RESILIENCE AND STABILITY OF PERMO-TRIASSIC KAROO BASIN COMMUNITIES: THE IMPORTANCE OF SPECIES RICHNESS AND FUNCTIONAL DIVERSITY TO ECOLOGICAL STABILITY AND ECOSYSTEM RECOVERY

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Hypothesis

• Community structure and dynamics are major determinants of taxon loss and recovery during and from mass extinctions.
  – Community dynamics take on greater evolutionary roles during extinction and recovery.
<table>
<thead>
<tr>
<th>Period</th>
<th>Beaufort lithostratigraphy east of 24°E</th>
<th>Beaufort biostratigraphy</th>
<th>New Beaufort U-Pb ID-TIMS geochronology</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIASSIC</td>
<td>Burgersdorp Fm.</td>
<td>Cynognathus</td>
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<td></td>
<td>Katberg Fm.</td>
<td>Lystrosaurus</td>
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<td></td>
<td>Palingkloof Mbr.</td>
<td>Dicynodon</td>
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<td>Elandsberg Mbr.</td>
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<td>Barberskrans Mbr.</td>
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<td>Ballouw Fm.</td>
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<td>Daggaboersnek Mbr.</td>
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<tr>
<td></td>
<td>Oudeberg Mbr.</td>
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<tr>
<td>PERMIAN</td>
<td>Middelton Fm.</td>
<td>Tropidostoma</td>
<td>ca. 255.2 Ma</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>256.25 Ma</td>
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<td></td>
<td></td>
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<td>259.26 Ma</td>
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<td>260.41 Ma</td>
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<td>261.24 Ma</td>
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<td></td>
<td>Koonap Fm.</td>
<td>Pristerognathus</td>
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<tr>
<td></td>
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<td>Tapinocephalus</td>
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<tr>
<td></td>
<td></td>
<td>Eodicynodon</td>
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</tr>
</tbody>
</table>

(Rubidge et al., 2013)

(Smith and Botha-Brink, 2014)
Paleocommunity state

- No. of taxa, $N$
- No. of guilds, $G$
- $S(N,G)$
Late Permian, Karoo
Local stability - resilience
Cistecephalus Zone, L. Permian
Resilience, transience and amplification

Stable, non-reactive

Stable, reactive
Resilience, transience and amplification

- Stable, non-reactive
- Stable, reactive

Amplification vs. Time since perturbation

- Amplification
- Stable, non-reactive
- Stable, reactive
Three “experiments”

- General effect of functional structure
- Effect of observed functional structure
- Patterns of extinction and recovery
Effect of functional structure

- amphibia
- aquatic non-tetrapod
- insect
- primary producer
- tetrapod amniote
Functional structure

- Observed communities more reactive on short-term than communities of equal N but lacking functional structure!
Summary

- General:
  - Observed systems more reactive
  - But no effect on resilience or amplification
- Stage 1 & recovery
  - Perturbations amplified
Effect of pattern of functional structure
Extinction Stage 2

Extinction Stage 1
Summary

- Observed functional structures more stable than expected.
- Community during final stage of extinction was the **most resilient of series**!
  - Community structure highly improbable and stable.
Patterns of extinction and recovery
Resilience, $p = 0.217$
Transience, $p = 0.253$

Resilience, $p = 0.246$
Transience, $p = 1.55 \times 10^{-06}$

EXTINCTION

Stage 1

Stage 2
RECOVERY

Resilience, $p = 0.273$
Transience, $p = 2.45E-005^{***}$
Conclusions

- Emergent community dynamics bias patterns of evolution, extinction and persistence
- Community stability paramount during intervals of mass extinction
  - Patterns of functional extinction maximize stability
  - Patterns of functional recovery maximize stability
- Beware the Invisible Hand for it does not exist. Selection does.