Phanerozoic Diversity and the Permian Global Community Catastrophe

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Is the natural course of community evolution skewed toward high taxa richness but decreasing taxa evenness?

Do extintions result in a disproportionate reduction of rare taxa?

Is the ‘26 My extinction cycle’ an artifact of taxa evenness?

Do originations surge following extinctions?

Database:

Benton, M. J. (ed) 1993, Fossil Record 2. Chapman & Hall, London. 845 p.

Number of Families: 2630

77 epochs, 553 Ma to 0 Ma

Sepkoski, J., Bambach, R. K., Raup, D. M., & Valentine, J. W. 1981.
Phanerozoic marine diversity and the fossil record.
Nature, London 293, 435-437.

The single underlying pattern was that taxa richness has increased over the Phanerozoic. Indeed today there are more extant species, genera, and families than at any other time.

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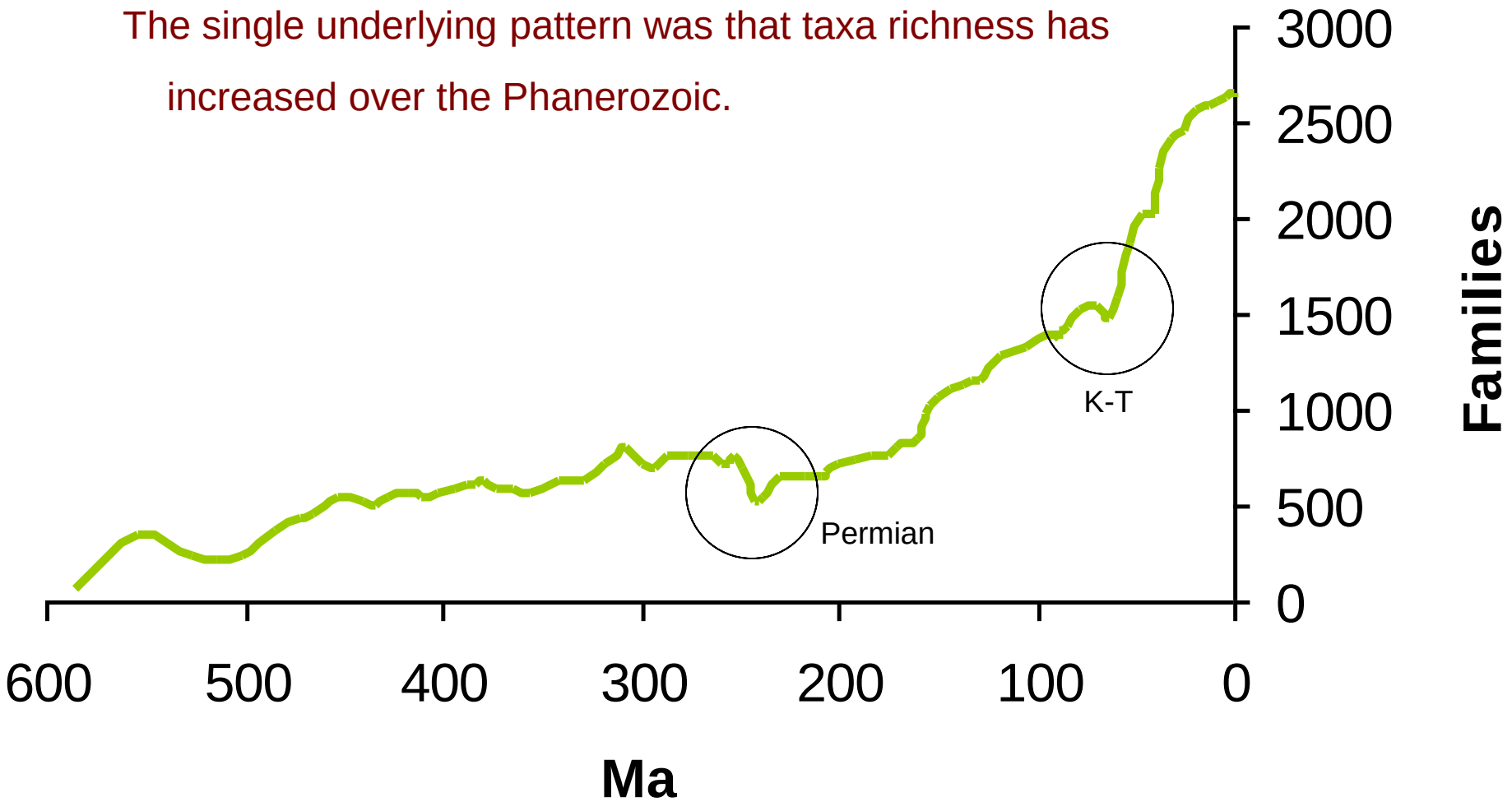
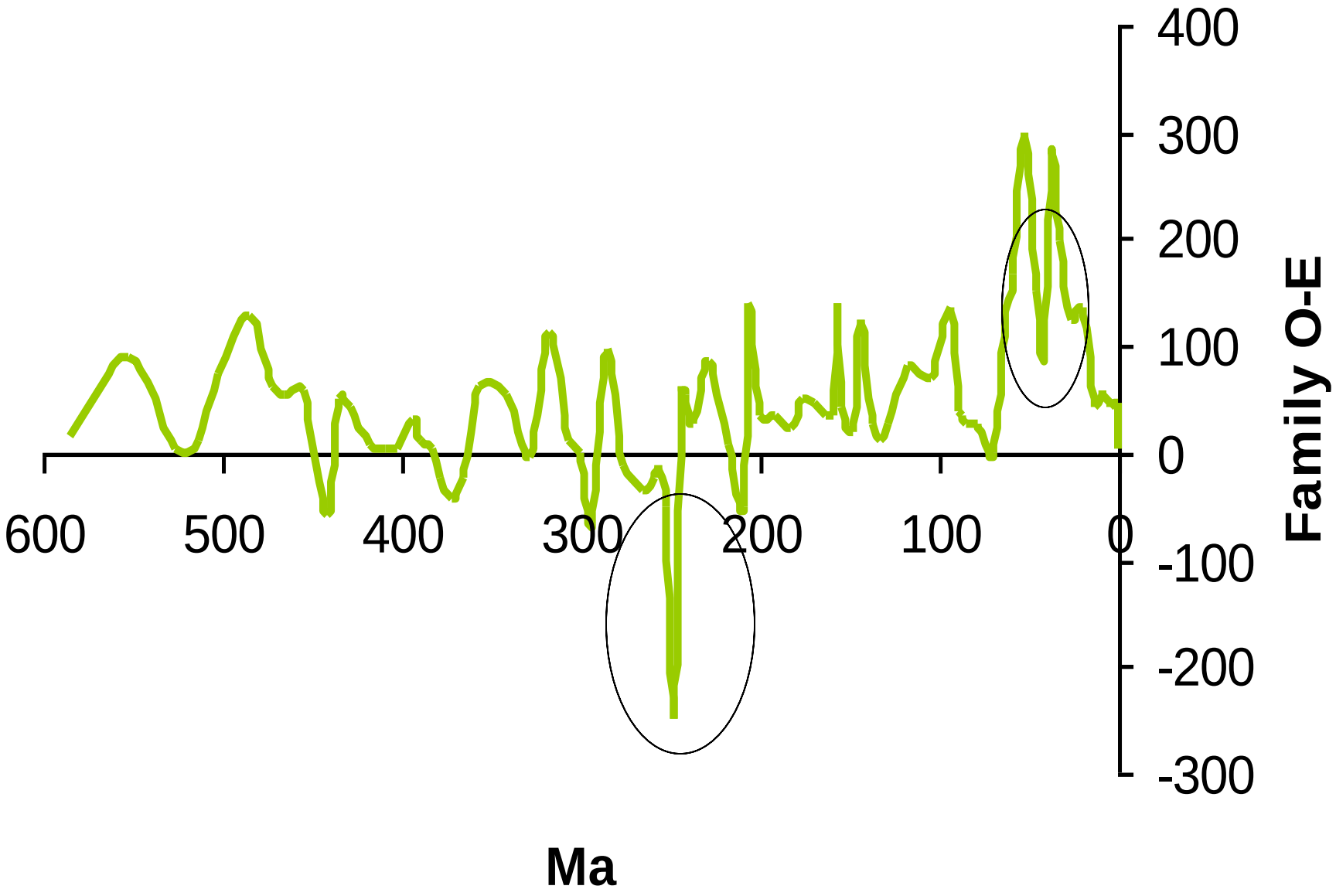
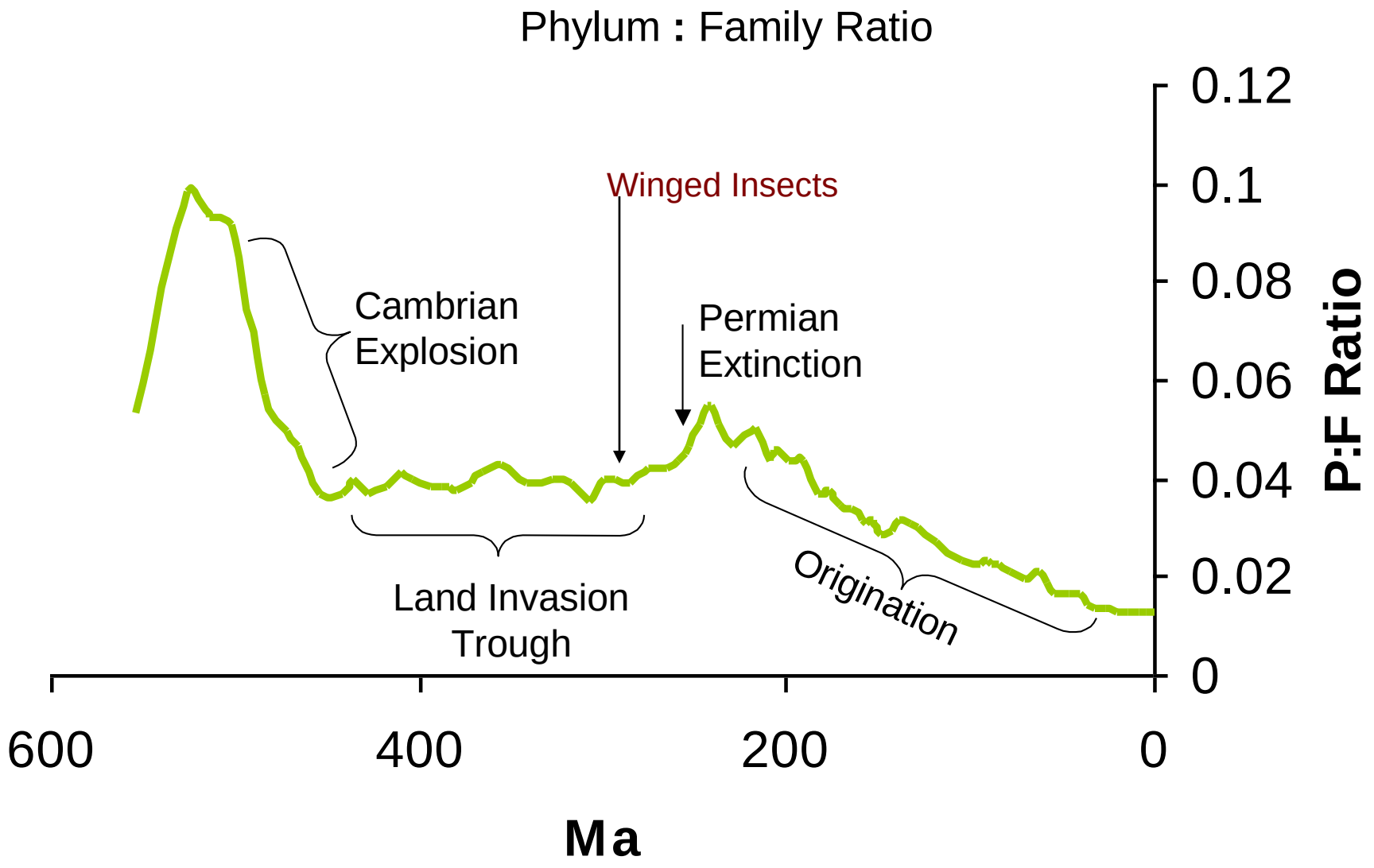
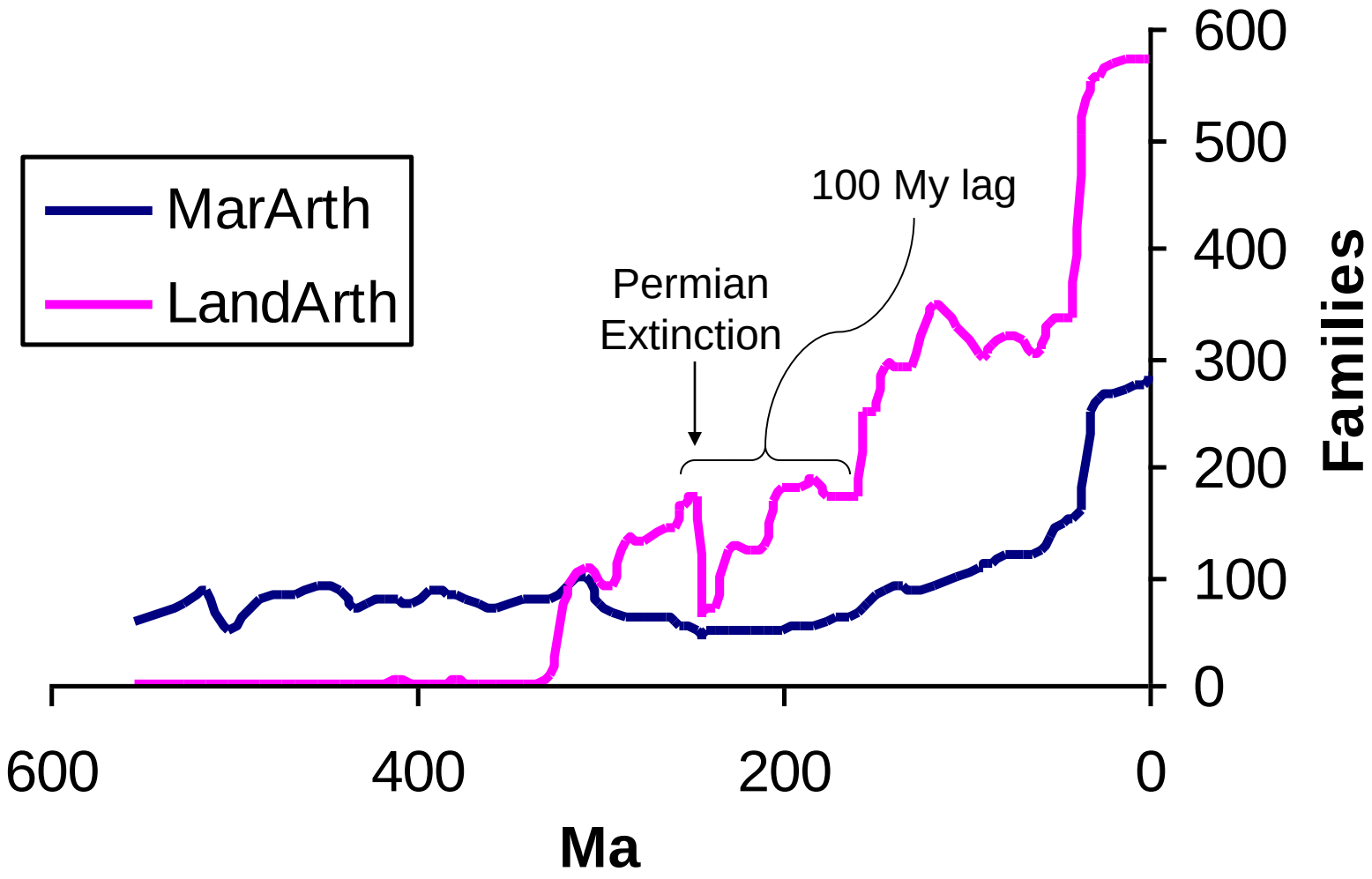



400
300
200
100
0
-100
-200
-300
Family O-E
600
500
400
300
200
100
0
Ma


Phylum : Family Ratio
Winged Insects
Cambrian
Explosion
Permian
Extinction
Land Invasion
Trough
Origination
0.12
0.1
0.08
0.06
0.04
0.02
0
P:F Ratio
600
400
200
0
Ma


MarArth
LandArth
100 My lag
Permian
Extinction
600
500
400
300
200
100
0
Families
600
400
200
0
Ma

Sepkoski, J., Bambach, R. K., Raup, D. M., & Valentine, J. W. 1981.
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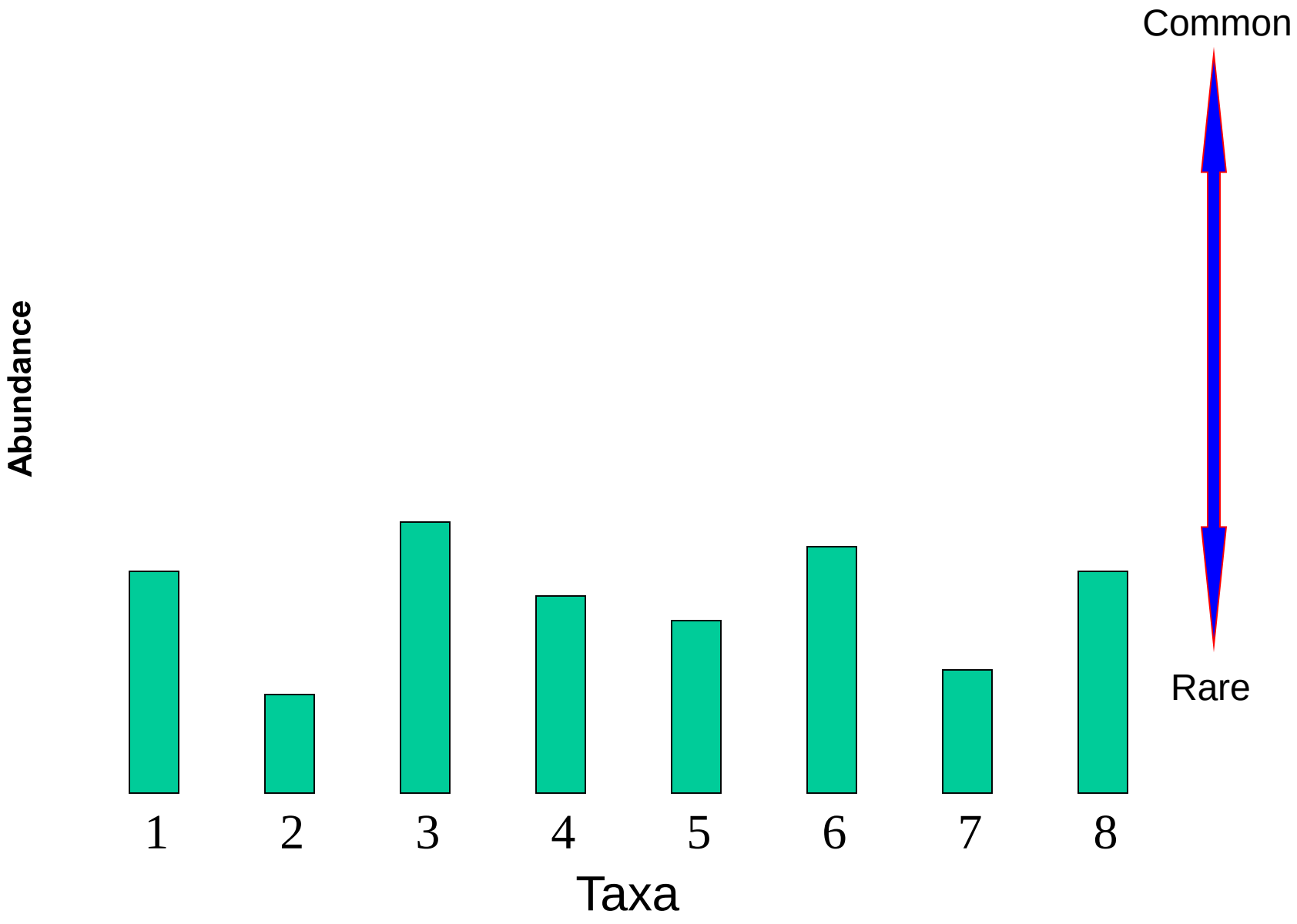
The single underlying pattern was that taxa richness has increased over the Phanerozoic. Indeed today there are more extant species, genera, and families than at any other time.

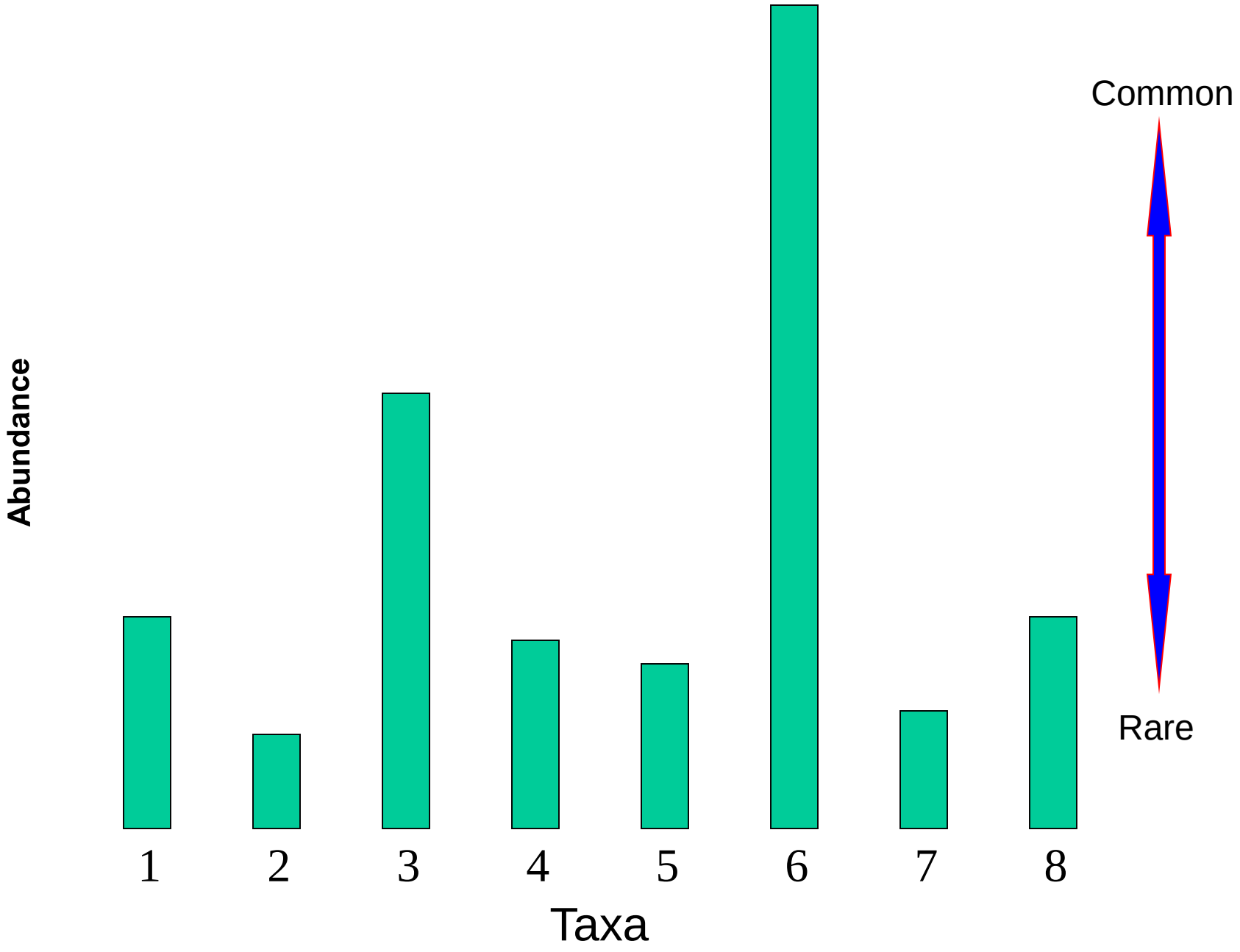
Taxa richness, (AKA “diversity”) is good!

Not necessarily:

The community ecologist views the matter a little differently:

the crucial analysis is how taxa richness is distributed among taxa.


Common
Abundance
Rare
1
2
3
4
5
6
7
8
Taxa


Abundance
Common
Rare
1
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7
8
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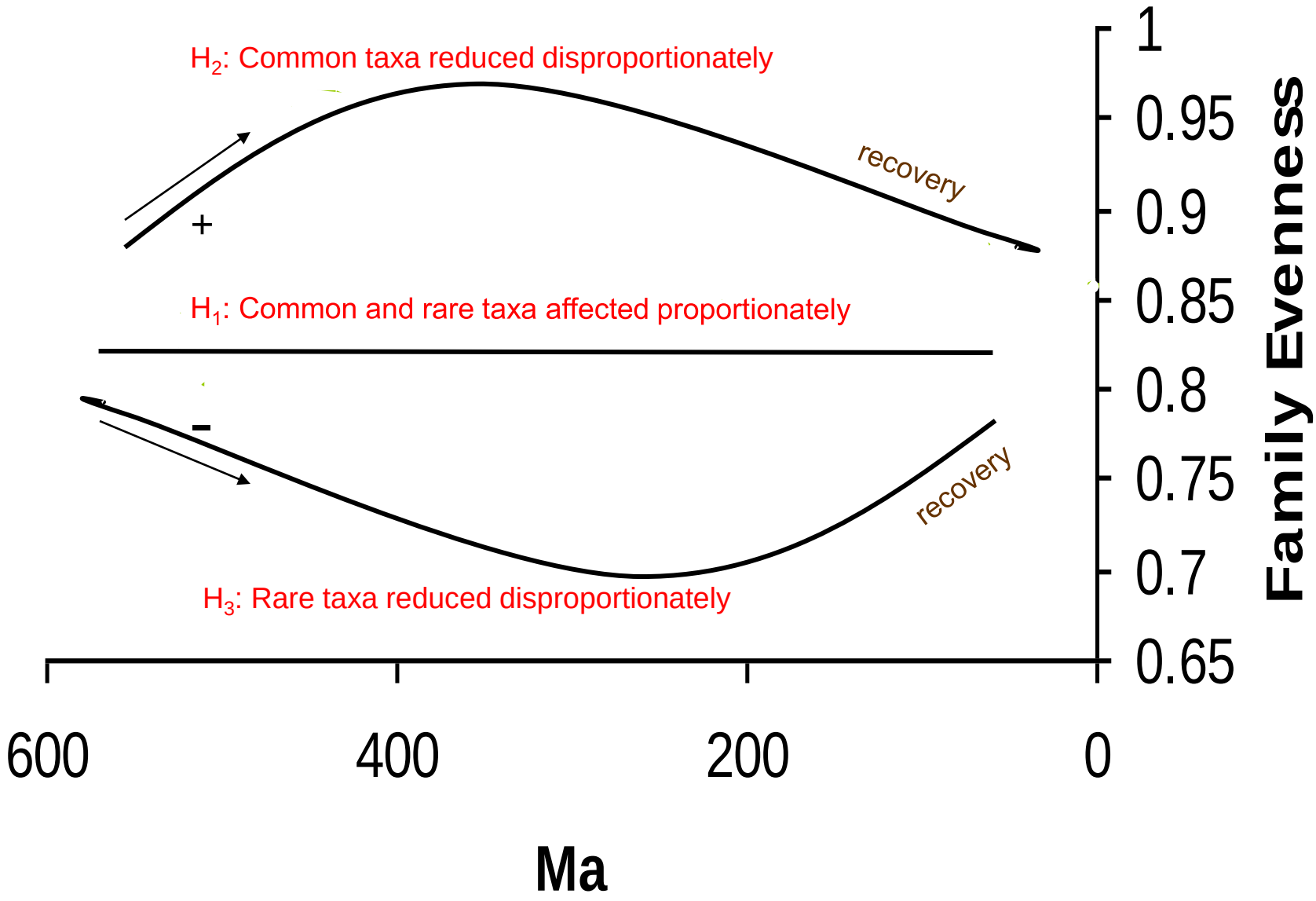
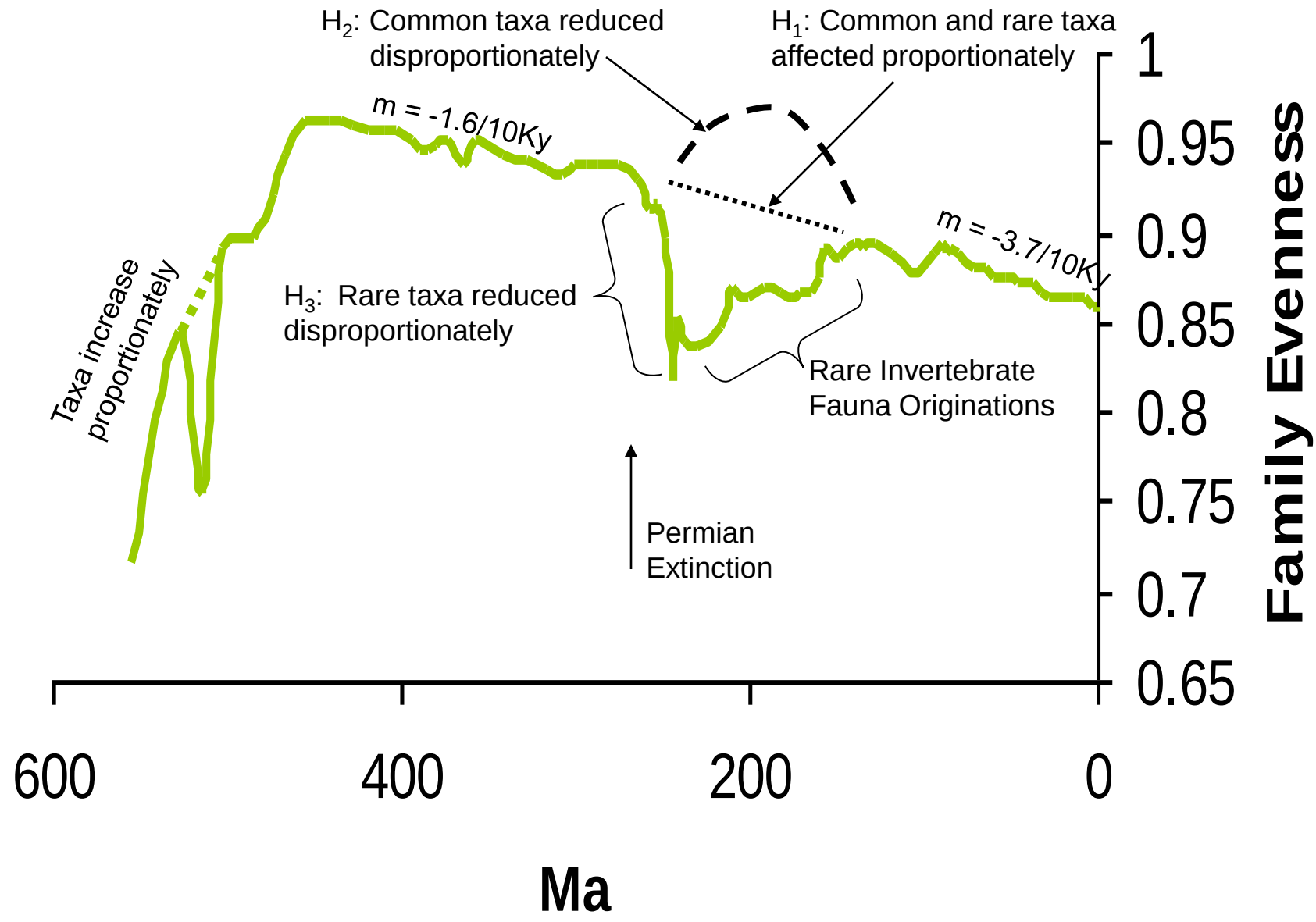
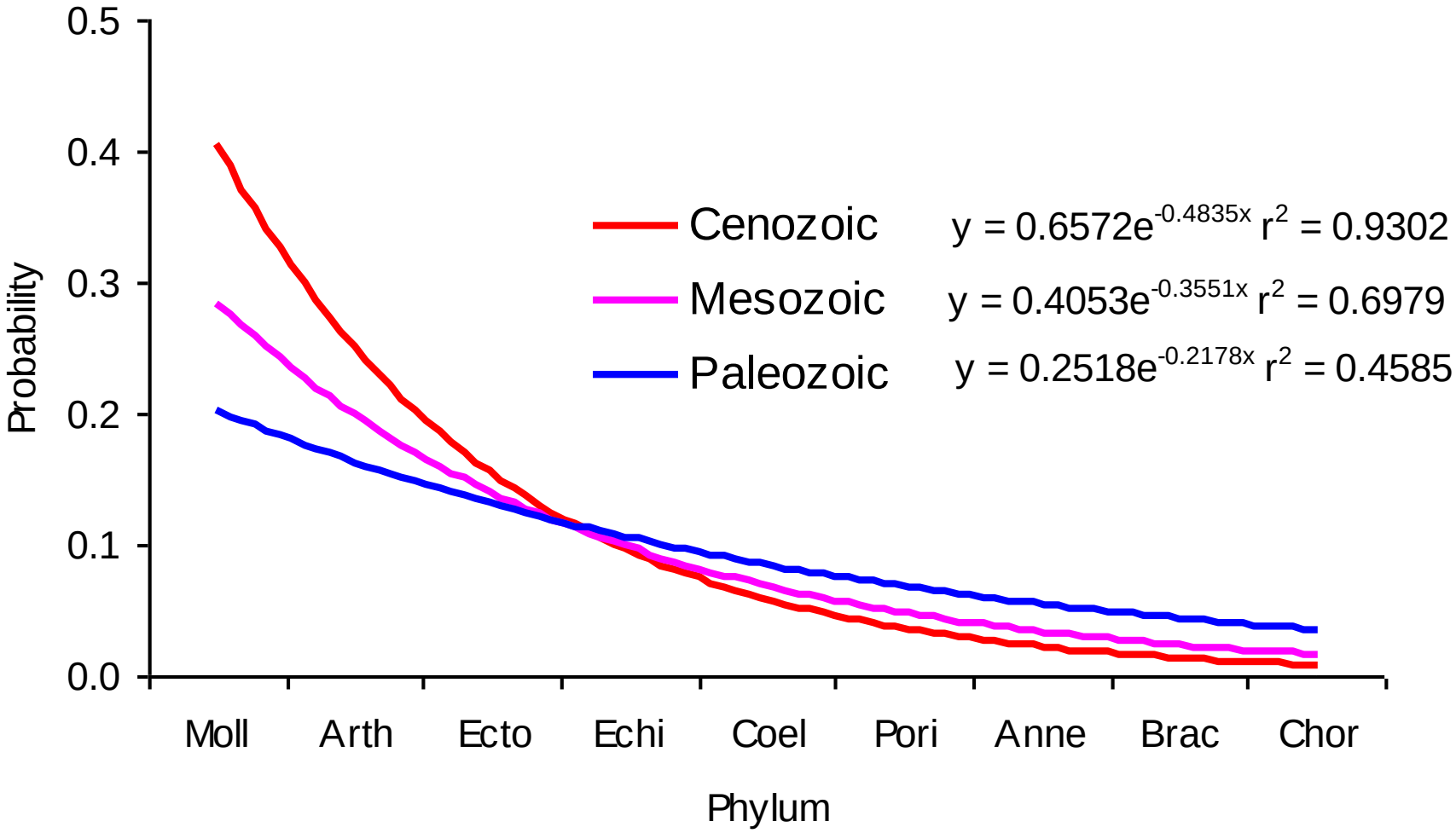
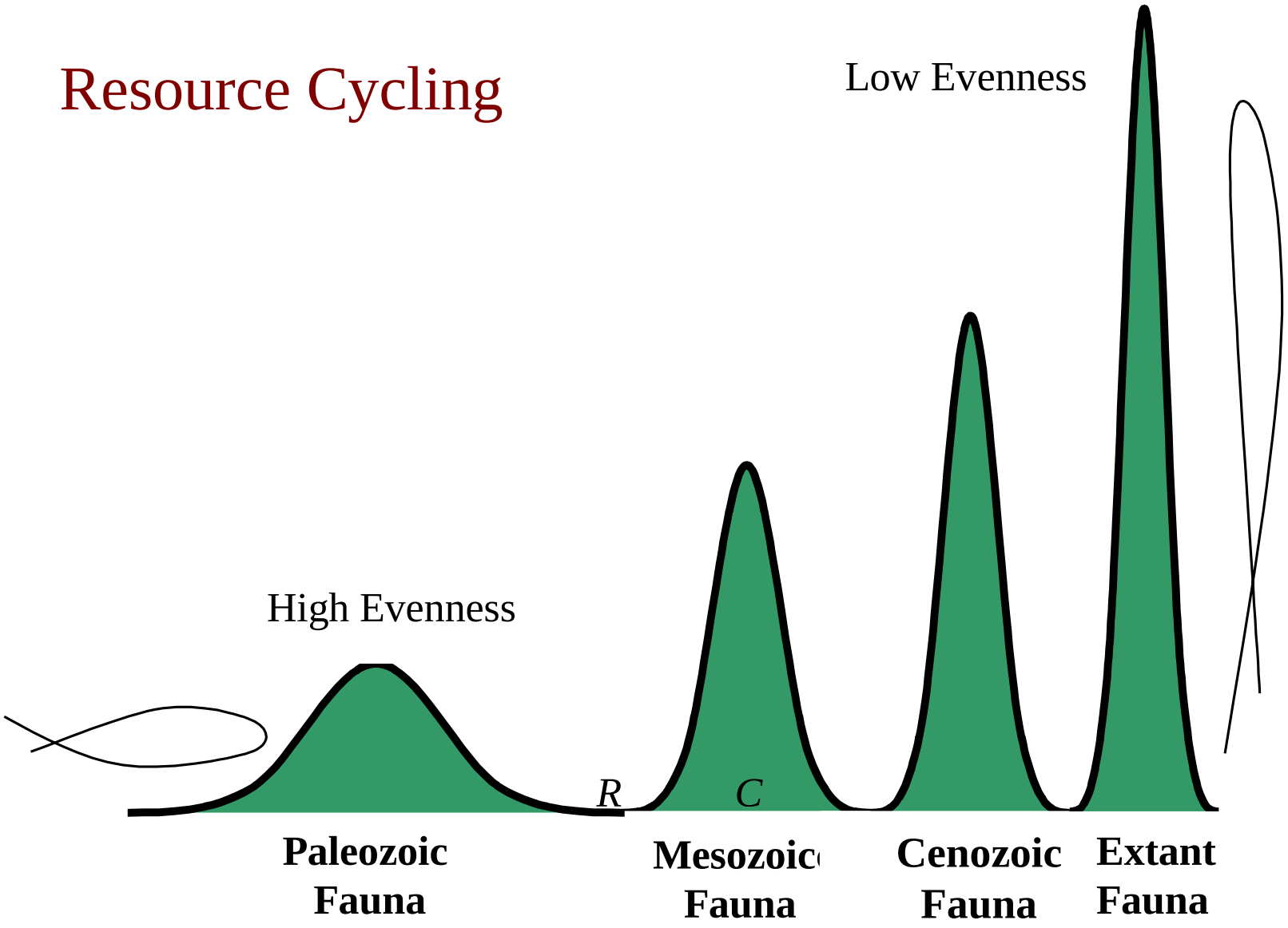


Assumption: a mass extinction reduces both common and rare taxa


H2: Common taxa reduced disproportionately
H1: Common and rare taxa affected proportionately
m = -1.6/10Ky
m = -3.7/10Ky
Taxa increase proportionately
H3: Rare taxa reduced disproportionately
Rare Invertebrate Fauna Originations
Permian Extinction
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
Family Evenness
600
400
200
0
Ma


0.5
0.4
0.3
0.2
0.1
0.0
Probability
Cenozoic
Mesozoic
Paleozoic
y = 0.6572e-0.4835x r2 = 0.9302
y = 0.4053e-0.3551x r2 = 0.6979
y = 0.2518e-0.2178x r2 = 0.4585
Moll
Arth
Ecto
Echi
Coel
Pori
Anne
Brac
Chor
Phylum

Resource Cycling



Raup, D. M. & Sepkoski, J. J. 1986. Periodic extinction of families and gerera. Science 231: 833-836.

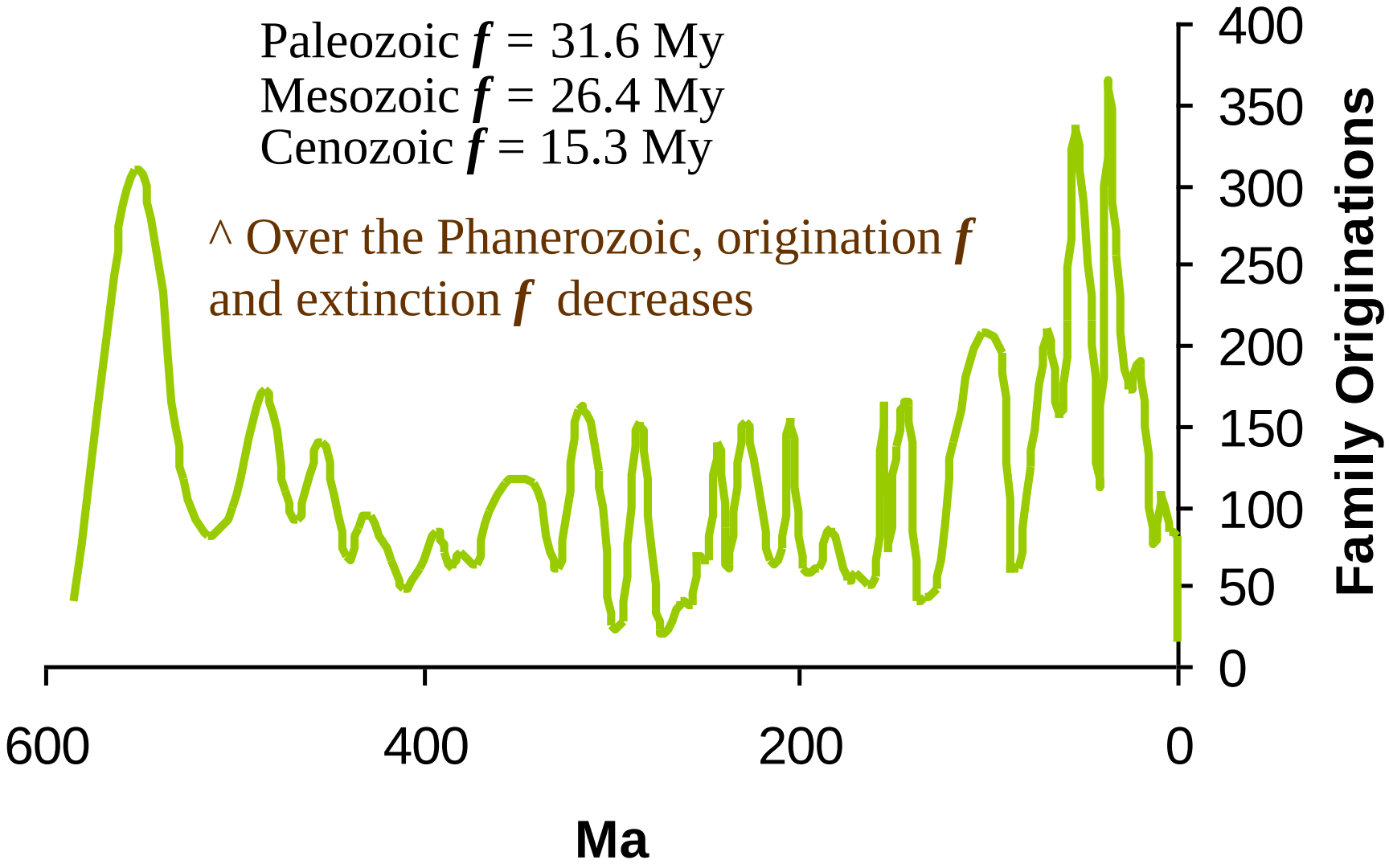
Using 2160 families, they suggested a 26 My periodic mass extinction cycle. (Meso- & Cenozoic)

17 years later, Dave Raup suggests the idea is still on the table but “comatose”.

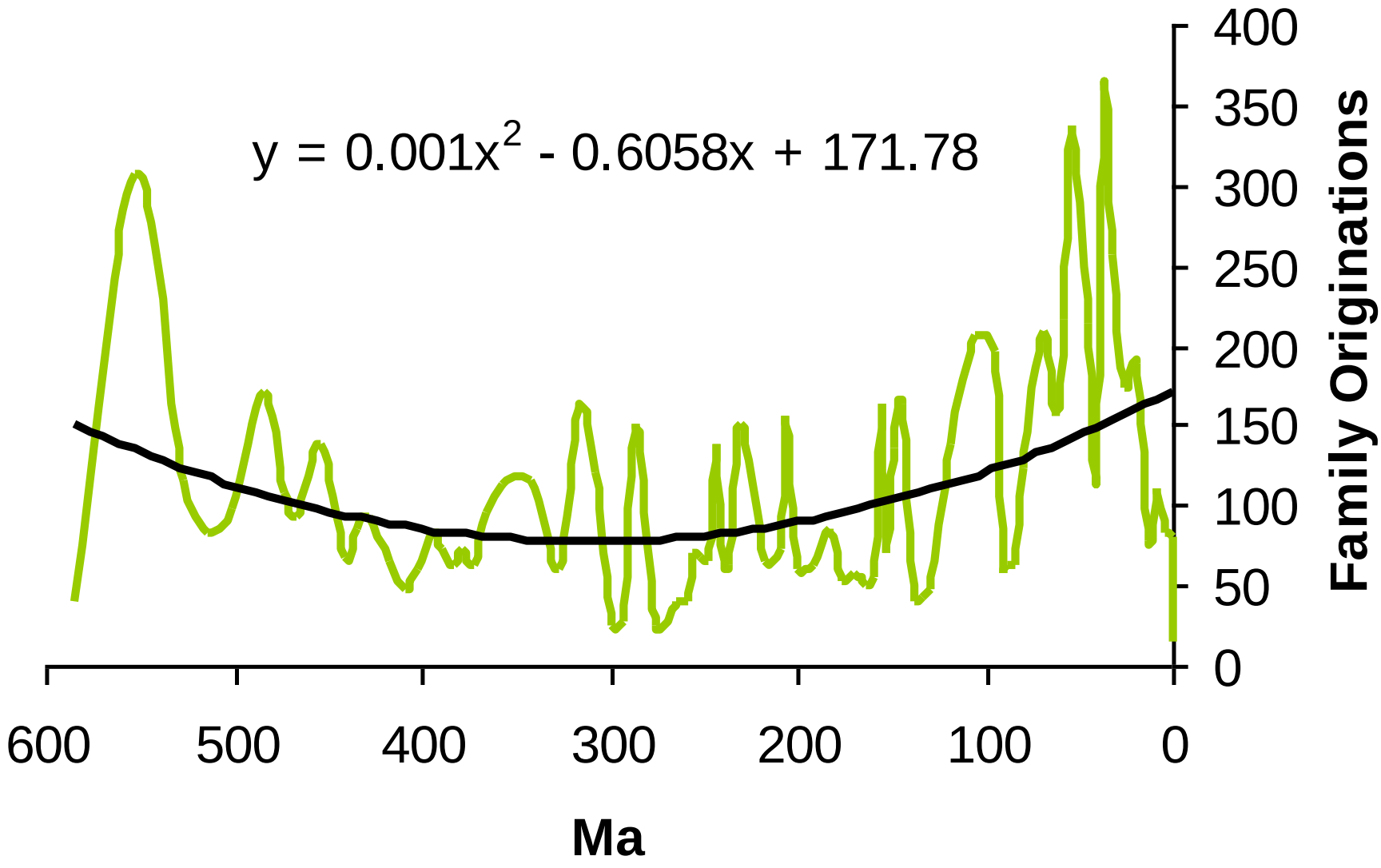
If extinctions are followed by surges in originations, then originations should yield a similar 26 My cycle.

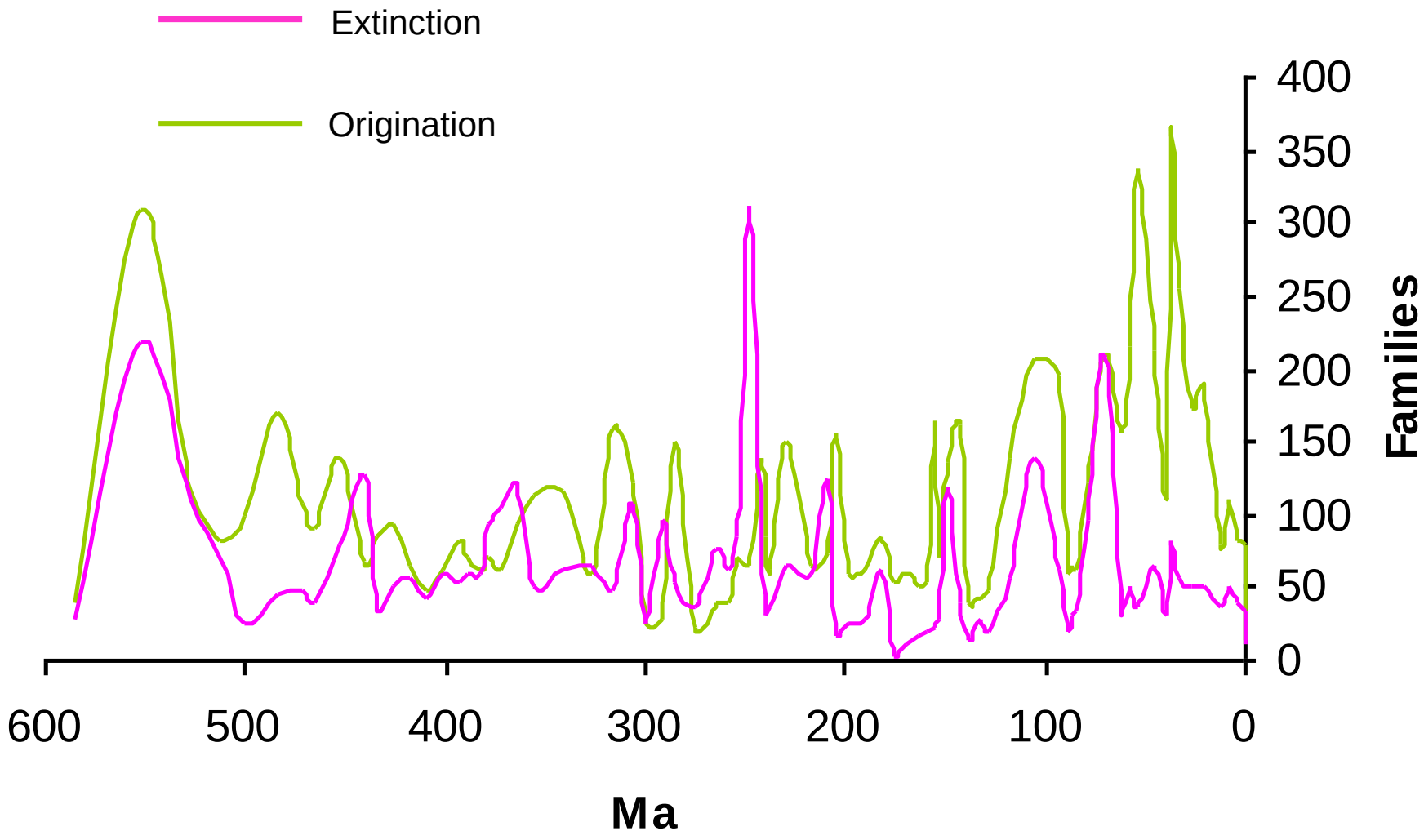
Using 2630 families, from the Fossil Record 2 databank, a test of Raup/Sepkoski 26 My cycle is made.

Is the '26 My extinction cycle' an artifact of taxa evenness?



Do originations surge following extinctions?




Extinction
Origination
400
350
300
250
200
150
100
50
0
Families
600
500
400
300
200
100
0
Ma

Is declining origination & extinction *f* a community response?