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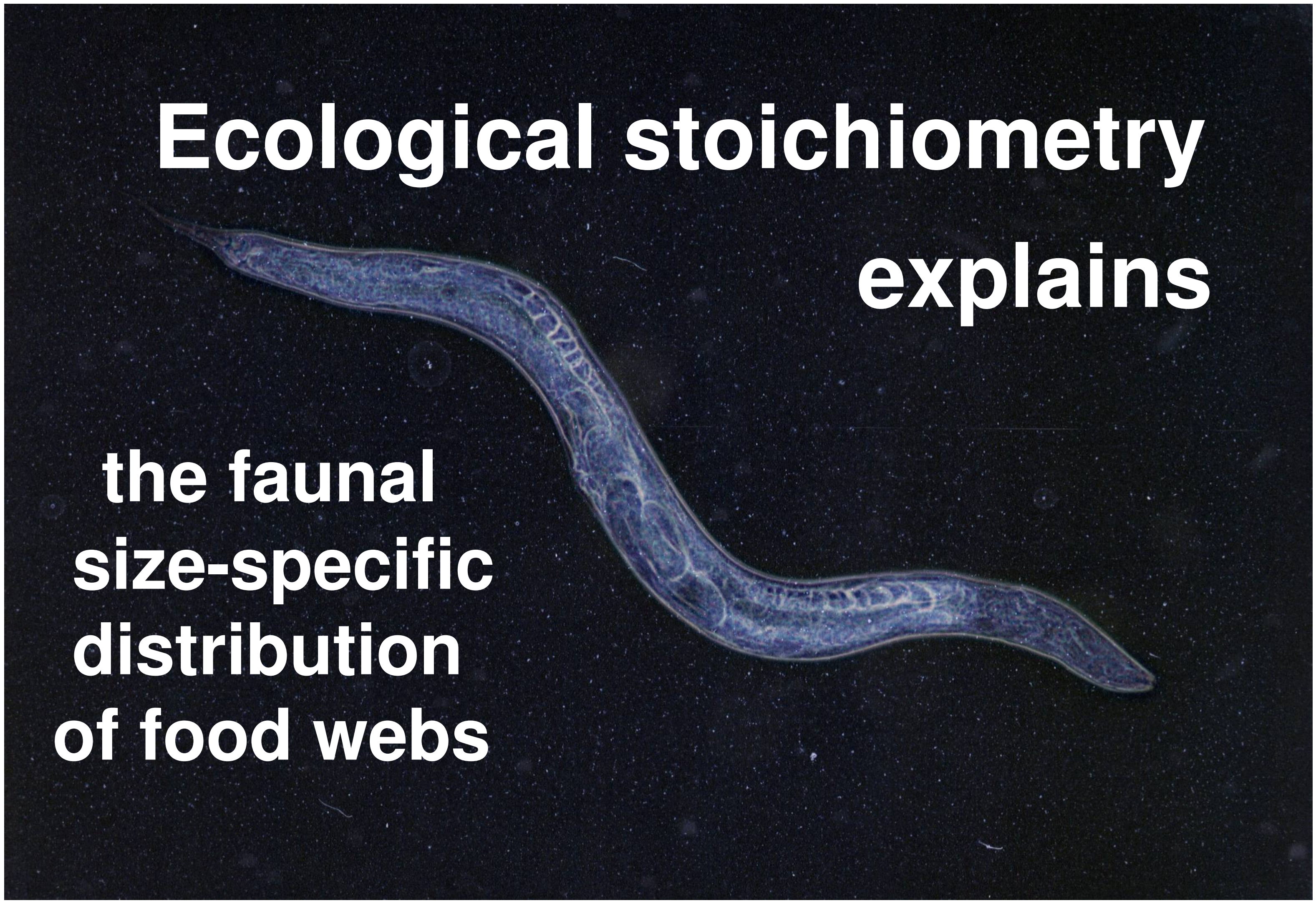
Ecological stoichiometry explains

the faunal size-specific distribution of food webs



Biological Indicator for Soil Quality (1999-2008)

BISQ is based on

A broad definition of biodiversity: all biota, ecosystems and functions (1994 ratification by Dutch Government and 1998 granted to RIVM)

BISQ aims to

Develop quality standards for soil organisms outside nature area's to protect ecological function and services of the soil

Our assessment relies upon

Soil food web models (RIVM)

Cross section through ecosystems (RIVM + U-Nijmegen)

500 locations in The Netherlands (RIVM + Wageningen-UR)

Collecting data on size, mass and abundance is expensive …

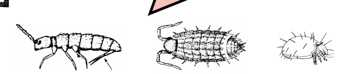
Nr	Taxon	M/V/J[1]	Kop[2]	lengte	breedte
1	Eucephalobus oxyuroides	♀		559,44	22,72
2	Aphelenchoides	j		468,72	11,34
3	Eucephalobus oxyuroides	♀		594,72	25,2
4	Panagrolaimus	j		380,52	15,12
5	Plectus	j		458,64	12,64
6	Aphelenchoides	j		660,24	13,86
7	Tylenchidae	j		403,2	10,08
8	Eucephalobus	j		254,52	12,6
9	Plectus	j		1504,44	25,92
10	Pratylenchus penetrans	♀		509,04	12,64
11	Aglenchus agricola	♂		544,32	15,12
12	Aglenchus agricola	♀		551,88	20,16
13	Tylenchidae	j		493,92	12,6
14	Helicotylenchus pseudorobustus	♀		693,0	25,2
15	Paratylenchus	j		216,72	11,34
16	Tylenchidae	j		315,0	12,6
17	Tylenchidae	j		554,4	12,64
18	Eucephalobus	j		428,4	20,16
19	Rhabditidae	j		408,24	20,16
20	Aphelenchoides	j		315,24	12,6
21	Malenchus andrassyi	♀		302,4	15,12
22	Cephalobidae	j		332,64	15,12
23	Acrobeloides	j	B	342,72	18,9
24	Aglenchus agricola	♀		594,72	22,68
25	Dolichodoridae	j		320,04	15,12

[1]) M=mannetje, V=vrouwtje, J=juveniel.

Ingevoerd door :

Taxocenes	EURO
Bacteria	2230
Fungi	1033
Nematoda	269
Arthropoda	1438
Oligochaeta	1540
Abiotics	1693

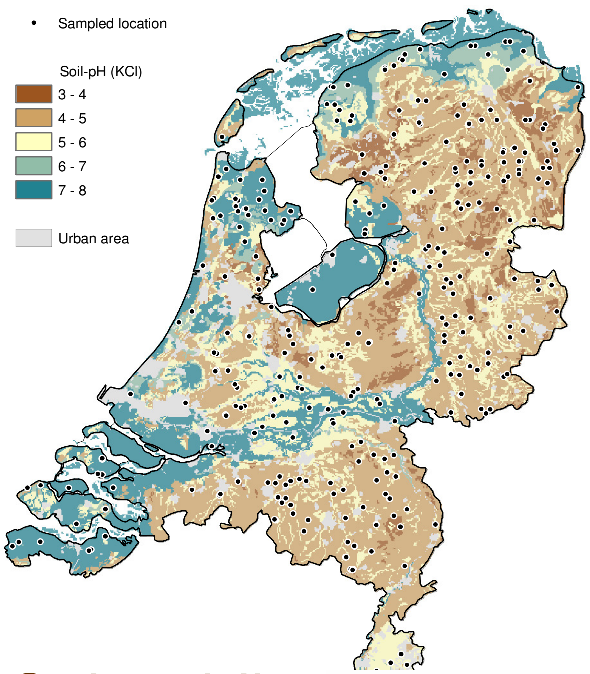
For each (sub)sample!



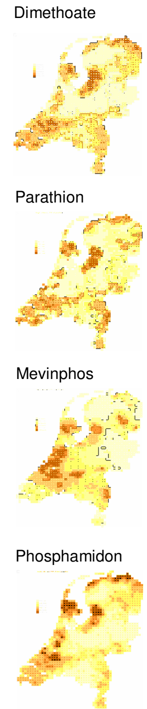
8200 EURO

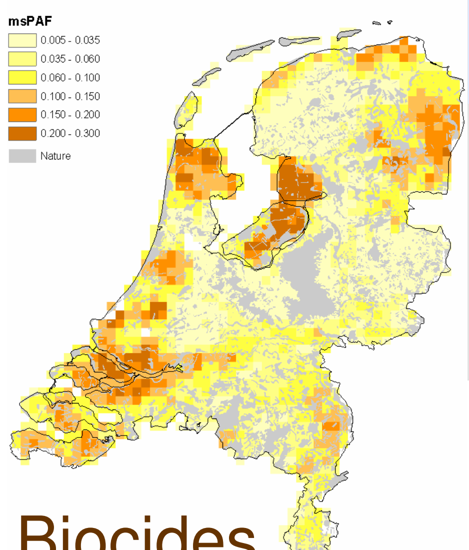
= **6670 GBP** =

10,000 USD

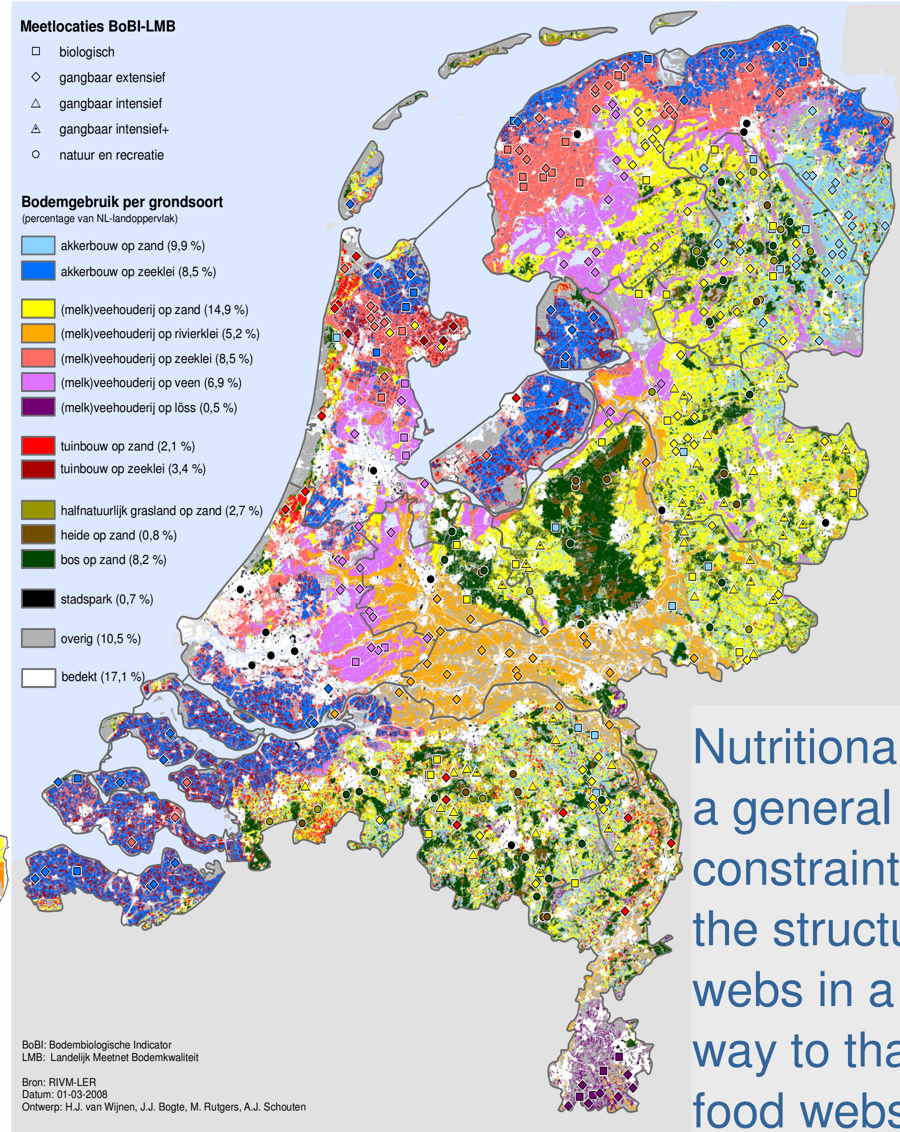


Soil acidity





Biocides



Nutritional quality acts as a general stoichiometric constraint on variation in the structure of soil food webs in a comparable way to that of aquatic food webs. How does such a trend hold for entirely different biota?

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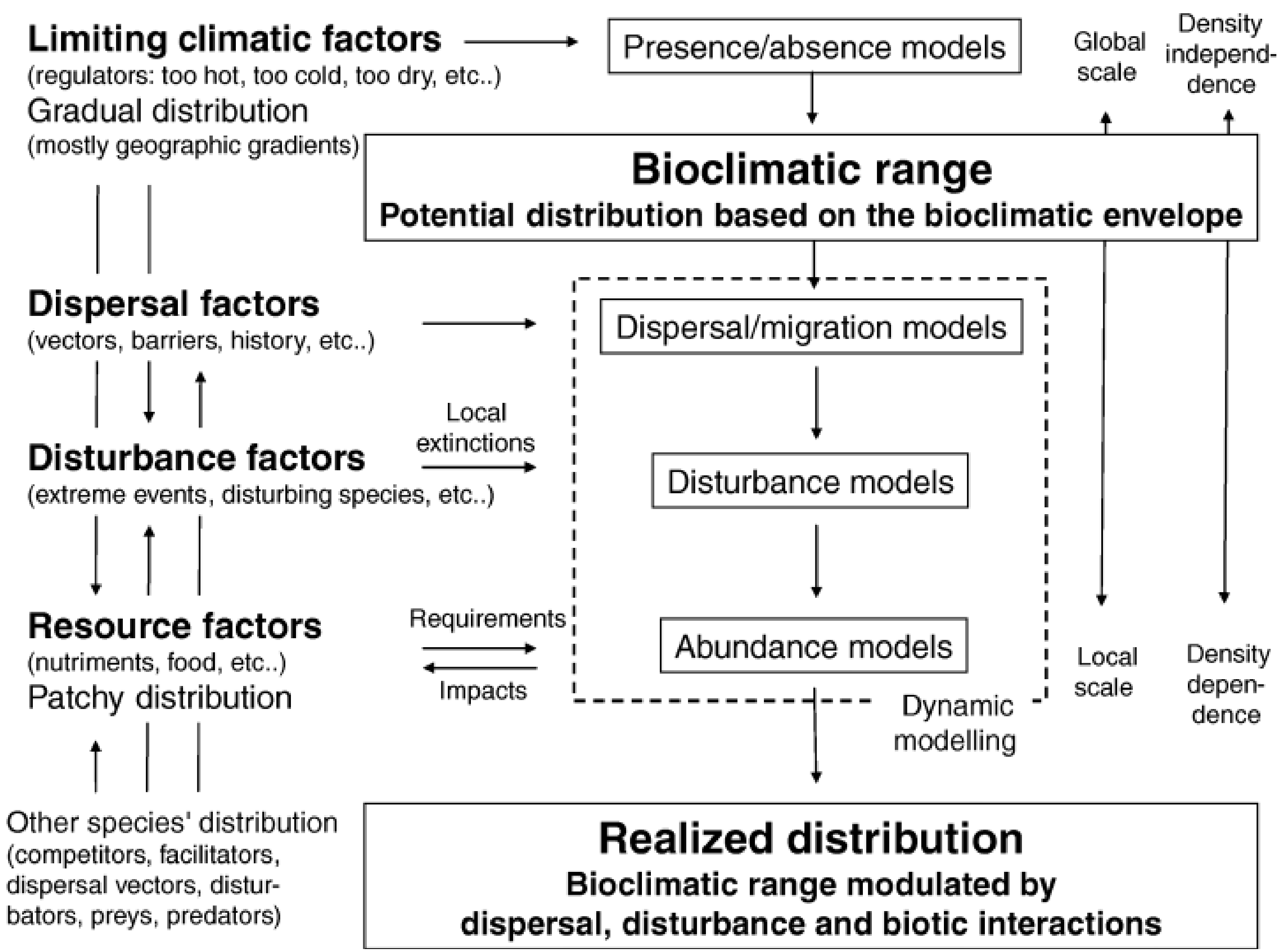
Guisan and Thuiller, *Ecology Letters* 8: 993–1009 (2005)



Any above— or belowground ecosystem type is

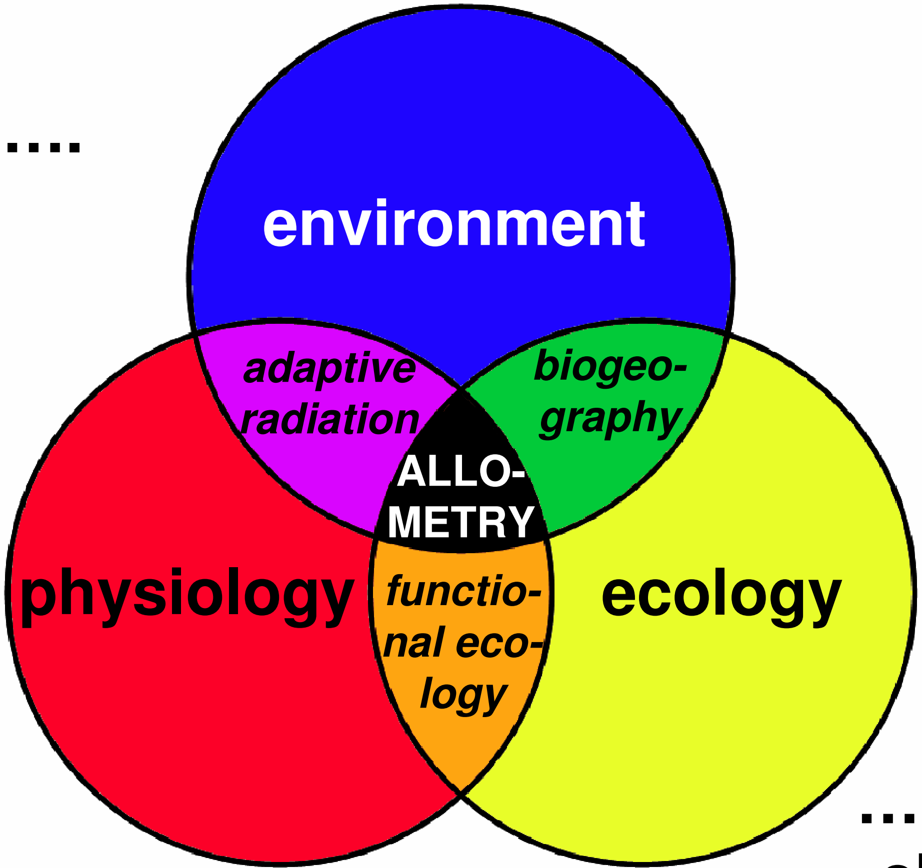
function of (g, c, d, f, a, e)

where: g = geo-position (geography, geology, geomorphology, ground- and topsoil, including paleogeography, land-use history, and soil development), c = climate (regional and local), d = disturbance regimes, f = taxa of the region, a = access potential of taxa, and e = ecological properties of species. The formula is relatively independent of scale; that is, it can be applied either at the biome level or at the community level. The first three factors (g, c, d) define the environment, and the second three (f, a, e) the flora (fauna, *red.*) and the vegetation in the narrower sense.

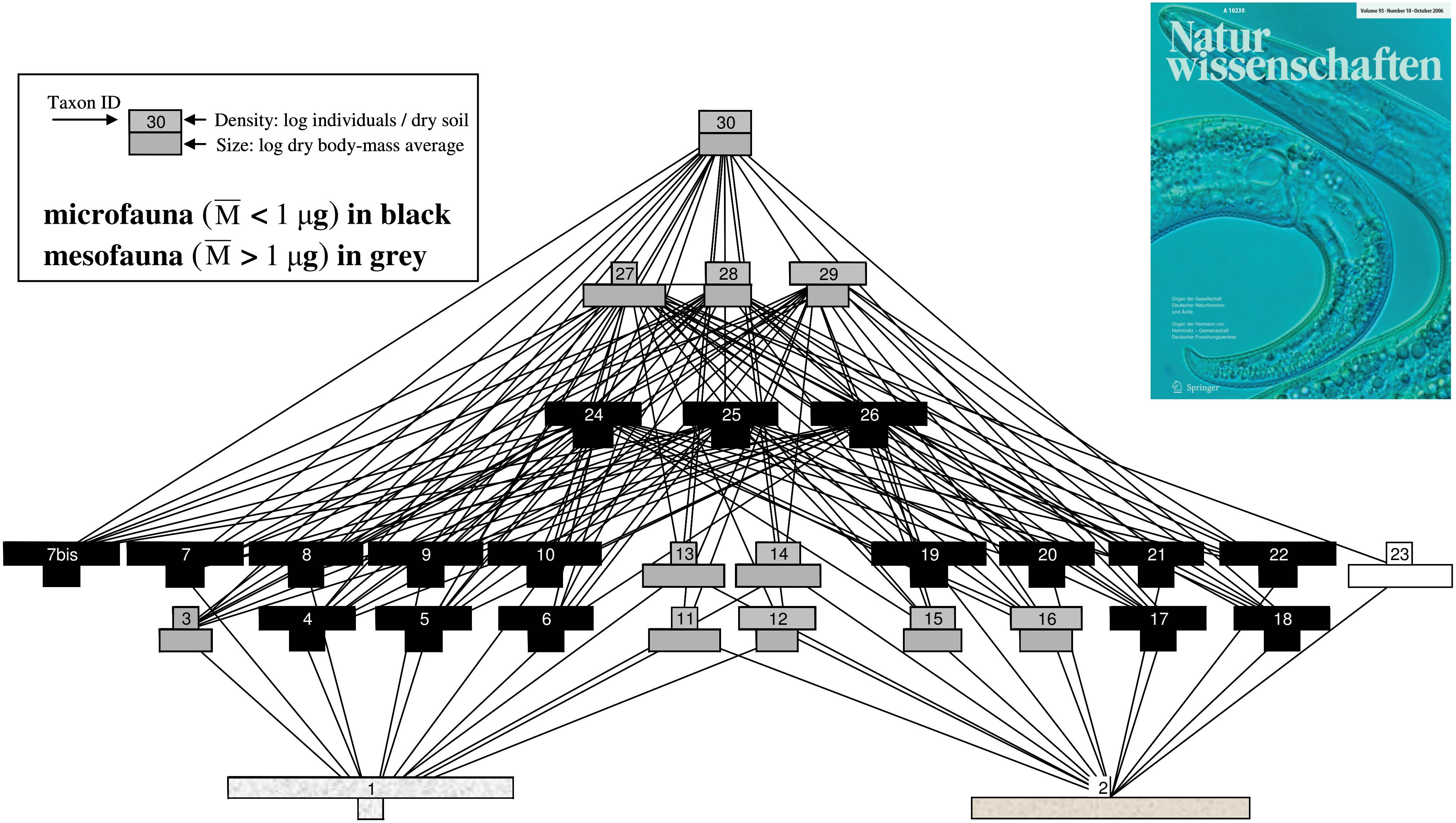
Mueller-Dombois, *Naturwissenschaften* 86: 253–261 (1999)

One debate on whether metabolic rate scales as $M^{3/4}$ or $M^{2/3}$ is going on. Although quarter-power scaling is pervasive and seems almost universal, exponents clearly CHANGE according to taxonomy and to the range of *M*. If so, does the allometric scaling provide a tool to characterize food webs?

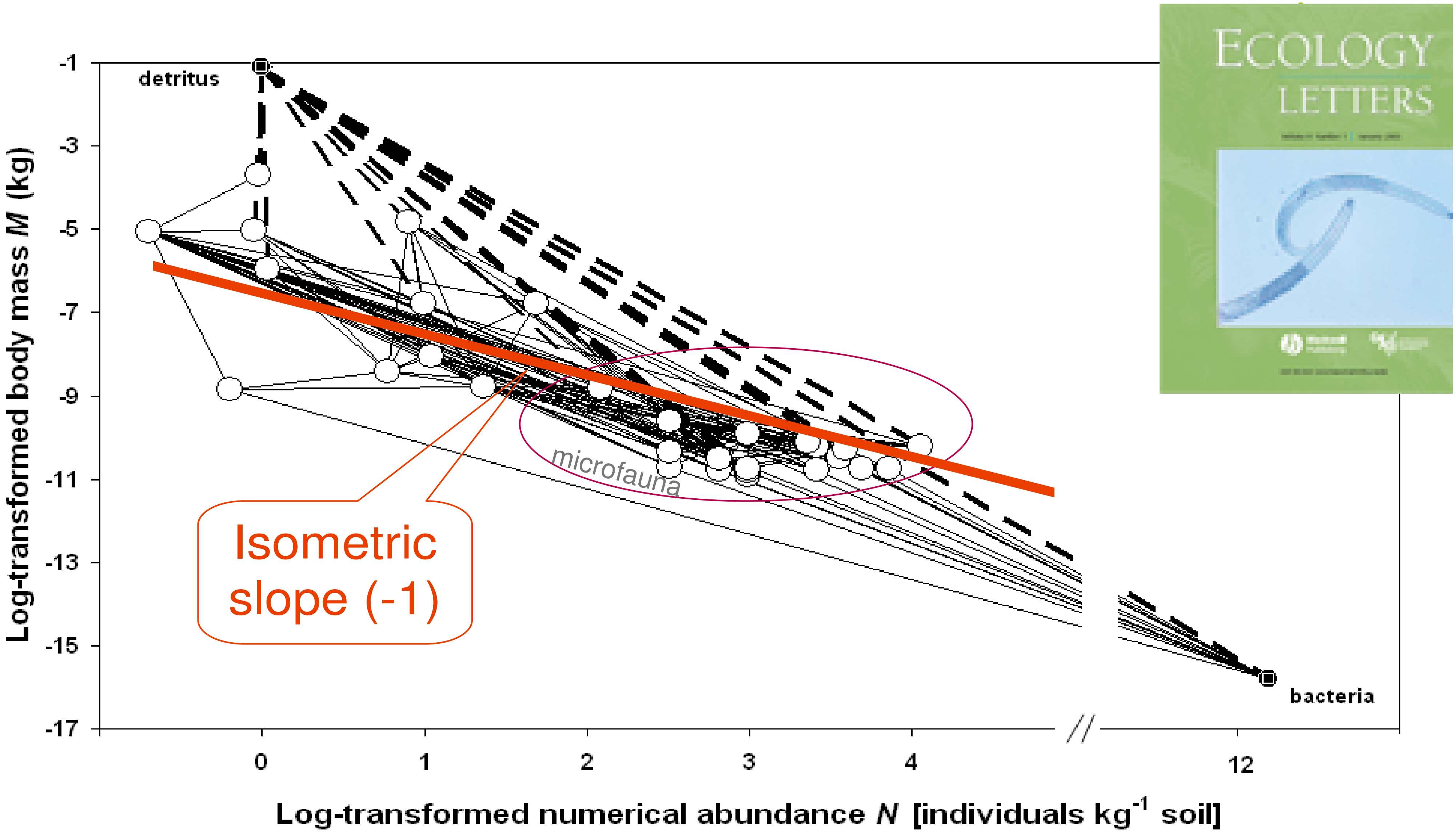
We expect it does….



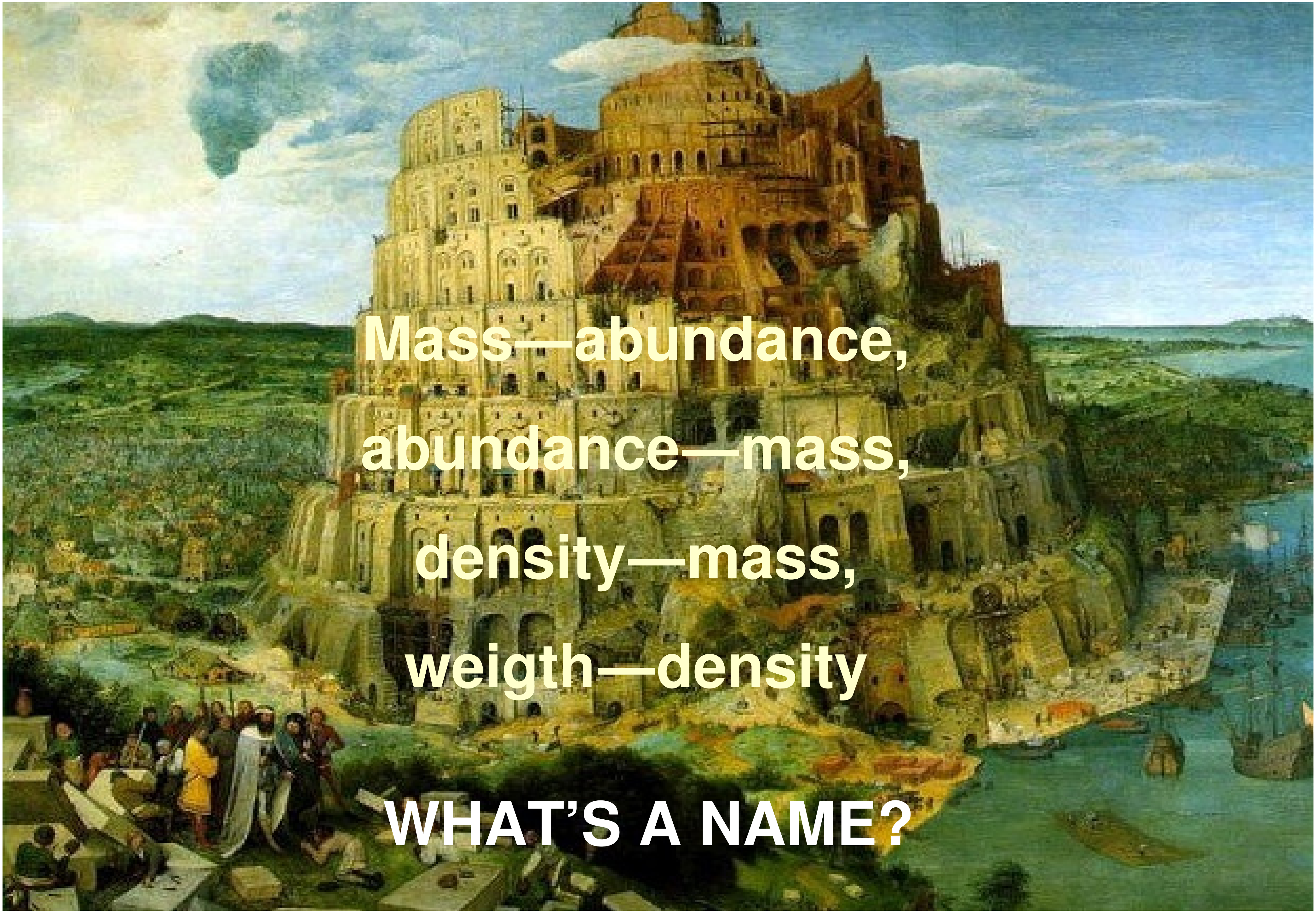
….regardless of the chosen regression



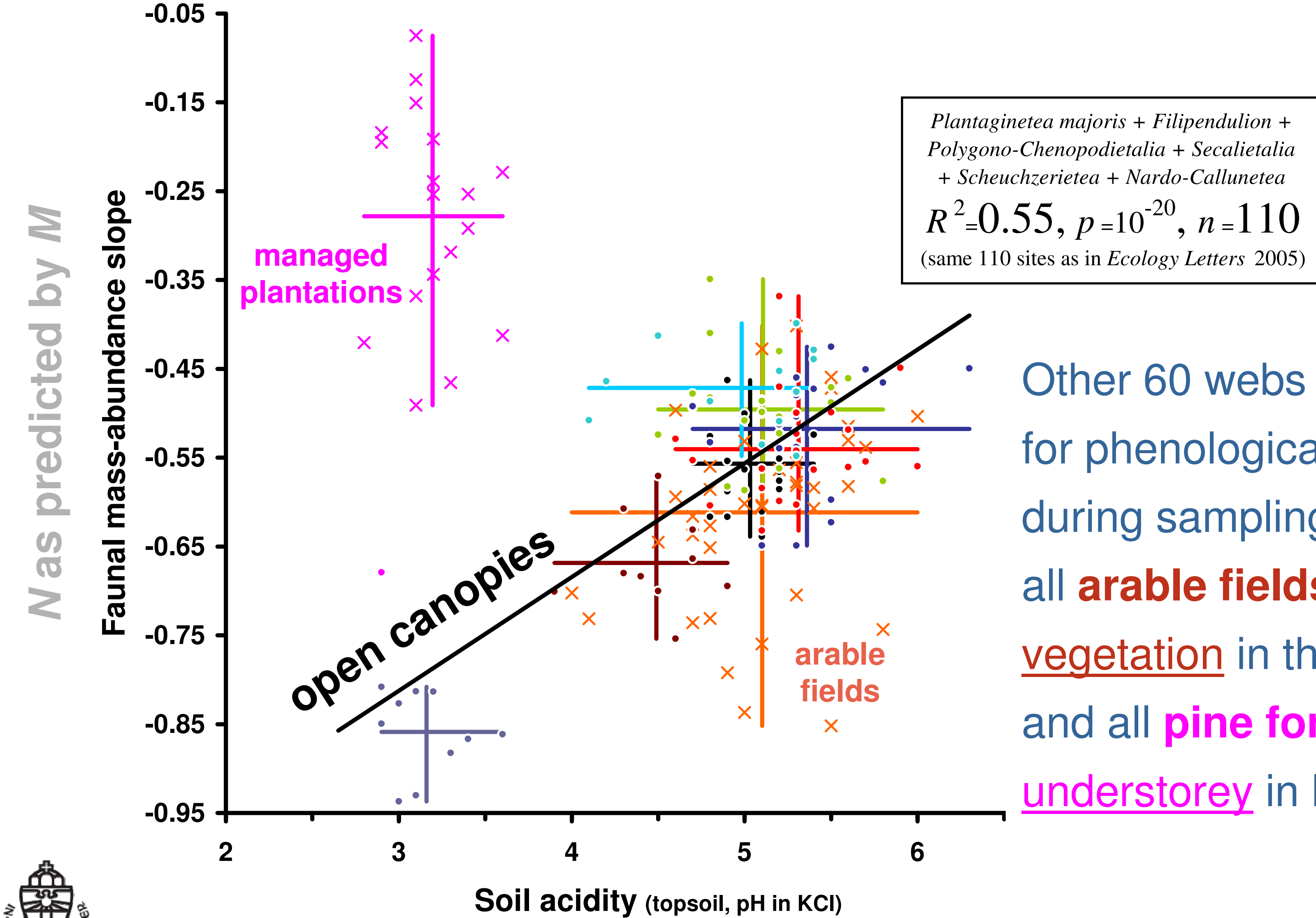
We can easily merge this huge amount of information in a Cartesian plane



… getting this !

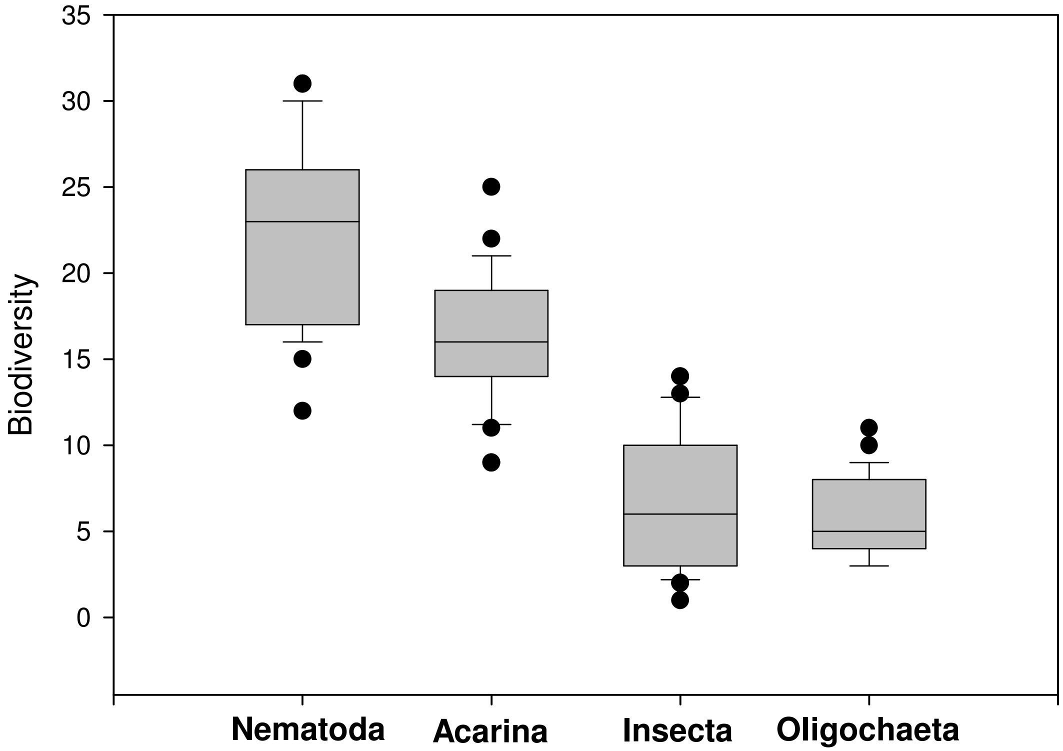

Mass—abundance,
abundance—mass,
density—mass,
weigth—density
WHAT'S A NAME?

Merging the open canopies together, as vegetation ecologists do, we get :



Other 60 webs excluded for phenological reasons during sampling efforts : all **arable fields** had no vegetation in the Winter, and all **pine forests** no understorey in late Fall

Nodes of taxa with low body-mass average occur more often, as expected from theory

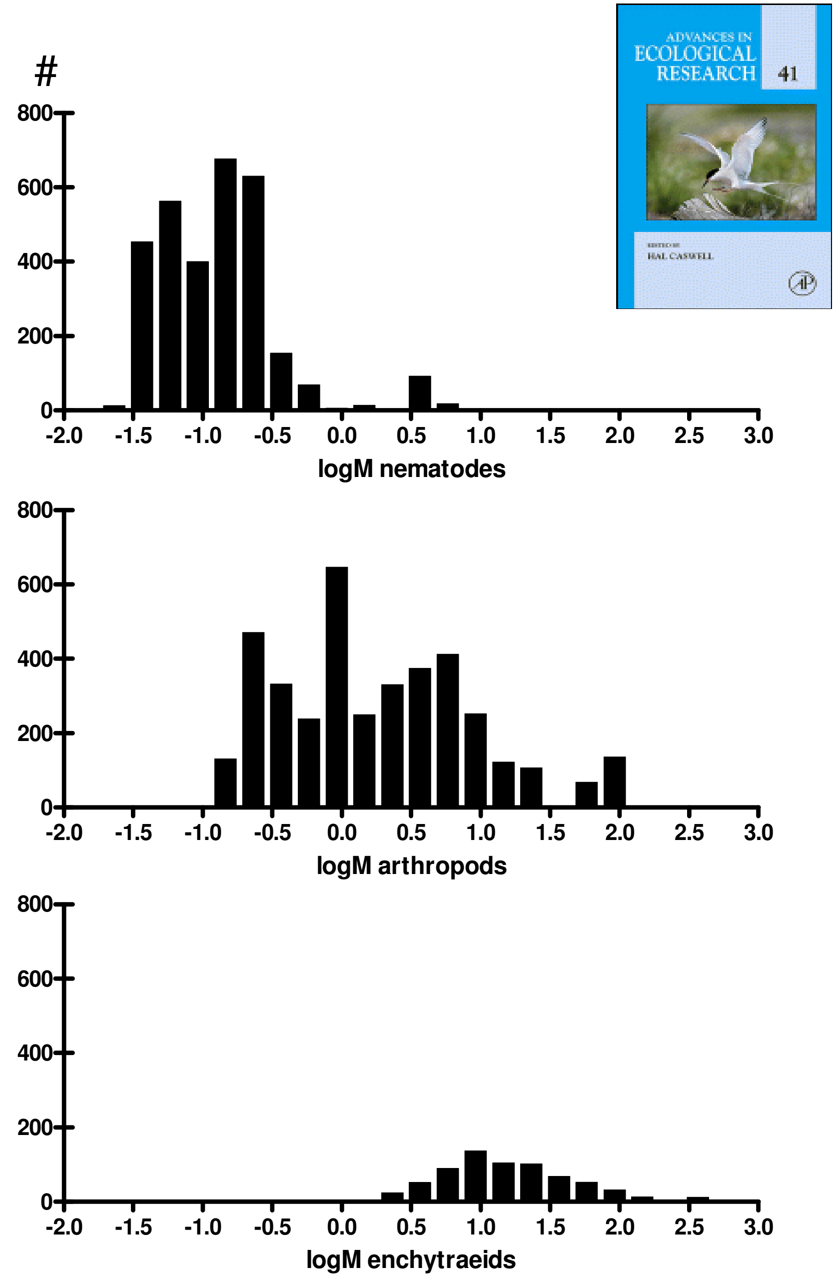


Mulder, Den Hollander, Schouten, Rutgers

Ecological Complexity 3: 219-230 (2006)

Reuman, Cohen, Mulder

Advances in Ecological Research 41 (2009)



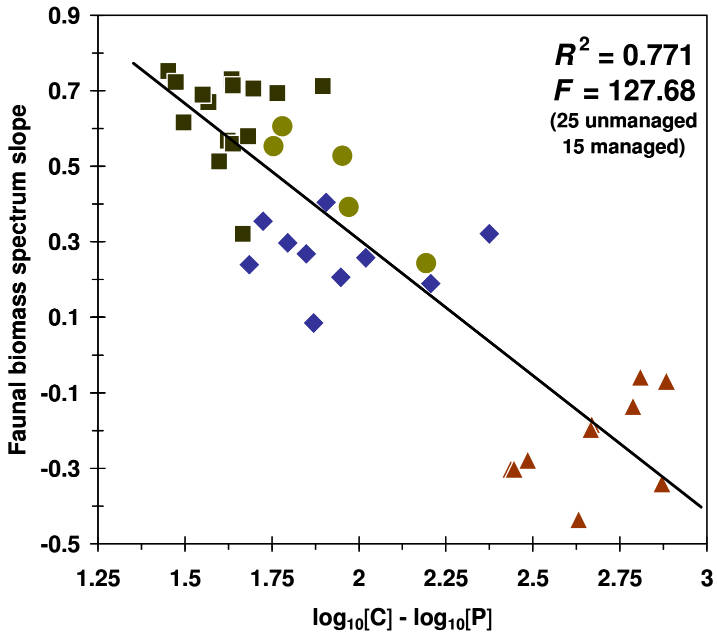
sizemic

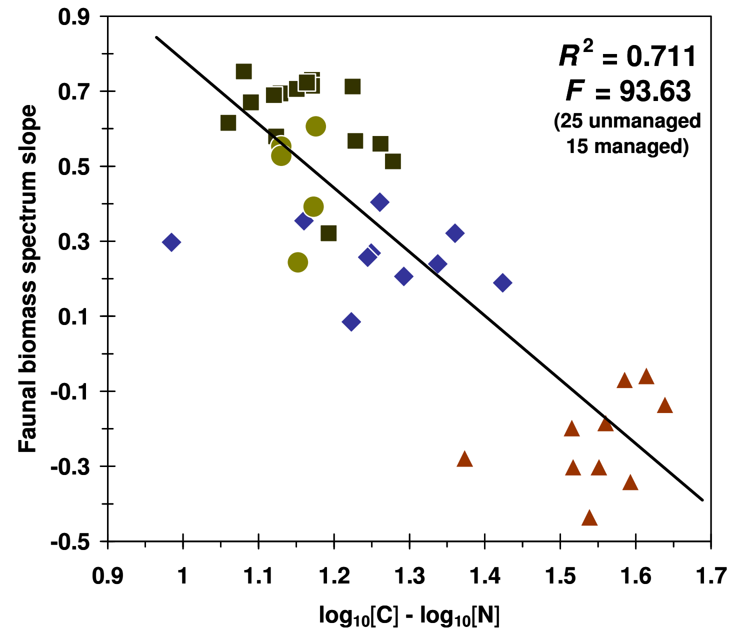
The biomass—size spectrum slope of a unique set of 146 soil food webs is significantly different from zero in almost all cases (the Goodness-of-Fit averages 0.73, mean $F = 15.6$). Runs test shows nonlinearity in only 7 webs.

	Food webs (#)	Significance (mean *p*)	Slope ≠ 0 (%)	Linearity (%)
organic grasslands	29	0.010	96.6	96.6
conventional farms	19	0.010	100	100
semi-intensive farms	21	0.014	95.2	95.2
intensive farms	19	0.001	100	94.7
arable fields	38	0.144	55.3	89.5
pine forests	20	0.002	100	100

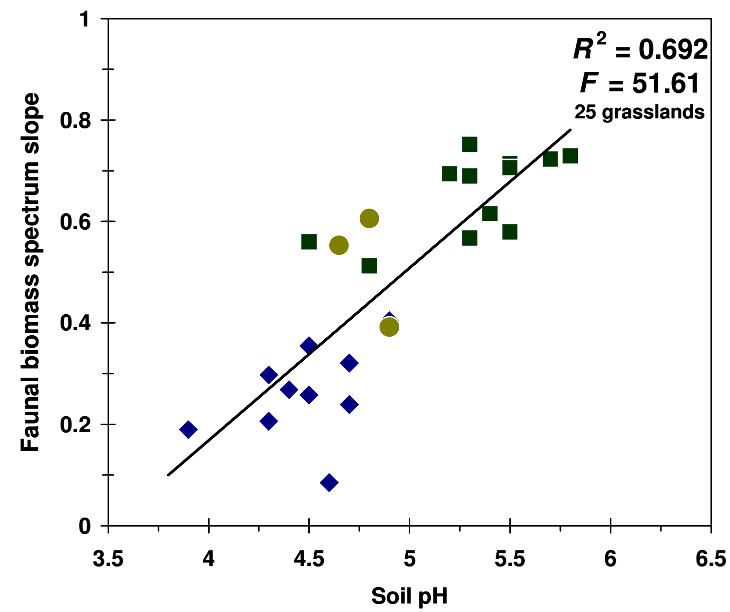
rivm
original data

IN·DEI·NOMINE·FELICITER





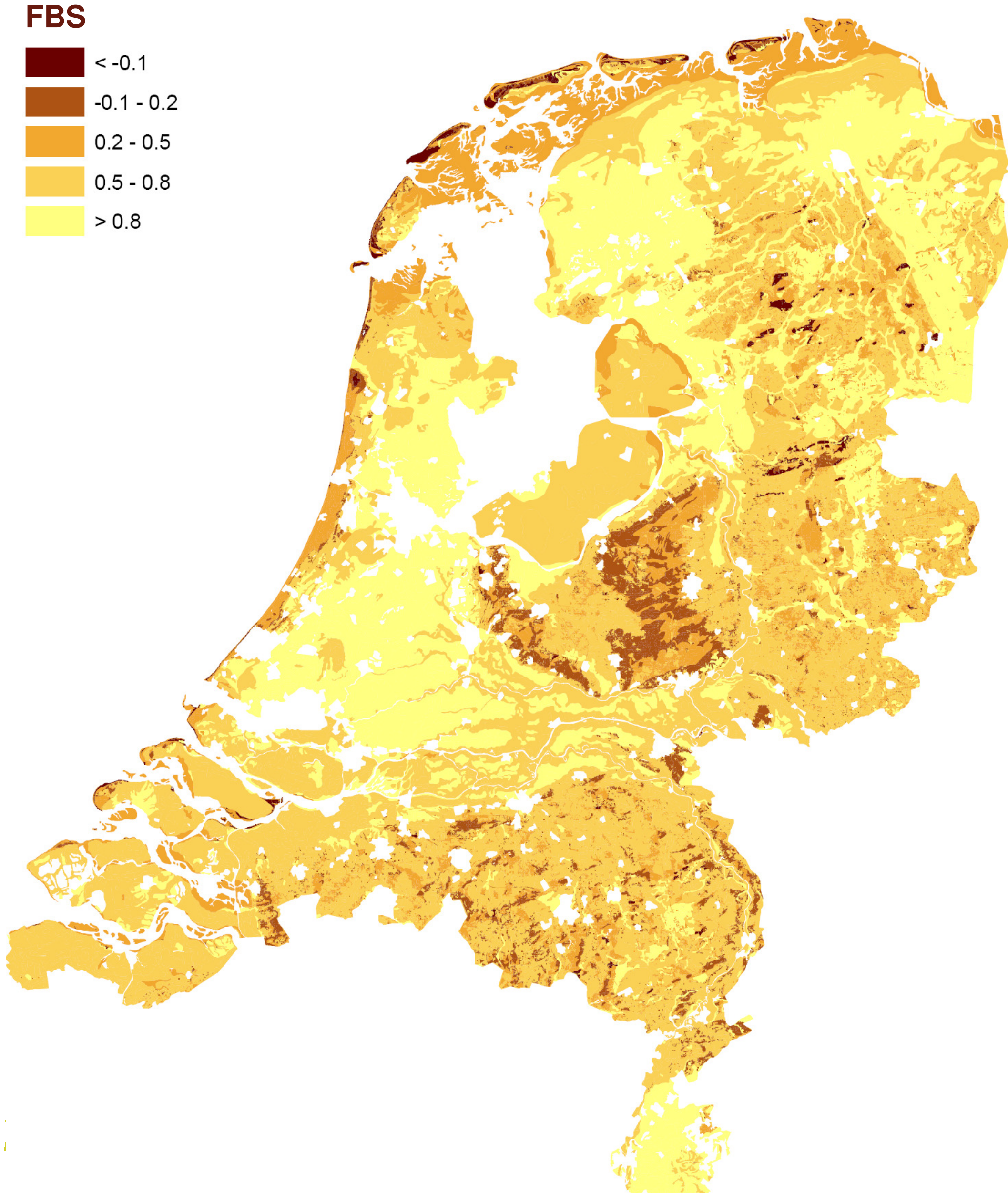
Relationships between allometric scaling and ecological stoichiometry. Clockwise: the log-transformed C : P and C : N ratios and the soil acidity as stoichiometrical predictors of the slope of the biomass spectrum of soil invertebrates. The faunal biomass spectrum slope is an index of how community patterns shifted by subtle changes in the nutrient ratios. The biomass spectrum slopes remain positively correlated with the concentrations of N ($p < 0.01$) and P ($p < 0.0001$), but not with C. The pastures are given as squares, the meadows as diamonds, and the heathlands as triangles. Control plots of a long-term experiment (*Biology and Fertility of Soils* 2009) as circles.



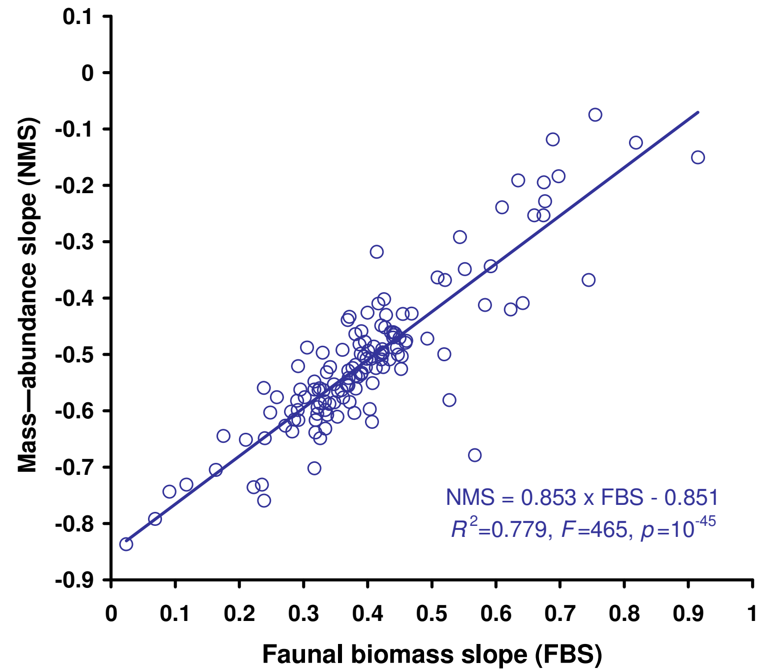
Mulder and Elser, *Global Change Biology* 15 (2009)

Mulder, Den Hollander, Vonk, Rossberg, Jagers op Akkerhuis, Yeates, *Naturwissenschaften* 96 (2009)

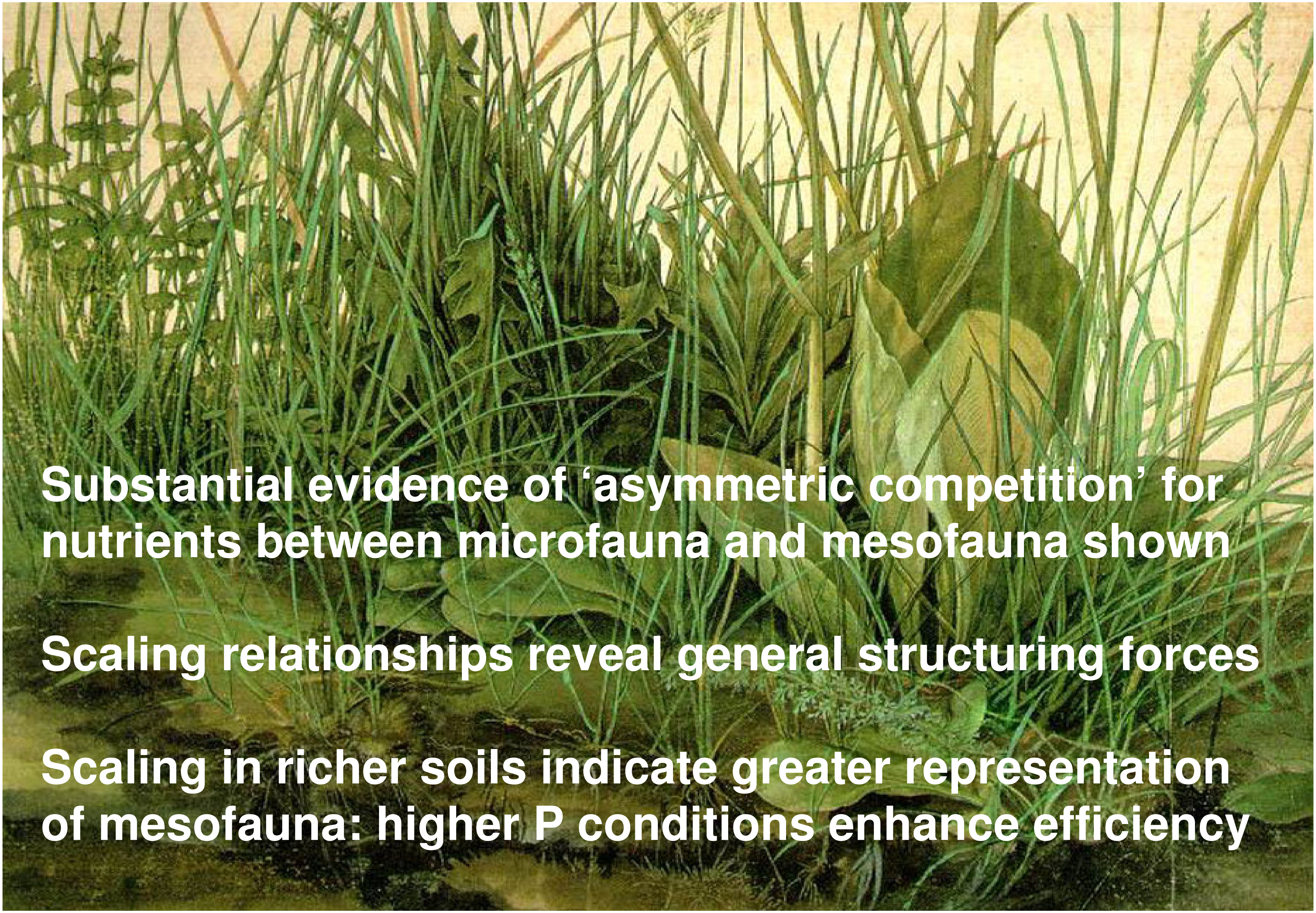
ONLINE OPEN

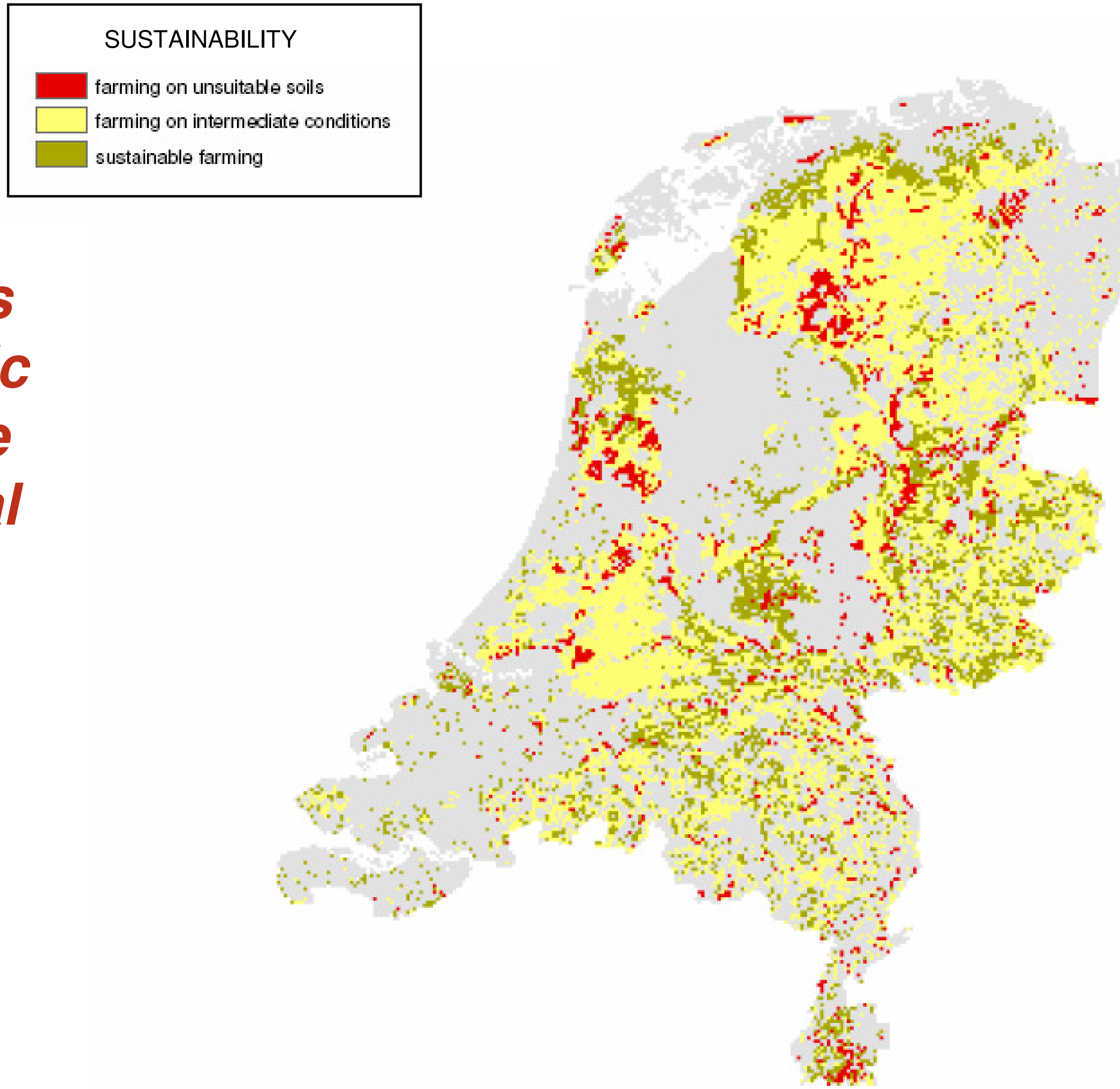


The regression (body mass-abundance or biomass slope) is not relevant, the change is significant (*e.g.*, flat slopes in pristine— but steep slopes in rural areas). Based on our 500 locations some extensive *GIS* analyses have been performed



Mulder, Den Hollander, Hendriks, PONE 3: e3573 (2008)
PLoS PUBLIC LIBRARY of SCIENCE


Substantial evidence of 'asymmetric competition' for nutrients between microfauna and mesofauna shown
Scaling relationships reveal general structuring forces
Scaling in richer soils indicate greater representation of mesofauna: higher P conditions enhance efficiency



Subtle changes in the allometric scaling provide therefore a final tool for both restoration ecology and sustainable management

The development of our models has been made possible by:







Site location

Eekeren, Nick van
Rutgers, Michiel
Schouten, Anton
Wijnen, Harm van

Field work

Dijk, Bert van
Groot, Arthur de
Hollander, Henri d
Schouten, Anton
Steenbergen, Erik

Lab sampling

Baerselman, Rob
Bloem, Jaap
Didden, Wim (†)
Dimmers, Wim
Goede, Ron de
Jagers o.A, Gerard
Keidel, Harm
Peijnenburg, Willie
Wouterse, Marja

Data processing

Bogte, Jaap
Bloem, Jaap
Hollander, Henri d
Jagers o.A, Gerard
Schouten, Anton

Model evaluation

Aldenberg, Tom
Cohen, Joel
Elser, James
Reuman, Dan
Yeates, Gregor

Model validation

Campbell, Colin
Hollander, Henri d
Posthuma, Leo
Rossberg, Axel
Zwart, Dick de

Model application

Brussaard, Lijbert
Posthuma, Leo
Rutgers, Michiel
Wijnen, Harm van

RIVM in blue, Wageningen University in brown, those belonging to other institutions in black