On measuring traits

Helmut Hillebrand
Trait-based approaches promise to overcome the „taxonomy gap“ and to amend „who is there“ by „why are they there“.
A „mechanistic Utopia“

Trait-based approaches promise to overcome the „taxonomy gap“ and to amend „who is there“ by „why are they there“.

Trait-based approaches profit from

- knowing the link between a measured trait and a function (performance)
- being able to repeatable measure these traits across species in a organism group
- ability to reduce the dimensionality of the „community“
  - Using $x_t$ traits instead of a much larger number of $X_s$ species
Three warnings about functional groups

1) Grouping species into functional groups loses and distorts the information

How many groups? Often no objective criterion possible

All empirical examples from Interreg Water Quality project led by NLWKN, work by Josie Antonucci
Three warnings about functional groups

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Boundaries arbitrary

Difference close to boundary exaggerated

Difference within functional groups ignored

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Three warnings about functional groups

1) Grouping species into functional groups loses and distorts the information

2) The number of functional groups increases with each new trait considered: No reduction in complexity

Same trait (edibility) split between immobile (left) and mobile (right) algae and 4 trophic groups (colors)

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Three warnings about functional groups

1) Grouping species into functional groups loses and distorts the information

2) The number of functional groups increases with each new trait considered: No reduction in complexity

3) Groupings occur (almost) always at the species level and across time, which ignores intraspecific variance

All empirical examples from Interreg Water Quality project
Does fuzzy coding help?

- **Yes**
  - Allows more differentiation in binary traits by more discrete categories
  - Allows integrating intraspecific trait variance
  - Allows continuous emerging properties

- **No**
  - Potential subjectivity of code categories
  - Discrete data often do not meet assumptions of statistical procedures

### Explanation of fuzzy codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Taxon has total and exclusive affinity for a certain trait category.</td>
</tr>
<tr>
<td>2</td>
<td>Taxon has a high affinity for a certain trait category, but other categories can occur with equal (2) or lower (1) affinity.</td>
</tr>
<tr>
<td>1</td>
<td>Taxon has a low affinity for a certain trait category.</td>
</tr>
<tr>
<td>0</td>
<td>Taxon has no affinity for a certain trait category.</td>
</tr>
</tbody>
</table>
If you can stick to continuous, do so

- For single traits allows to understand changes at the species and community level
If you can stick to continuous, do so

- For single traits allows to understand changes at the species and community level
- For multiple traits allows describing communities

Trait space of Wadden Sea phytoplankton
Two first PCs show strong impact by binary traits

All empirical examples from Interreg Water Quality project led by NLWKN, work by Josie Antonucci
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- For single traits allows to understand changes at the species and community level
- For multiple traits allows describing communities
- For communities allows quantifying changes in trait space, e.g. hypervolumes

^Blonder 2018; > Truchy et al. in prep., Swedish freshwater macroinvertebrate monitoring
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For multiple traits allows describing communities
For communities allows quantifying changes in trait space, e.g. hypervolumes
Correlations between traits allows i) functional insights and ii) identification of trait dimensions that can be compared between organism groups
Functional trait dimensions of trophic metacommunities

Bauer, Barbara; Kleyer, Michael; Albach, Dirk C.; Blasius, Bernd; Brose, Ulrich; Ferreira-Arruda, Thalita; Feudel, Ulrike; Gerlach, Gabriele; Hof, Christian; Kretz, Holger; Kuczynski, Lucie; Löhmus, Kertu; Moorthi, Stefanie; Scherber, Christoph; Scheu, Stefan; Zott, Gerhard; Hillebrand, Helmut.
Trait dimensions

Regional species pool organized in multiple spatially structured communities

(A) Dispersal & mobility - movement dimension

Biogenic niche construction

(B) Environmental filtering - tolerance dimension

(C) Biotic filtering - interaction dimension

Local communities and interaction networks

X | trait diversity  
Y | trait diversity  
Z | trait diversity

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Barbara Bauer, Michael Kleyer, Dirk C. Albach, Bernd Blasius, Ulrich Brose, Thalita Ferreira-Arruda, Ulrike Feudel, Gabriele Gerlach, Christian Hof, Holger Krefl, Lucie Kuczynski, Kertu Löhmus, Stefanie Moorthi, Christoph Scherber, Stefan Scheu, Gerhard Zotz and Helmut Hillebrand
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Drift & stochastic extinctions

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Conclusion

- Traits are highly important and useful tool to link community composition to environment and functions.
- Their usefulness is highest if used as measured characteristics (as in plant ecology) across a wide range of organisms without grouping.