sPlot – the first global vegetation-plot database to address plant trait-environment relationships across the world's biomes

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Synthesis Centre (sDiv) of iDiv
sPlot

- The global vegetation-plot and trait database of the sDiv Working Group on “Global Plant Trait-Environment Relationships”.

- Hosted by the Synthesis Centre (sDiv) of the German Centre of Integrative Biodiversity Research Halle-Jena-Leipzig (iDiv).

- The sPlot database will combine (1) vegetation-plot data, (2) plant trait data and (3) a taxonomic backbone.
Aim: the analysis of plant trait-environment relationships across the world's biomes on the basis of vegetation-plot data.
Motivation

- Macroclimate is a major predictor for trait values, but the interaction of local and global drivers is still poorly known

(i) To which extent are relationships between traits preserved across environmental gradients worldwide, irrespective of macroclimate?
(ii) To which degree is the effect of local abiotic drivers mediated by climate?

So far, there is
- no good global coverage of multiple traits (apart from LES)
- no global vegetation-plot database
- no availability of fine-scale environmental factors
The sPlot consortium

Team of experts worldwide representing:
➢ Theory
➢ Vegetation plot/trait databases
➢ Data analysis and synthesis

sPlot Consortium members (as of 31 January 2014):

Leaf economics spectrum

• Leaves with low long leaf life span (LL) and high leaf mass per area (LMA) versus

Leaves with high photosynthetic capacity per leaf mass (Amax), high dark respiration rates (Rdark), high leaf nitrogen contents (N) and high phosphorus contents (P)

Fig. 1 from Osnas et al. 2013, Science 340: 741-744.
Trait values as a function of macroclimate

- Latitudinal gradient in SLA ($\log_{10}$ transformed)
- Based on species occurrence data on 1° grid cells.

Fig. 1 from Swenson et al. 2012, Global Ecol. Biogeogr. 21: 798-808.
### Trait-environment relationships at the scale of North America

- Strong trait-environment relationships across biomes

<table>
<thead>
<tr>
<th>Trait</th>
<th>Lat</th>
<th>Alt</th>
<th>MAT</th>
<th>TS</th>
<th>TR</th>
<th>AP</th>
<th>PS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum height</td>
<td>0.25</td>
<td>-0.05</td>
<td>-0.10</td>
<td>0.15</td>
<td>0.16</td>
<td>0.16</td>
<td>-0.25</td>
</tr>
<tr>
<td>Leaf %N</td>
<td>-0.01</td>
<td>0.18</td>
<td>0.23</td>
<td>-0.04</td>
<td>-0.05</td>
<td>0.14</td>
<td>0.23</td>
</tr>
<tr>
<td>Leaf %P</td>
<td>0.62</td>
<td>0.07</td>
<td>-0.54</td>
<td>0.65</td>
<td>0.62</td>
<td>-0.42</td>
<td>0.30</td>
</tr>
<tr>
<td>Seed mass</td>
<td>-0.26</td>
<td>-0.20</td>
<td>0.47</td>
<td>-0.43</td>
<td>-0.44</td>
<td>0.50</td>
<td>0.01</td>
</tr>
<tr>
<td>Specific leaf area</td>
<td>-0.48</td>
<td>-0.19</td>
<td>0.33</td>
<td>-0.40</td>
<td>-0.36</td>
<td>0.44</td>
<td>0.07</td>
</tr>
<tr>
<td>Wood density</td>
<td>-0.61</td>
<td>-0.24</td>
<td>0.62</td>
<td>-0.54</td>
<td>-0.51</td>
<td>0.23</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Lat, absolute value of latitude; Alt, altitude; MAT, mean annual temperature; TS, temperature seasonality (standard deviation of 12 mean monthly temperatures); TR, annual temperature range (maximum – minimum annual temperatures); AP, total annual precipitation; PS, precipitation seasonality (coefficient of variation of 12 monthly rainfall totals). Bold values indicate significant correlations ($P < 0.05$).

Table 1 from Swenson et al. 2012, Global Ecol. Biogeogr. 21: 798-808.
Why do we need community data?

- Traits are filtered by the environment, but do not exclusively determine the trait values at a certain site.
- Within-site variation of trait values is caused by:
  - Limiting similarity within communities
  - Different species composition in different local environments
  - Trait relationships might vary differently with macroclimate in different communities

-> Community data have to be included
Species trait values versus community mean trait values

- Species traits value plotted against (unweighted) mean site variables

Or

- Community mean trait values plotted against (weighted or unweighted) site variables

Fig. 4B, D from Ackerly et al. 2002, Oecologia 130: 449-457.
Community weighted means (CWM) in large databases

- German Vegetation Reference Database (GVRD), all plots with pH and geographic information (MAT and MAP)
- Grasslands and forests
- n = 6632 plots, 1787 species
- SLA for 1277 species

| Estimate | Pr(>|t|) |
|----------|---------|
| Intercept| 32.3270 | < 2e-16 |
| MAT      | -1.2659 | 1.69E-05 |
| MAP      | -0.0155 | 3.28E-09 |
| MAT x MAP| 0.0024  | 2.06E-13 |
SLA $\sim$ pH

- German Vegetation Reference Database (GVRD), all plots with pH
- Grasslands and forests
- $n = 6636$ plots, 1787 species
- SLA for 1277 species

$y = 21.488 - 0.106 \times x, \ p = 0.000741$
German Vegetation Reference Database (GVRD), all plots with pH and geographic information

- Grasslands and forests
- n = 6632 plots, 1787 species
- SLA for 1277 species

\[ \text{SLA} \sim \text{MAP} \times \text{pH} \]

| Estimate | Pr(>|t|) |
|----------|----------|
| Intercept| 19.2205  | < 2e-16  |
| MAP      | 0.0066   | 8.67E-04 |
| pH       | 0.9489   | 1.59E-04 |
| MAP x pH | -0.0011  | 9.41E-04 |
Account for formation

- German Vegetation Reference Database (GVRD), all plots with geographical information
- Only Grasslands
- $n = 2776$ plots, 1285 species
- SLA for 914 species
Account for formation

- German Vegetation Reference Database (GVRD), **all plots with geographical information**
- **Only Forests**
- n = 3210 plots, 1013 species
- SLA for 725 species

![Graph showing relationship between Community Weighted Mean SLA and pH](image)
• Expand to Remote sensing and ecosystem functions
The sPlot Rules

4.a Data can be contributed to sPlot only upon invitation by the Steering Committee. The owner of this database becomes a member of the sPlot Consortium.

4.d Trait data will technically be handled through the TRY initiative. All trait data submitted to sPlot will be transferred to TRY. Persons who contribute trait data via TRY and agree on the sPlot Rules have the same rights as all other sPlot Consortium members.

4.e All data contributed to the sPlot database remain intellectual property of data contributors and may be withdrawn at any time.

5.a. The sPlot database can only be used by sPlot Consortium members for specific research projects focusing on global- or at least continental-scale analyses.

5.c. Each member of the sPlot Consortium has the right to propose analytical or other papers using sPlot data.

6.a The sPlot Steering Committee will send the approved paper proposal to all members of the sPlot Consortium and inform them which amount of data of which contributors is supposed to be used in the respective analyses. The members of the sPlot Consortium can then declare their willingness to join the paper project as active co-authors during a period of one month (opt-in papers).
Vegetation-plot databases in sPlot

• Invitation to large & representative databases started on 5 August 2013

• 30 Databases have already agreed to join sPlot (~ 1.25 million rel.):
  - *European Vegetation Archive (EVA)*
    combined database of 20+ European countries: c. 750,000 rel.
  - *Botanical Information and Ecology Network (BIEN 3)*
    for the Americas: c. 350,000 rel.
  - National Vegetation Database of South Africa: c. 47,000 rel.
  - Vegetation Database of Québec: c. 28,000 rel.
  - Database of Siberian Vegetation: c. 31,000 rel.
  - West African Vegetation Database: c. 12,000 rel.
  - Vegetation Database of North Asia: c. 9,000 rel.
  [...]

• 35 further databases have been invited: c. 300,000 rel.

• Further recommendations of plot databases are welcome, particularly from Latin America, South and Southeast Asia, Australia as well as any plots from tropical and subtropical forests with records of the herb layer
Concept of data integration in sPlot

Europe
- National DB 1
- National DB 2
- National DB 3

Contributing DB 1
- Contributing DB 2
- Contributing DB 3

N and S America
- National DB 1
- National DB 2
- National DB 3

Contributing DB 1
- Contributing DB 2
- Contributing DB 3

Other continents
- DB A
- DB B

Additional supranational databases in preparation that could serve as sPlot partners:
- Arctic Vegetation Archive (AVA)
- African Vegetation Information Platform (AVIP)
Timeline

6-9 March ‘13  1st sPlot Workshop in Leipzig (with 42 participants)

since 15 June ‘13  J. Dengler employed as coordinator (25% position)

12 July ‘13  Governance and Data Property Rules approved

July ‘13  Invitation of contributing databases started

Aug-Nov  Basic database structure agreed; Biodiversity Informatics Unit at FSU Jena involved with programming

since Dec. ‘13  Decision to implement sPlot under Turboveg 3; collaboration with Stephan Hennekens

Presently  First extra-European databases are prepared for joining them with EVA under Turboveg 3

Summer ’14  First global plot dataset available for joining with trait data from TRY for preliminary analyses

Autumn ’14  2nd sPlot Workshop planned for Leipzig

Data paper to be published; analytical papers to be started
http://www.idiv-biodiversity.de/sdiv/workshops/workshops-2013/splot

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TRY
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