coefficient. These two collections are then linked at the next highest level in the analysis.
- The data in these two data sets are then combined as a new datum, and the procedure repeated.

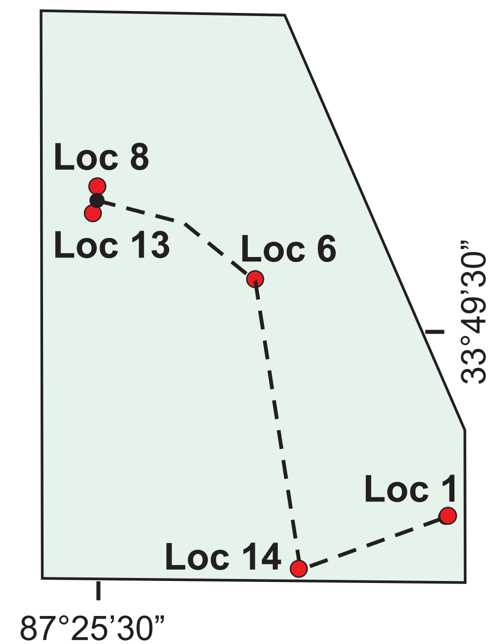
	locality 6	locality 8/13
locality 1/14		
locality 8/13		

	locality 6	locality 8/13
locality 1/14	0.419	0.516
locality 8/13	0.483	

When you've completed all of the analyses, draw a dendrogram using the percent similarity coefficient numbers along the X-axis (proportion similar), arrange the localities along the Y axis, and draw lines linking the groups of collections.

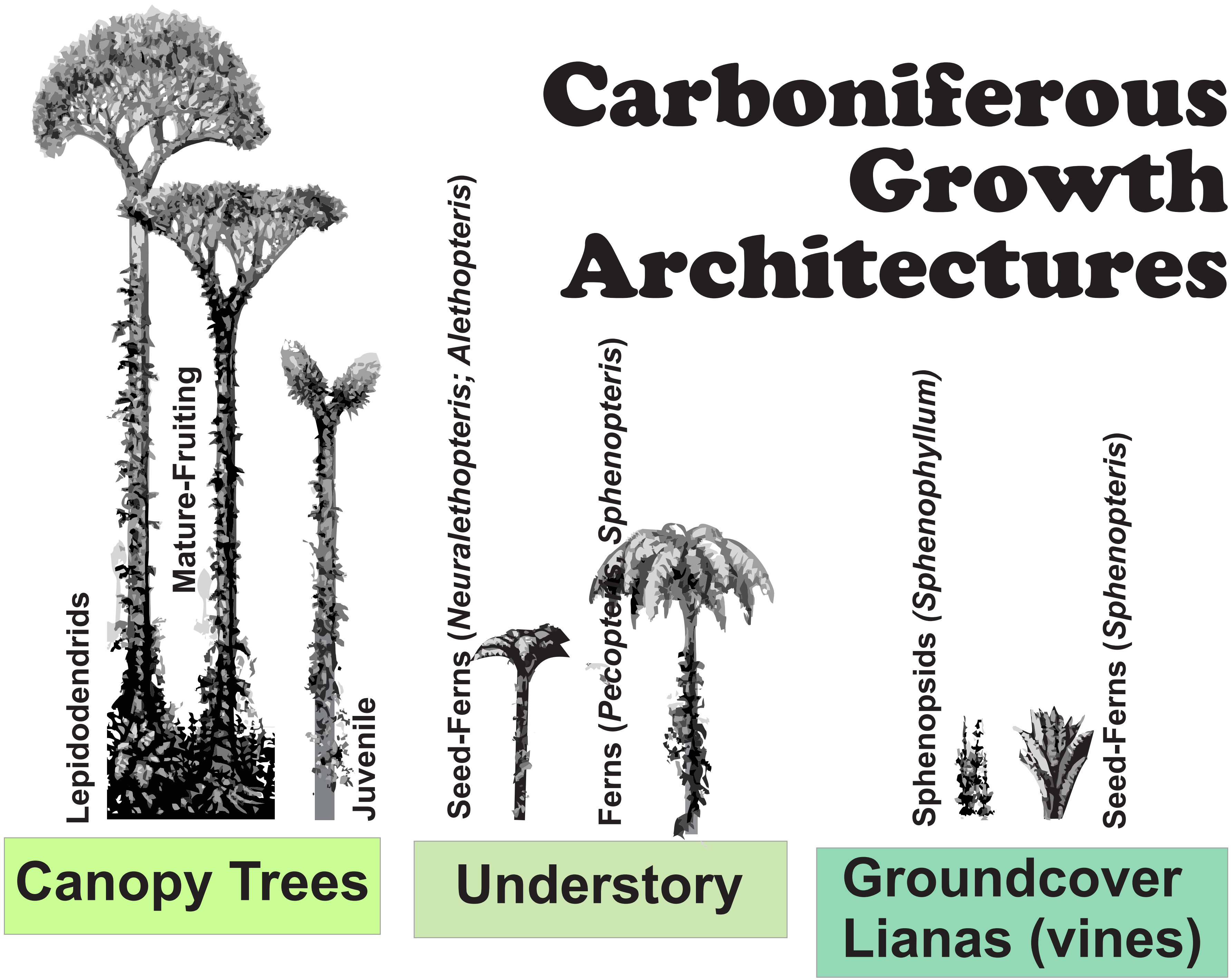
Locality 8/13	**77%**
Locality 1/14	**61%**
Locality 8/13 & 1/14	**52%**
Locality 8/13 & 6	**48%**





- What community assemblages can you interpret from the cluster analysis?
  - That is, what assemblages cluster close together and which cluster farther apart?

Carboniferous Growth Architectures



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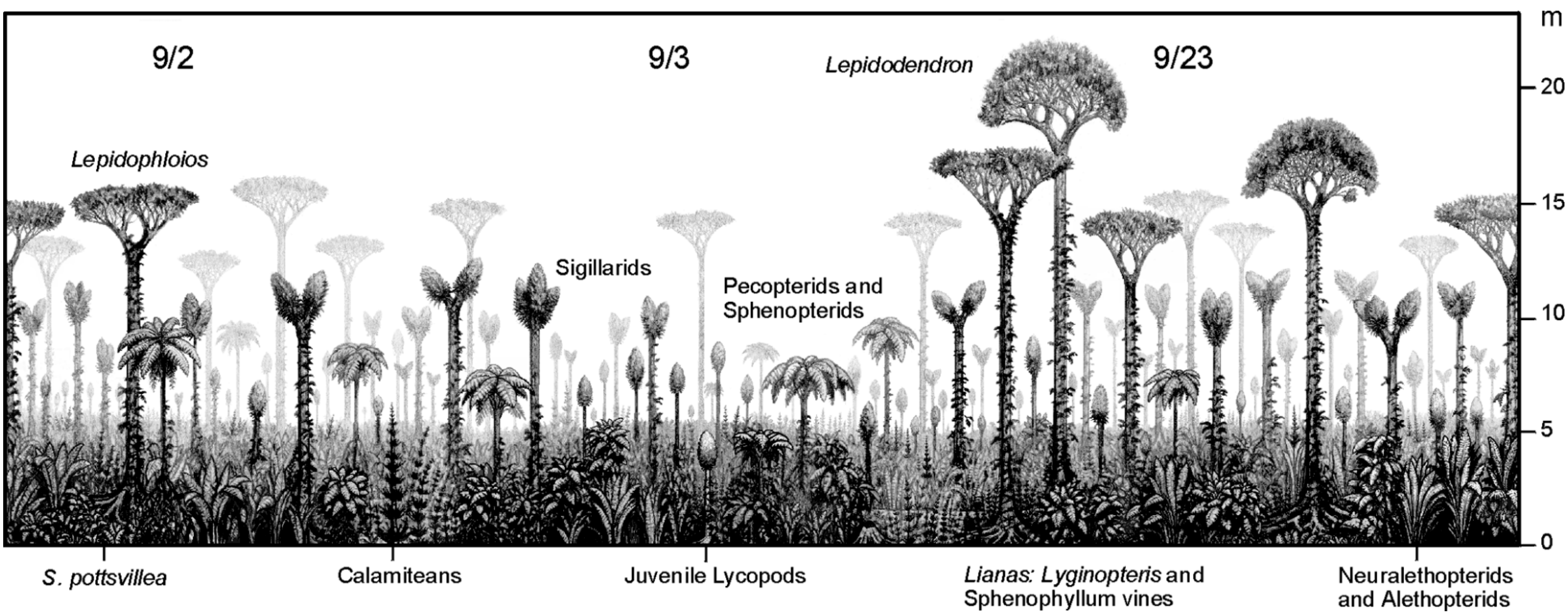
Sphenophyllum cuneifolium	1	0	1	0	0	
Sphenopteris cf. schatzlarensis	3	7	16	0	0	
Sphenopteris herbacea	1	2	0	3	0	
Sphenopteris pseudocristata	1	2	13	0	0	

TELL ME ABOUT THE FOREST

Using the attached plan of the sampling sites, the basic plant architectures for each of the major growth habits (canopy, subcanopy, groundcover), the proportion of litter in each site and the relationships between sites as determined from cluster analysis, draw a reconstruction of the Carboniferous forest across the five-site transect.



SUMMARY

Using the concept of forest, it is possible to:

- teach basic, universal ecological measures
- apply these to an autochthonous assemblage in the same context as modern ecology
- enhance student’s fundamental and advanced quantitative skills
- introduce exploratory statistical concepts including similarity coefficients and Q-mode cluster analysis
- provide an opportunity for students to reconstruct an ancient forest from a quantitative data set
- demonstate the possibility of understanding deep time ecosystems even when organisms are extinct and no modern analogs exist