German Centre for
Integrative Biodiversity Research (iDiv)
Halle-Jena-Leipzig

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

iDiv is a research centre of the DFG Deutsche Forschungsgemeinschaft

idiv-biodiversity.de

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):

I. Aubin, T. Becker, G. Bönisch, B. Boyle, A. Breen, H. Bruelheide, A. Carni, M. Chytrý, J. Csiky, F. de Bello, J. Dengler, S. Díaz, B. Enquist, N. Ermakov, R. Field, M. Finckh, J. Gaikwad, E. Garnier, V. Golub, A. Gutierrez, S. Haider, S. Hennekens, J.-M. Hero, T. Hickler, S. Higgings, J. Homeier, U. Jandt, F. Jansen, B. Jimenez-Alfaro, N. Jürgens, J. Kattge, E. Kearsley, M. Kleyer, S. Klotz, B. König-Ries, A. Korolyuk, I. Kühn, J. Lenoir, J. Leps, C.-F. Li, Y. Lin, G. Lopez-Gonzalez, M. Mahecha, M. Major, V. Minden, A. Moles, G. Muche, L. Mucina, R.K. Peet, V. De Patta Pillar, J. Pinto-Zárate, M. Polyakova, P. Poschlod, O. Purschke, J. Rangel-Churio, C. Römermann, M. Rutherford, B. Sandel, J. Schaminée, S. Scheiter, M. Schmidt, F. Schrodt, J. Shuker, J. Sibik, U. Silc, A. Sorokin, Suzuki, K., N. Swenson, O. Tackenberg, P. van Bodegom, C. Violle, D.A. Walker, C. Webb, E. Welk, T. Wentworth, M. Winter, C. Wirth, G. Zizka

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)

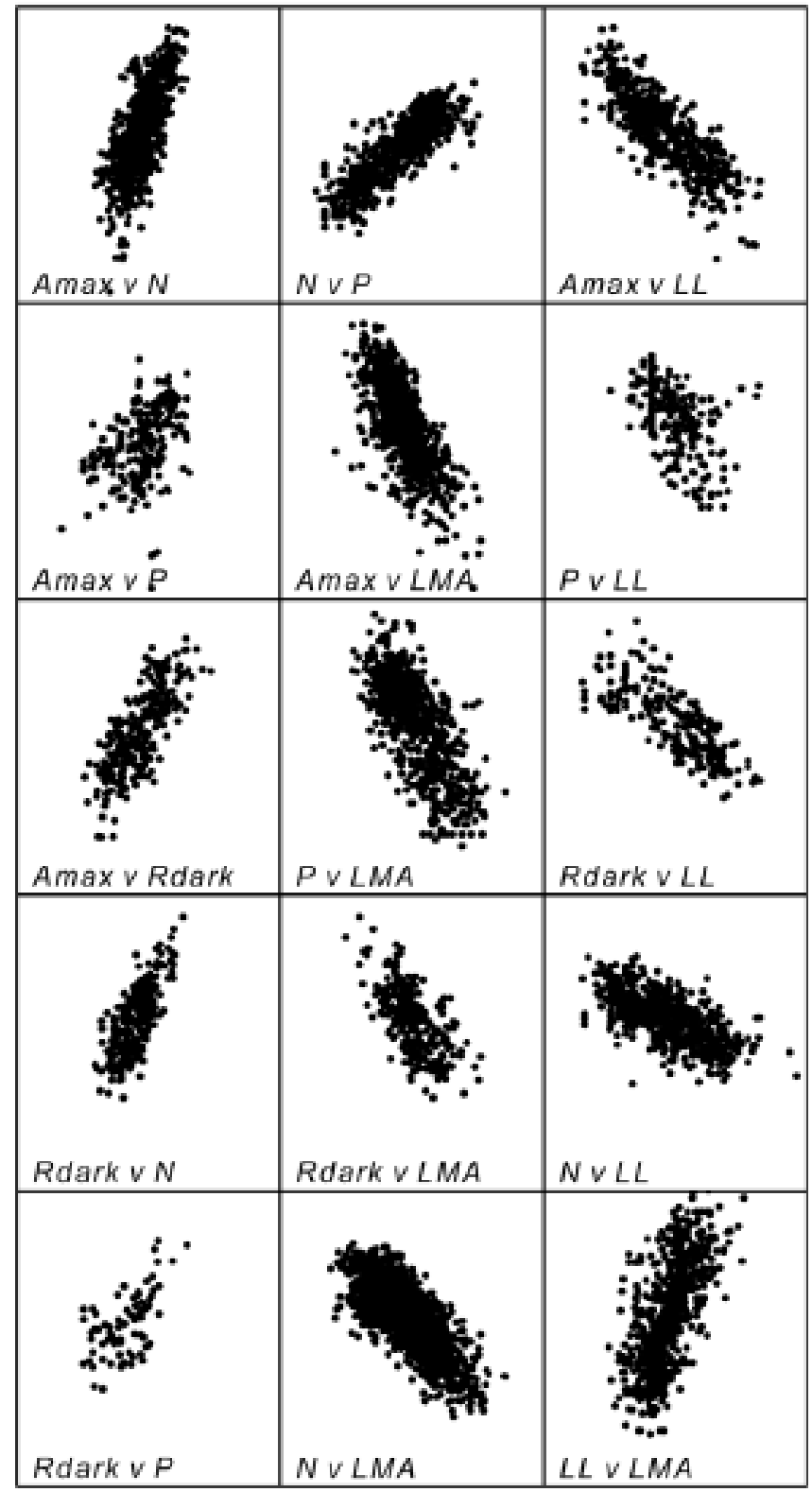


Fig. 1 from Osnas et al. 2013, Science 340: 741-744.

Trait values as a function of macroclimate

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

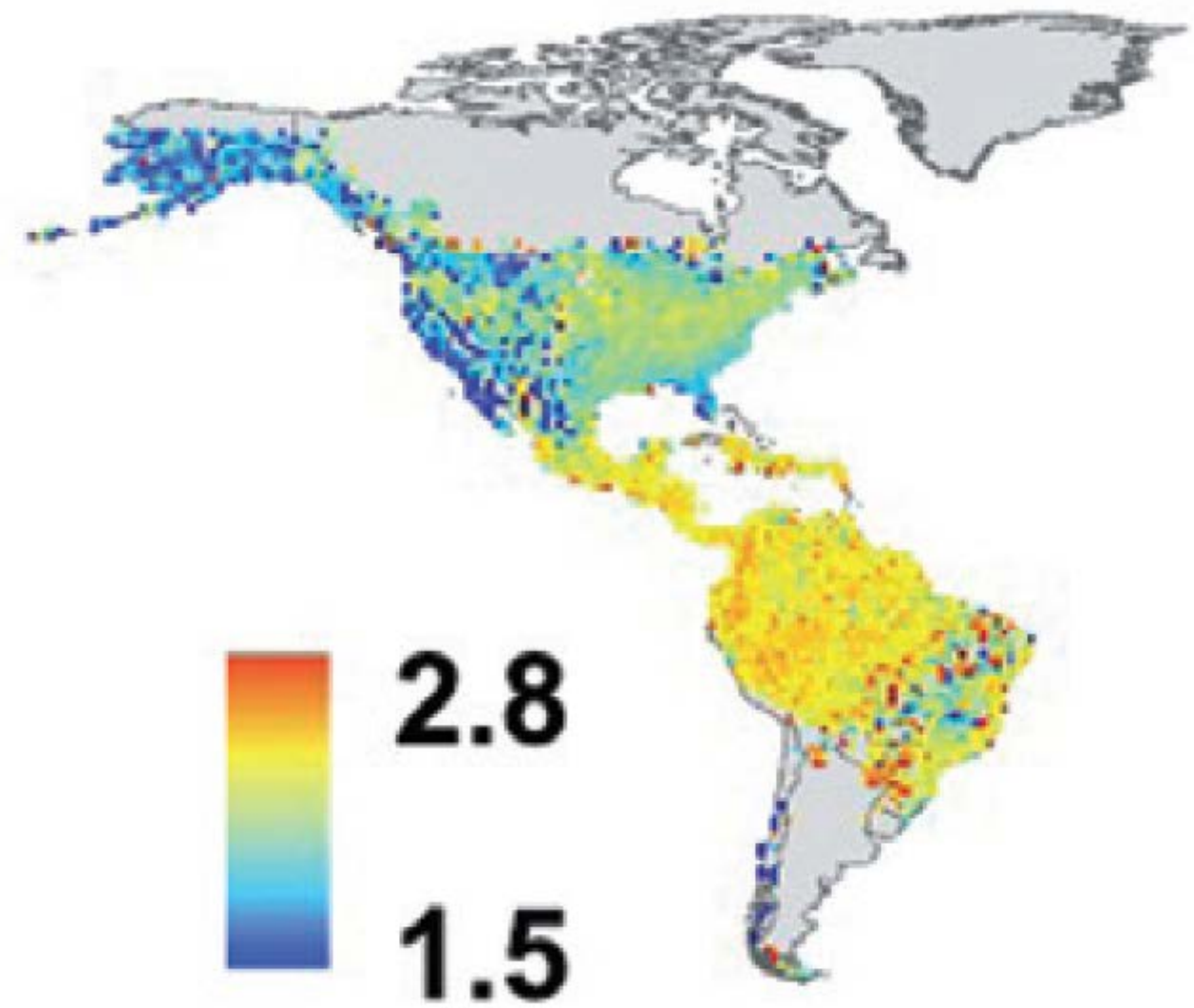


Fig. 1 from Swenson et al. 2012, Global Ecol. Biogeogr. 21: 798-808.

Trait-environment relationships at the scale of North America

- Strong trait-environment relationships across biomes

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

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.

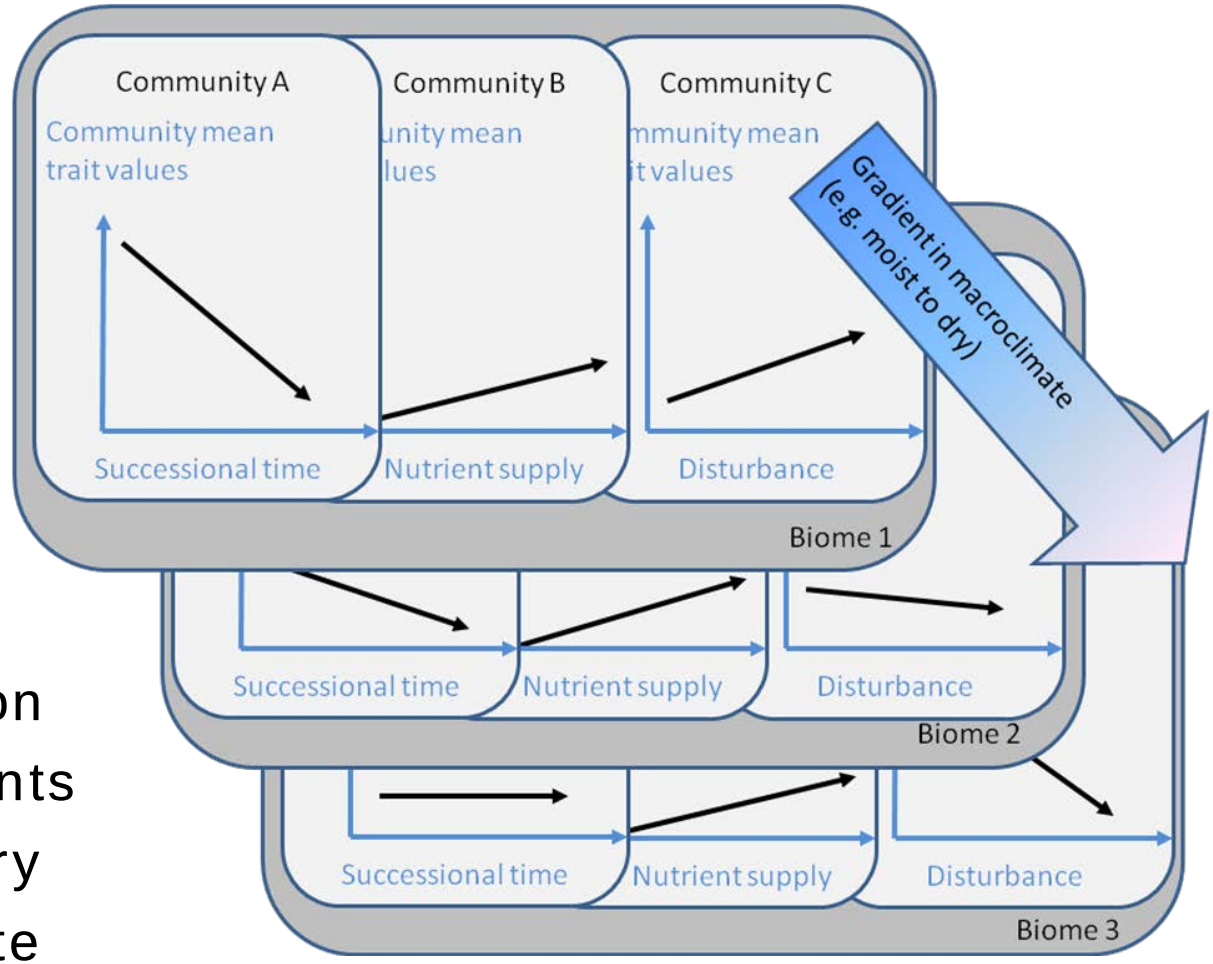
Why do we need community data?

- 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

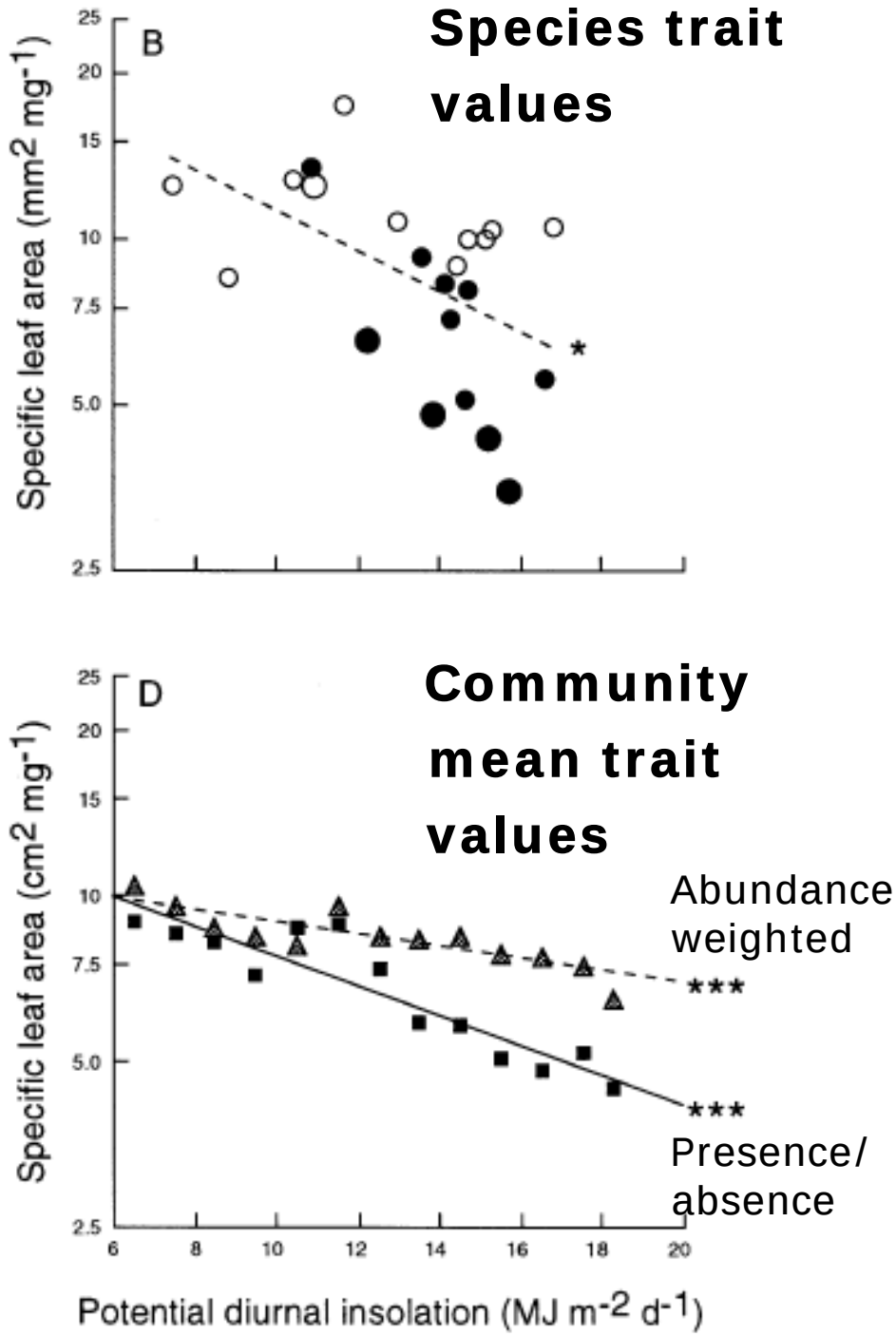
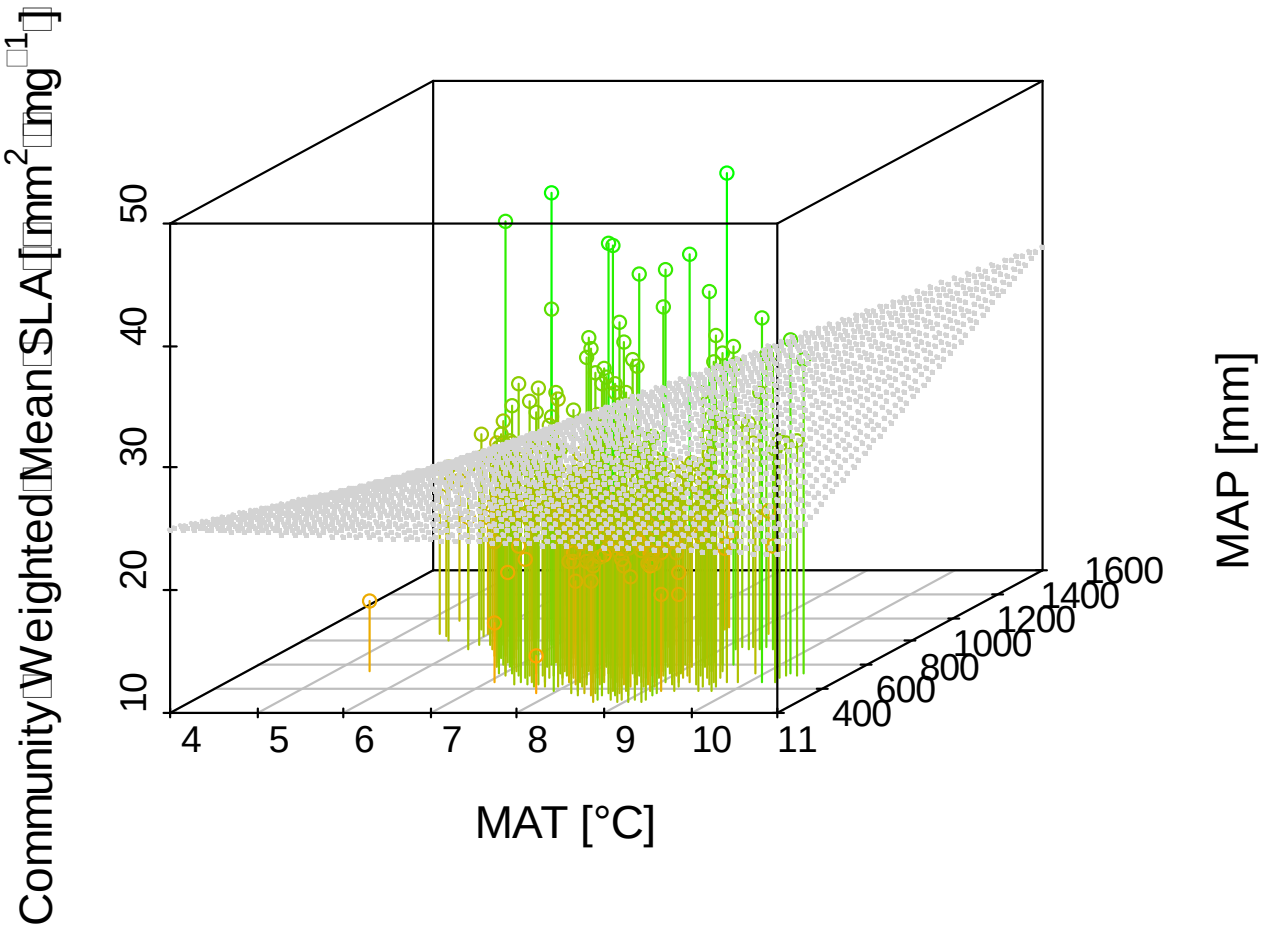


Fig. 4B, D from Ackerly et al. 2002, Oecologia 130: 449-457.

Community weighted means (CWM) in large databases

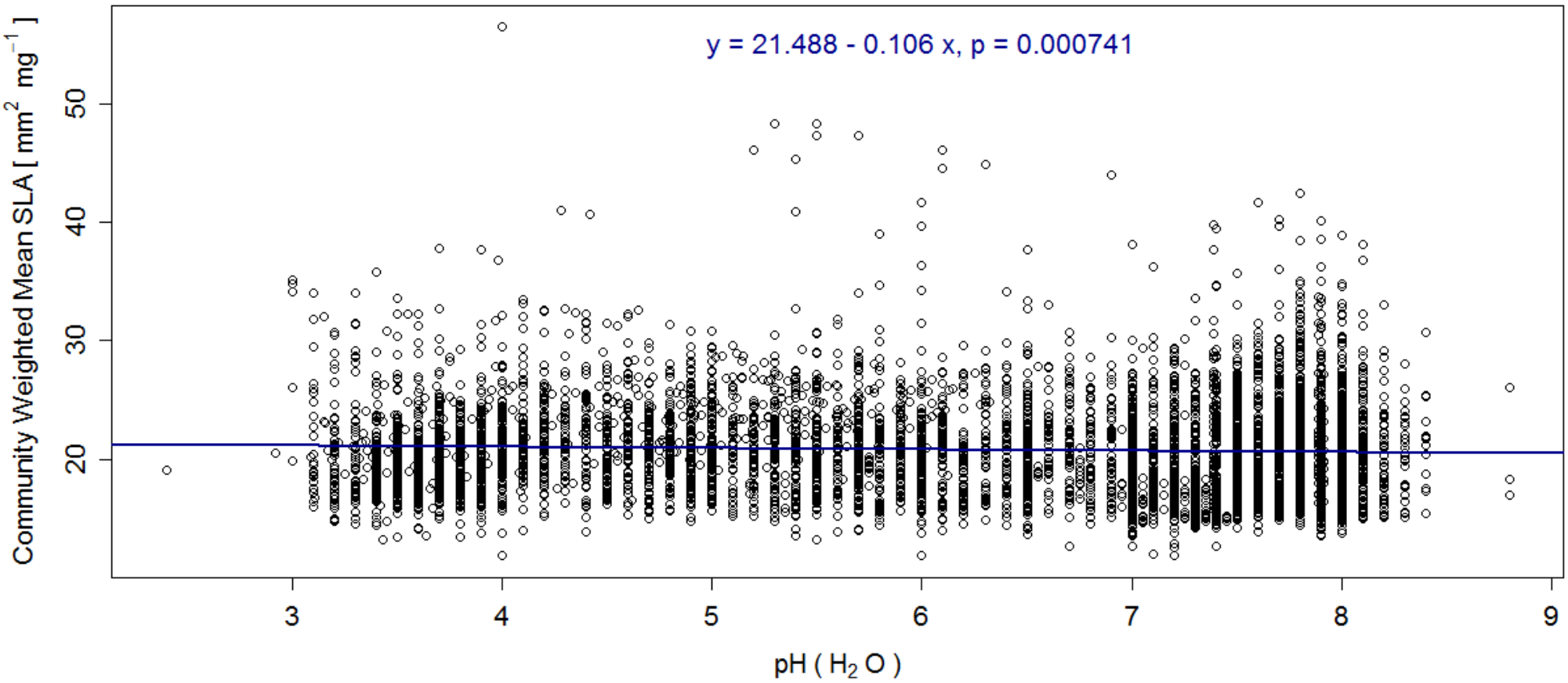
- German Vegetation Reference Database (GVRD), **all plots with pH and geographic information (MAT and MAP)**
- Grasslands and forests
- n = 6632 plots, 1787 species
- SLA for 1277 species



	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**

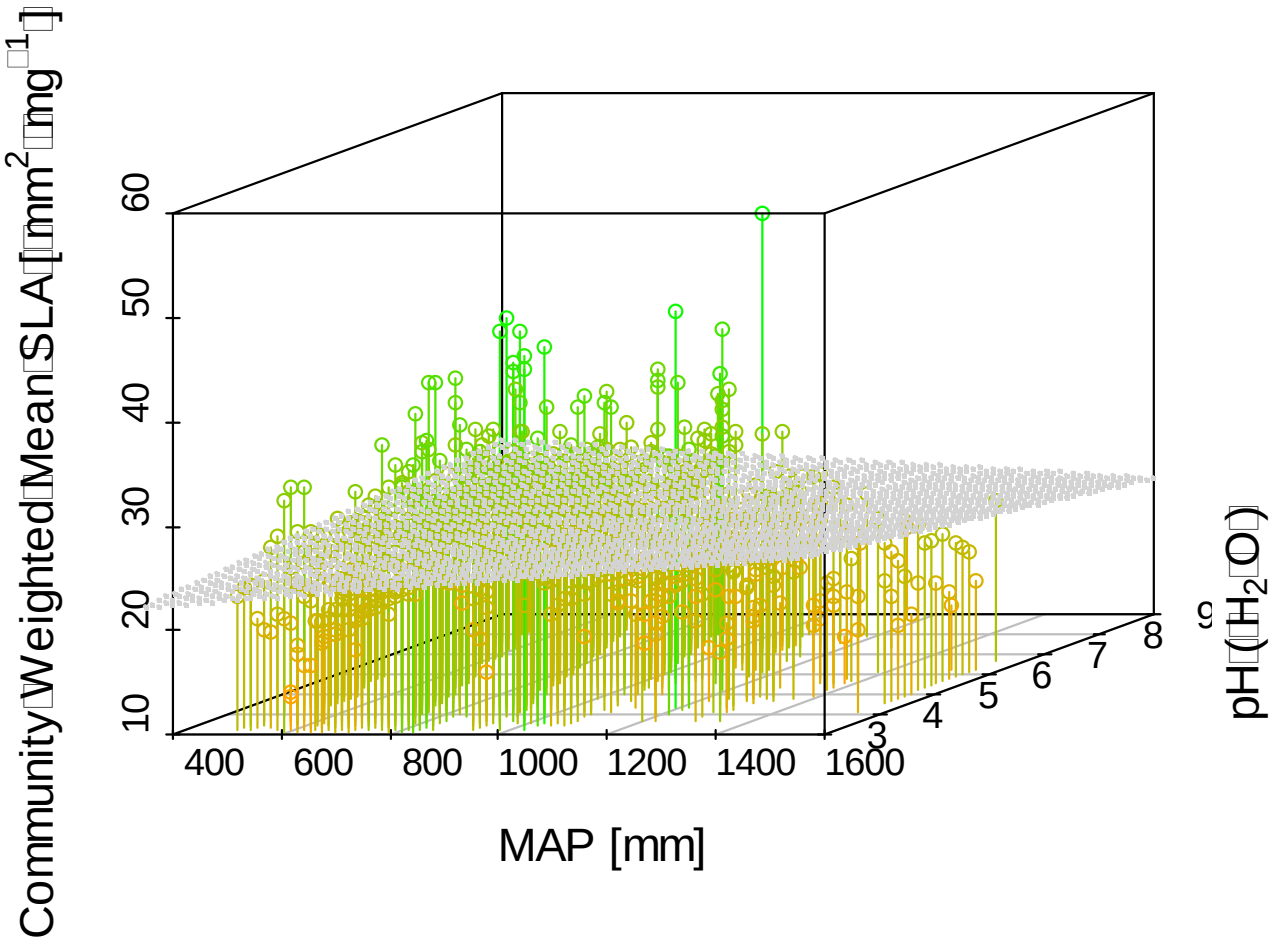
SLA ~ pH

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



SLA ~ MAP * pH

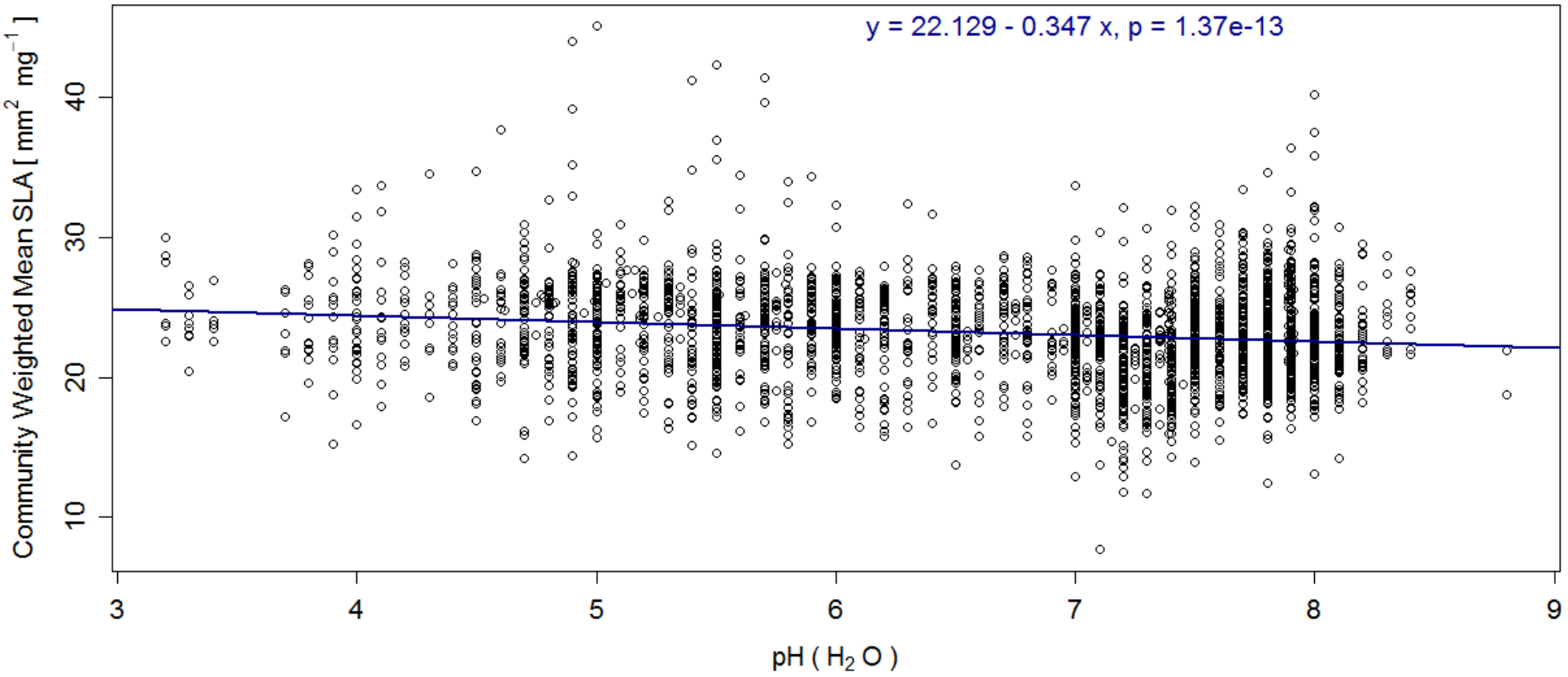
- German Vegetation Reference Database (GVRD), **all plots with pH and geographic information**
- Grasslands and forests
- n = 6632 plots, 1787 species
- SLA for 1277 species



	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**

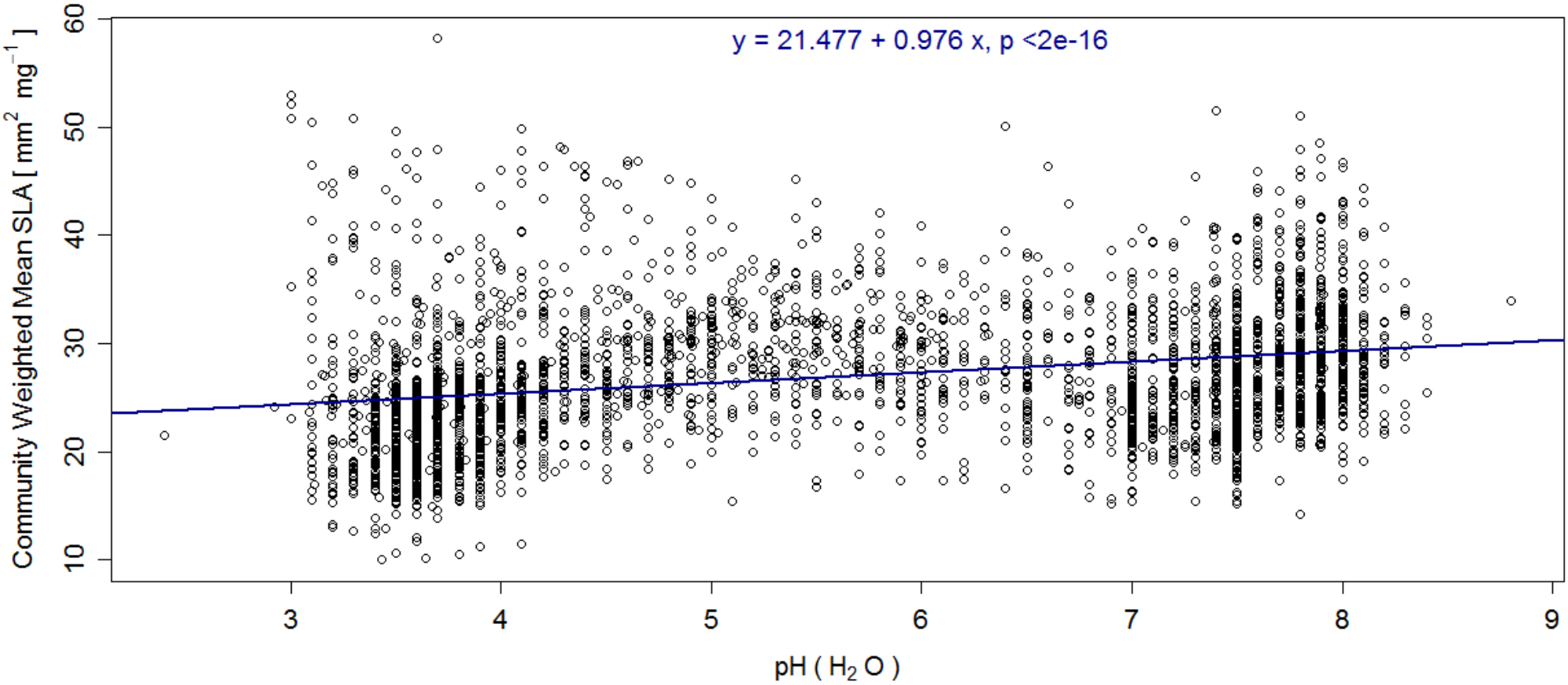
Account for formation

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



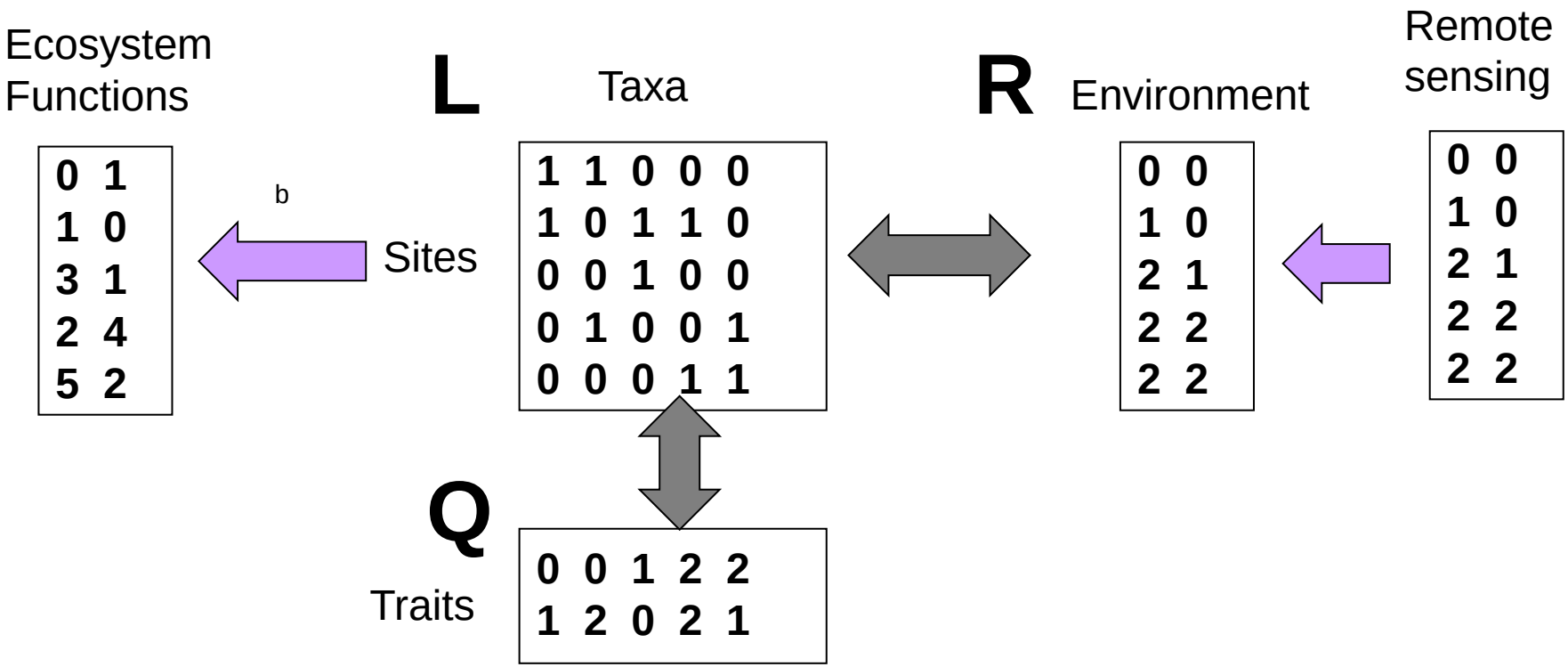
Account for formation

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



Outlook

- 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.

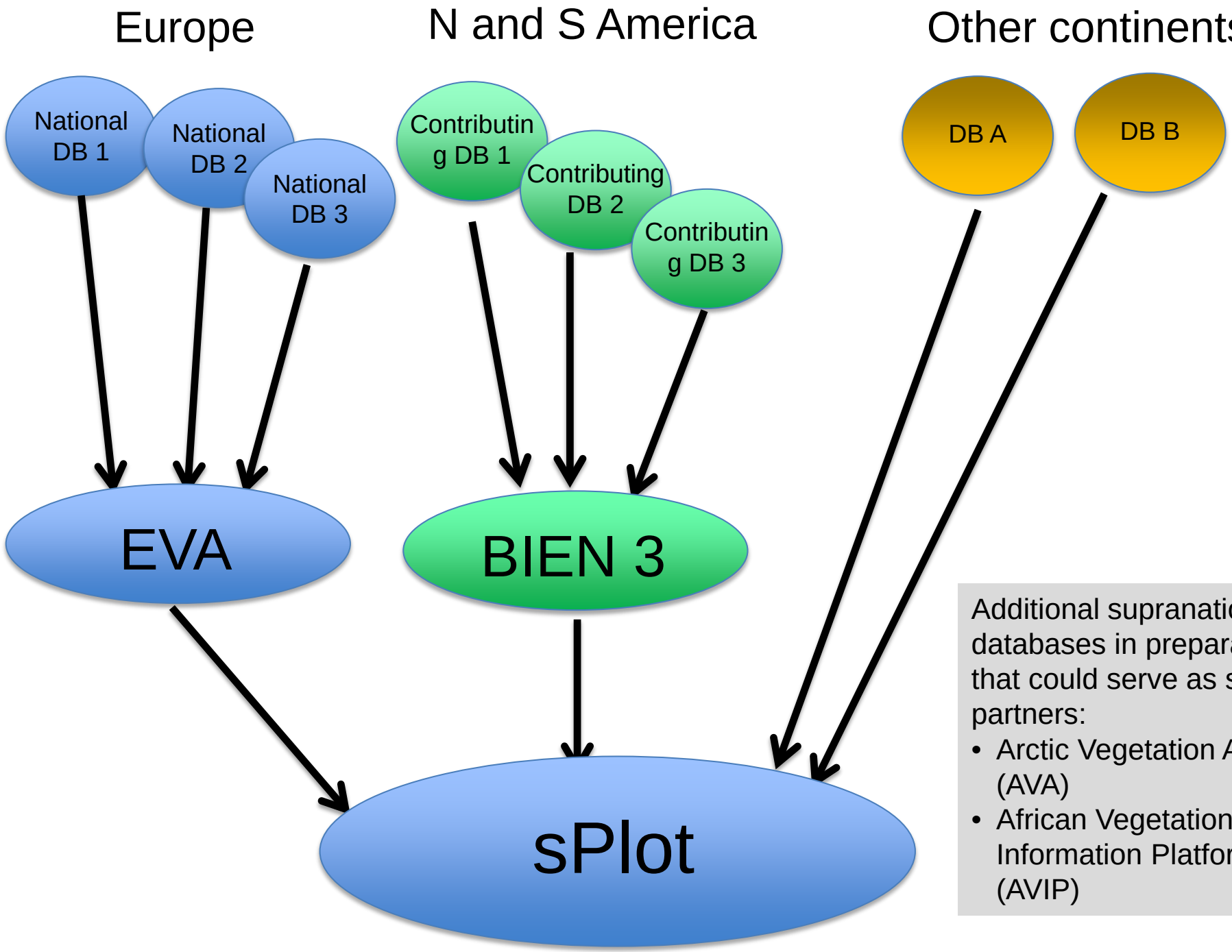
6.a The sPlot Steering Committee will send the approved paper proposal to all members of the sPlot Consortium and inform them which amount of data of which contributors is supposed to be used in the respective analyses. The members of the sPlot Consortium can then declare their willingness to join the 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



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	Invitiation 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

Acknowledgements

TRY

DFG

sDiv crew