Nematode species at risk – a new index to assess pollution in soft sediments of freshwater systems

Sebastian Höss
Walter Traunspurger, Marvin Brinke
Peter von der Ohe
Evelyn Claus, Peter Heininger

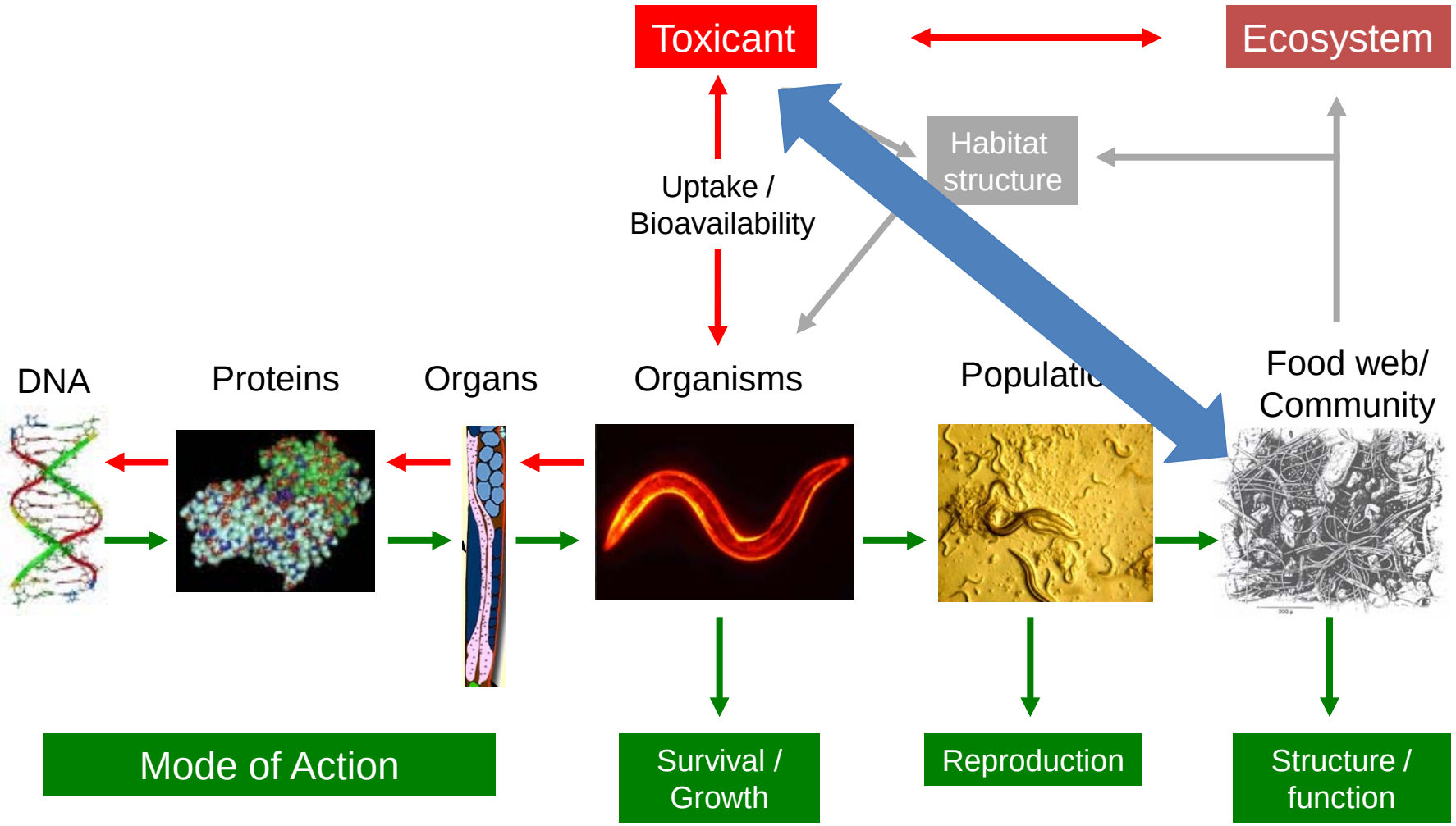
ecossa ecological sediment & soil assessment

Universität Bielefeld

HELMHOLTZ ZENTRUM FÜR UMWELTFORSCHUNG UFZ

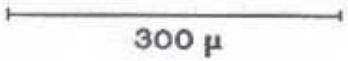
bfg Bundesanstalt für Gewässerkunde

Environmental Risk Assessment (ERA)



Sediments and Bioindication

- → Sediments are strongly polluted due to accumulation of contaminants (soft sediments)
- → Sediments are habitat for a highly divers benthic community
- → Biomonitoring only with macroinvertebrates (e.g AQEM; ASTERICS)
- → Soft sediments are mainly dominated by micro- and meiofauna
- → Notice of meiofauna in ecotoxicology is increasing (i.e. nematodes: Maturity Index; Toxicity tests with *C. elegans*: ISO 10872)
- → **We still need more meiofauna in aquatic ecotoxicology and biomonitoring programs !!!**

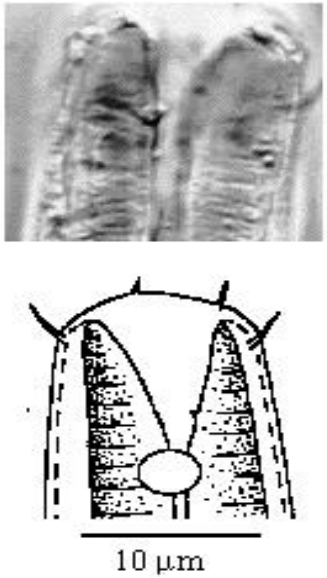


Tom Fenchel (1992)

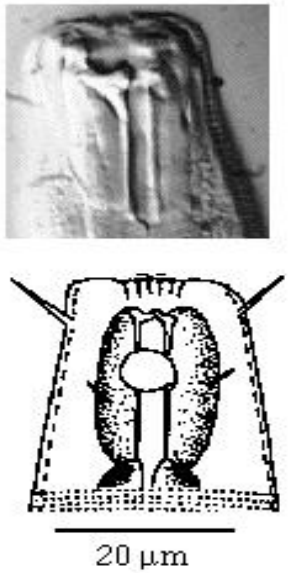
Nematodes

- Nematodes are the most abundant and diverse metazoans in freshwater habitats
  - approx. 2500 European species estimated
  - >1 Million individuals per m^2 (up to 90 % of total meiofauna)
- Nematodes are ubiquitous
- Nematodes evolved various feeding strategies

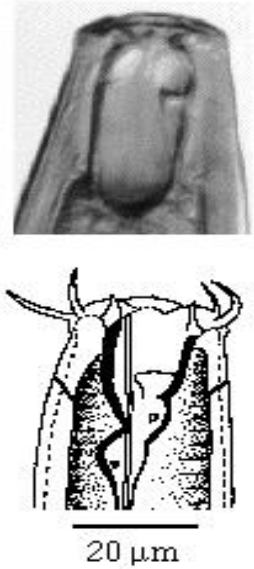
Bacteria Feeder



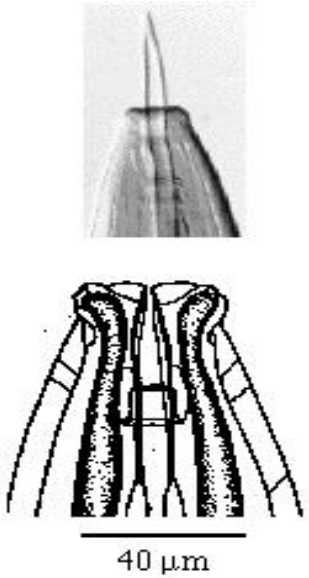
Algae Feeder



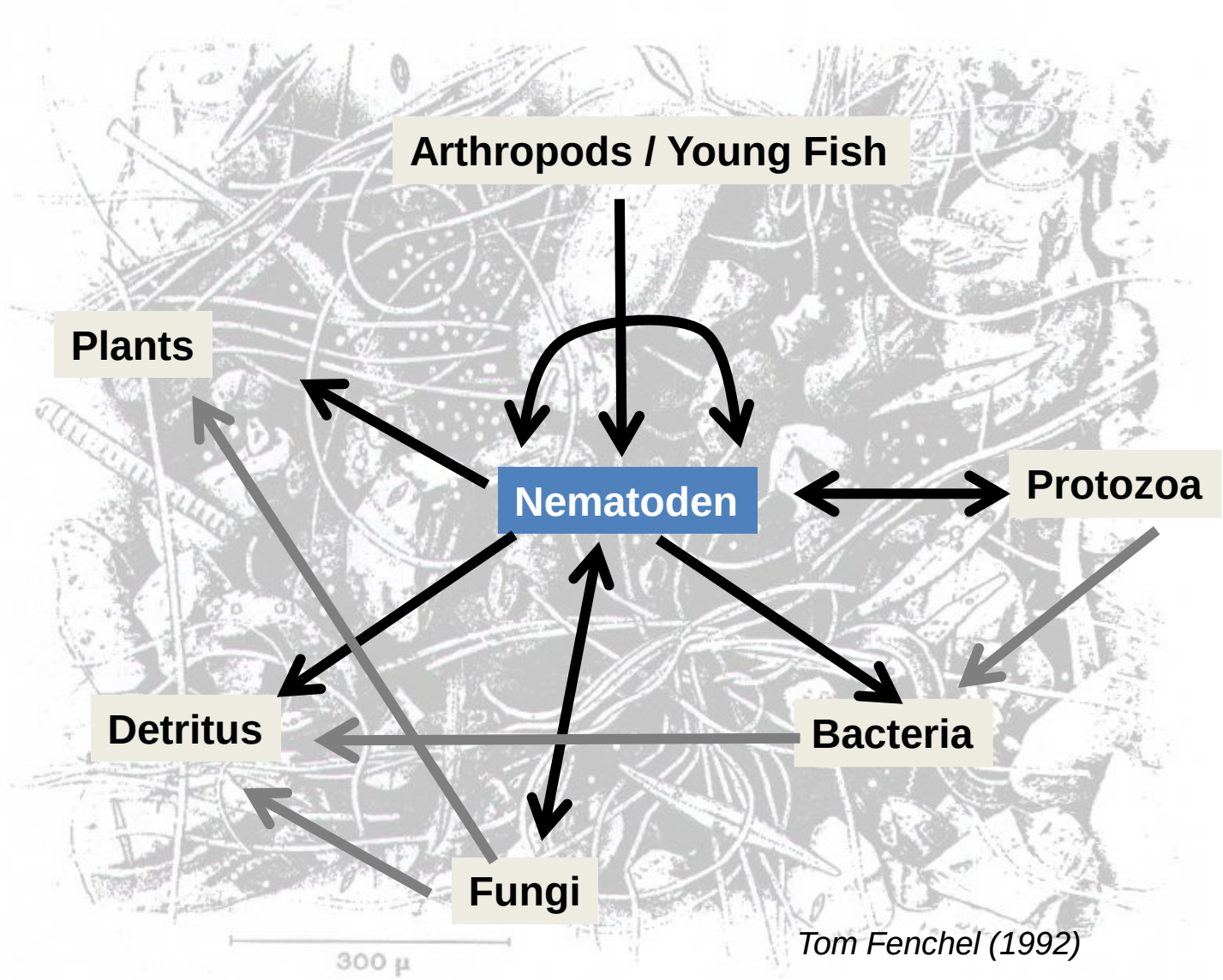
Predator



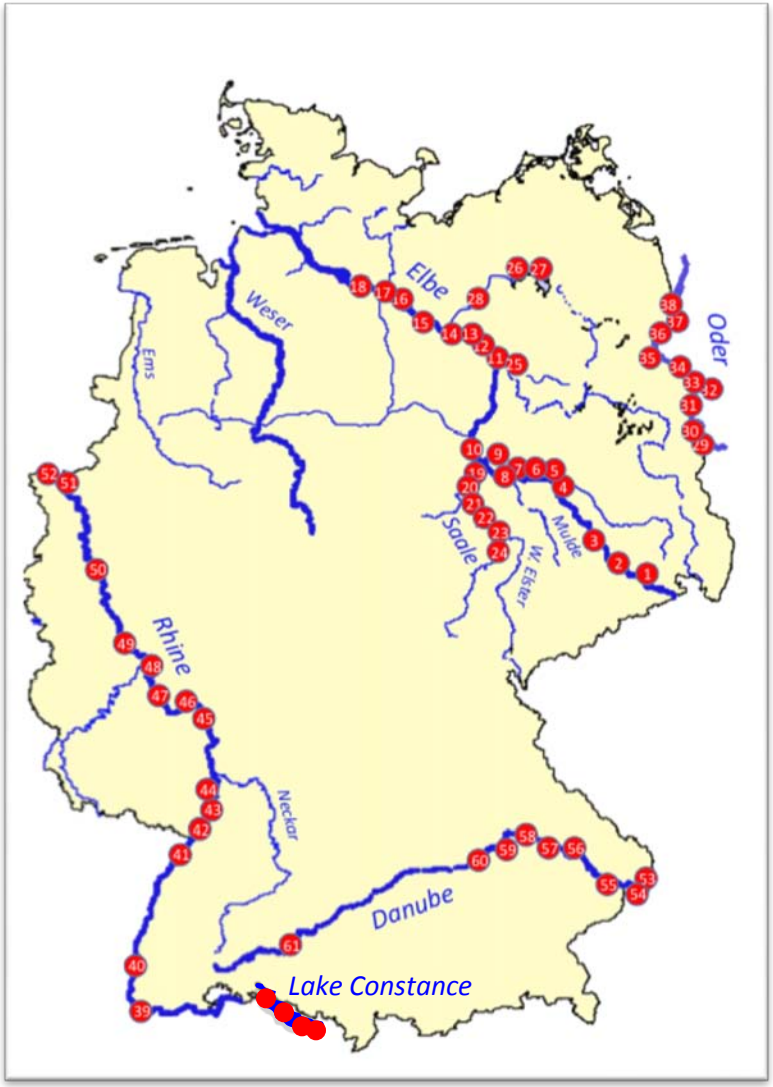
Plant Feeder



Nematodes in benthic food webs



Sampling Sites



River sediments:
2000 to 2008
165 Samples (3 Replicates)
65 Sites (26 Sites with n = 2 bis 13)
8 River basins (Danube, Elbe, Oder, Rhine, Saale, Havel, Müritz-Elde, Warthe, Oderhaff)

Lake sediments:
Lake Constance (BUS-Projekt: 2003-2006)
43 Samples (5 Replikate)
43 Sites (7 Profiles)

→ Analysis of nematode species composition

→ chemical analysis of pollutants

→ geo-chemical properties (TOC; particle size distribution)

Sediment Contamination as Toxic Units

→ ***Toxic Units***: *LC_{50} Daphnia magna*

$TU = [x]/LC_{50}$ (x) ← *Daphnia magna*

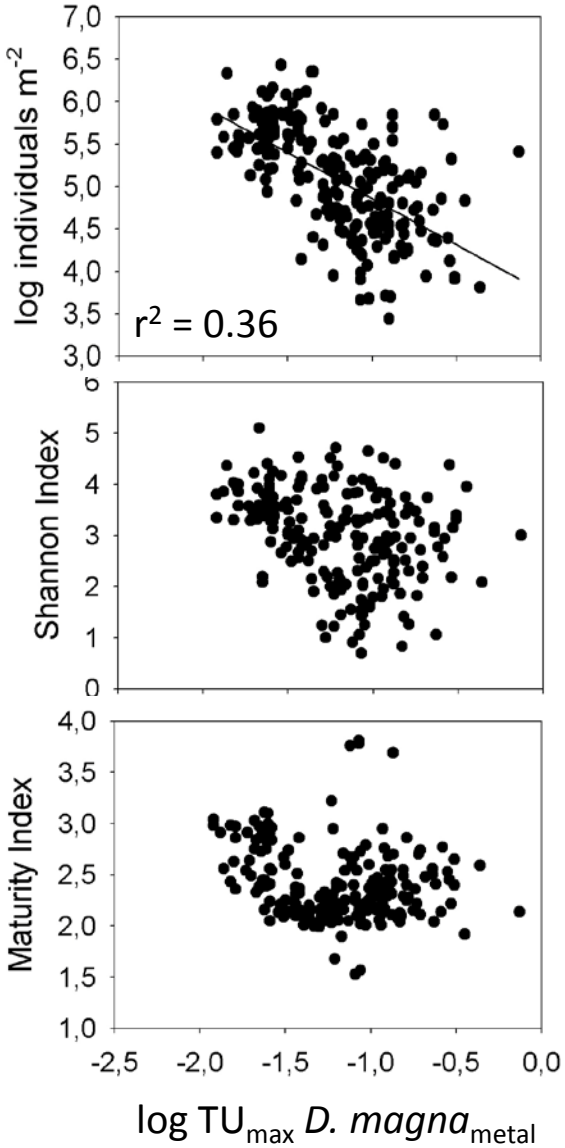
↑

Porewater concentrations
$= [Sed]/K_{OC}*TOC$

TU_{max} *D. magna*$_{metal}$ = Maximal TU for metals

TU_{max} *D. magna*$_{organic}$ = Maximal TU for organic chemicals

Nematode Communities



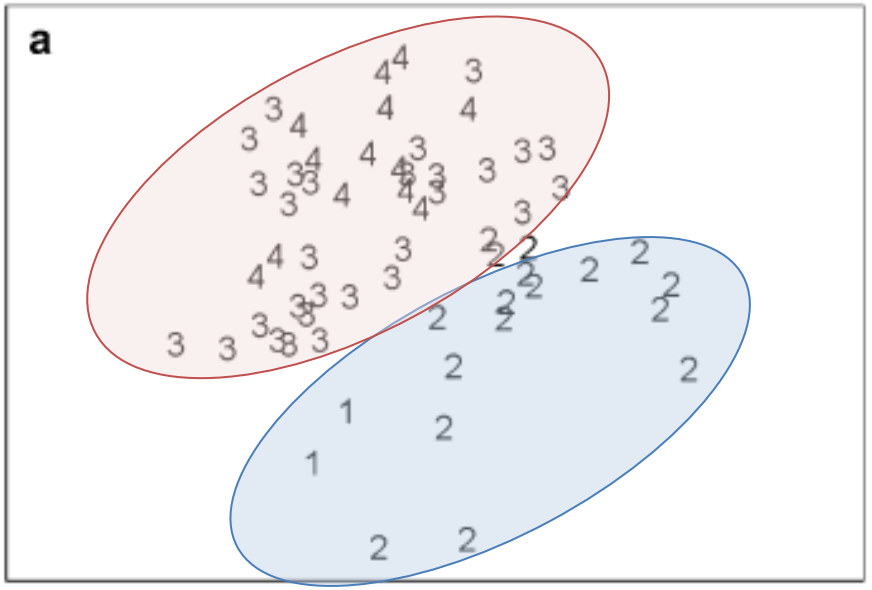
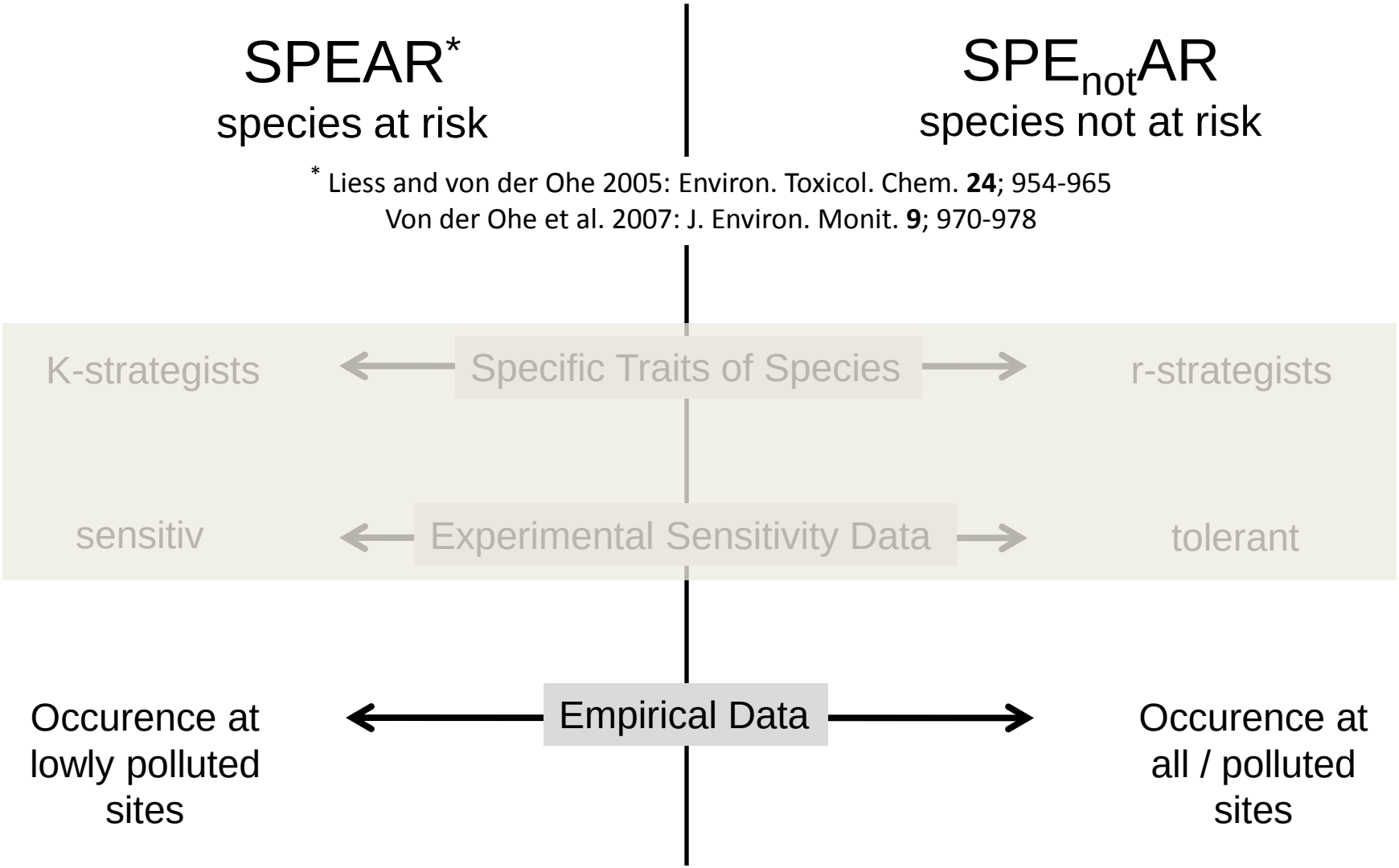


Fig. 5. Multidimensional scaling (MDS) ordination of square-root transformed relative abundances of nematode genera from various samples (see Fig. 1, Table 1); data points of the various samples were replaced by information on (a) anthropogenic pollution (pollution classes: 1–4; see Table 2) and (b) the site structure: A = groyne field, B = natural, lentic, C = harbor, lock (Table 2).

Heininger et al. 2007, Environ. Poll. 146, 64-76

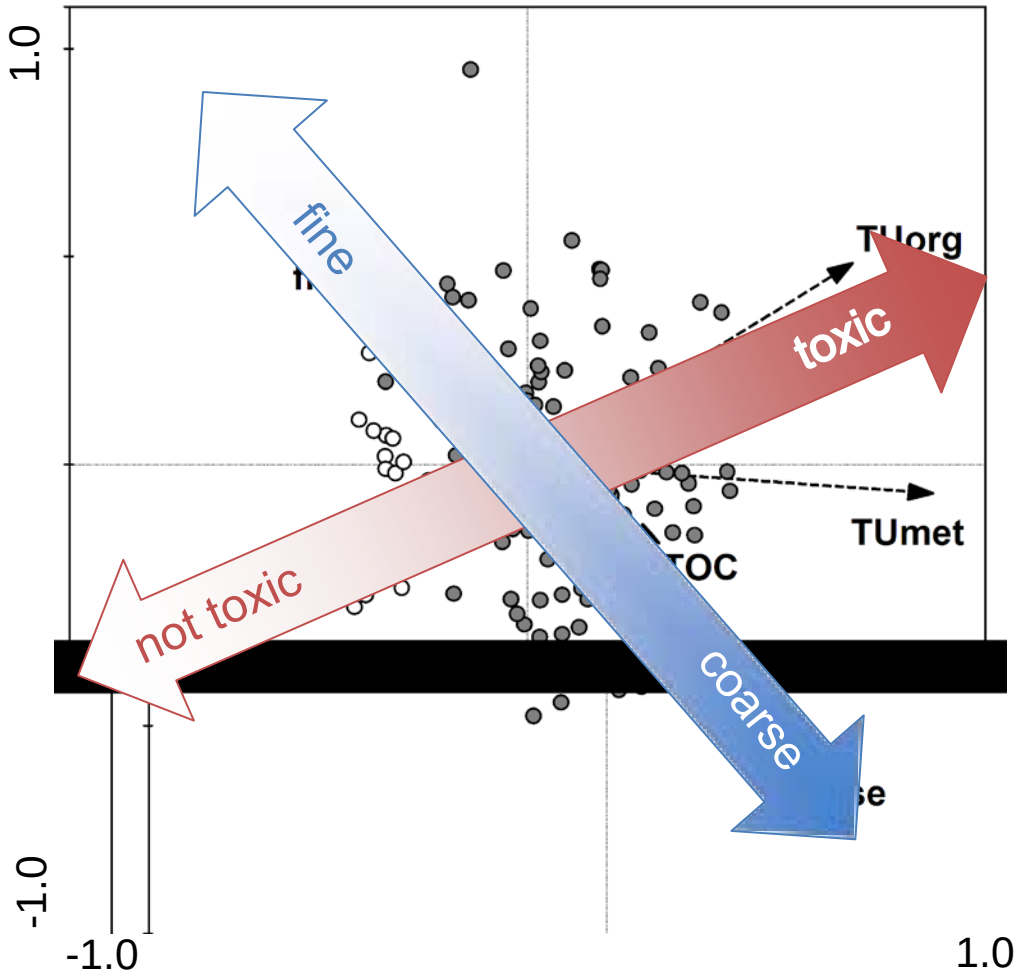
Classification of Nematode Species



* Liess and von der Ohe 2005: Environ. Toxicol. Chem. **24**; 954-965
Von der Ohe et al. 2007: J. Environ. Monit. **9**; 970-978

Nematode Community: Multivariate Analysis

Canocical Correspondance Analysis: based on nematode species composition



Nematode Community: Multivariate Analysis

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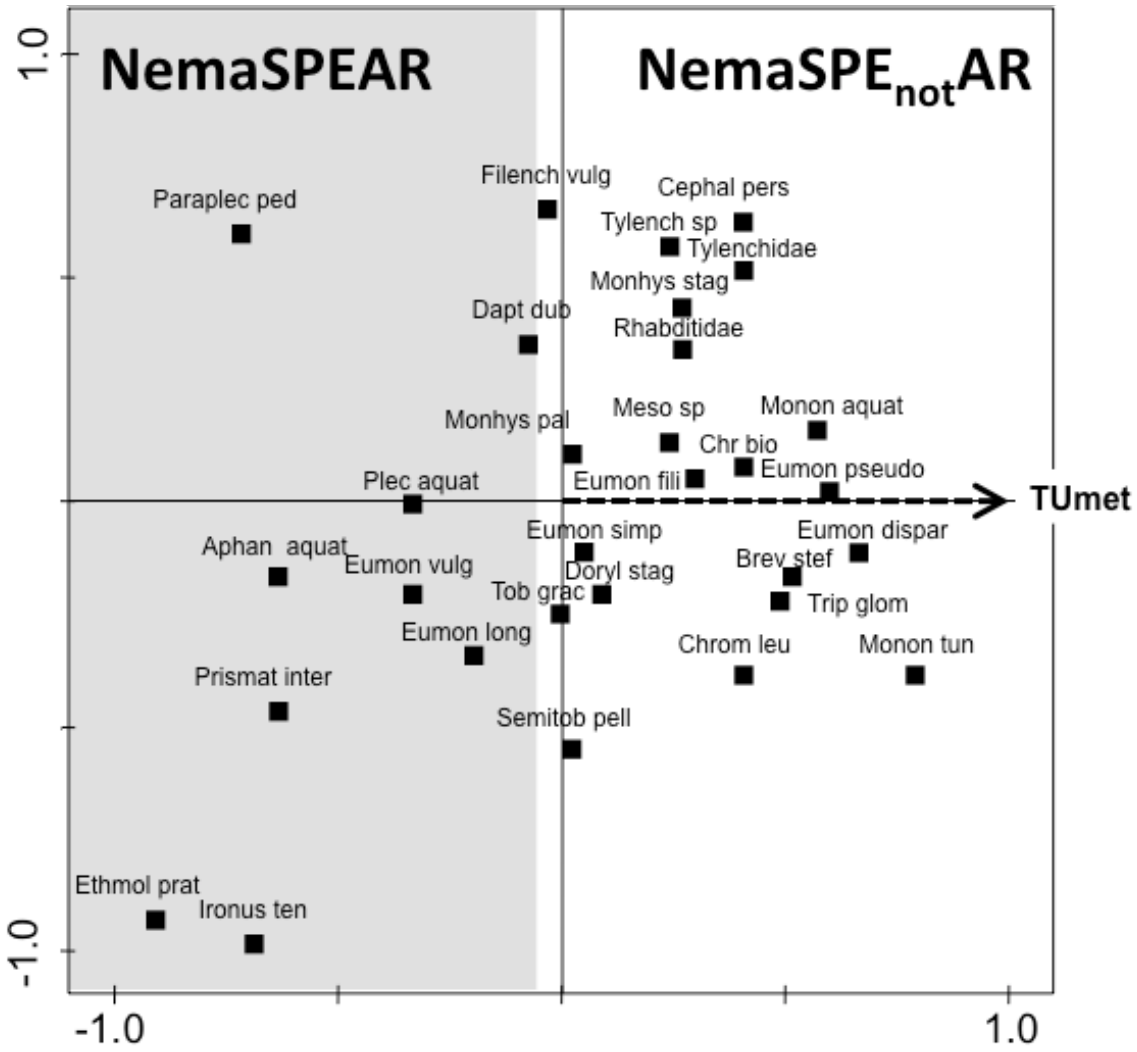


NemaSPEAR[%]

	TU_{metal}	$TU_{organic}$
Total	279	279
SPEAR	**67**	**60**

>70% overlap

Daptonema dubium
Achromadora tenax
Alaimus primitivus
Coslenchus costatus

Eumonhystera longicaudatula
E. vulgaris
E. simplex
Plectus aquatilis
Tobrilus pellucidus
Ethmolaimus pratensis
Prismatolaimus intermedius
Paraplectonema pedunculatum
Ironus tenuicaudatus

Eumonhystera simplex
Tobrilus pellucidus
Fictor fictor

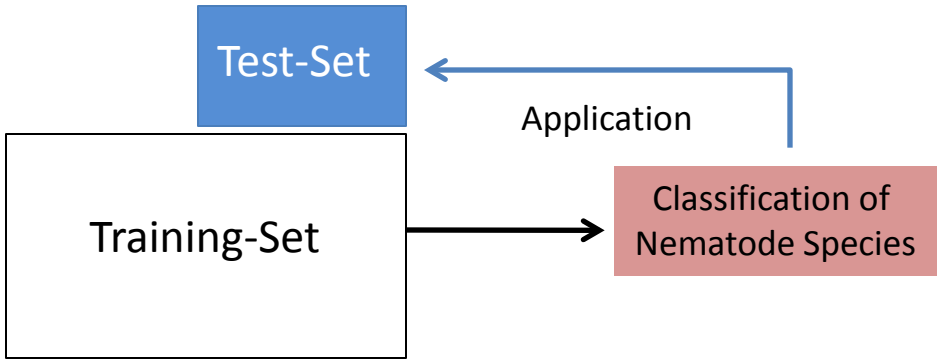
→ Calculation of Index

$$\text{NemaSPEAR[\%]}_{metal/organic} = \frac{\sum \log(SPEAR_{TUmetal/Tuorganic})}{\sum \log(total)} \times 100$$

NemaSPEAR[%]: Validation

Validation of Indices

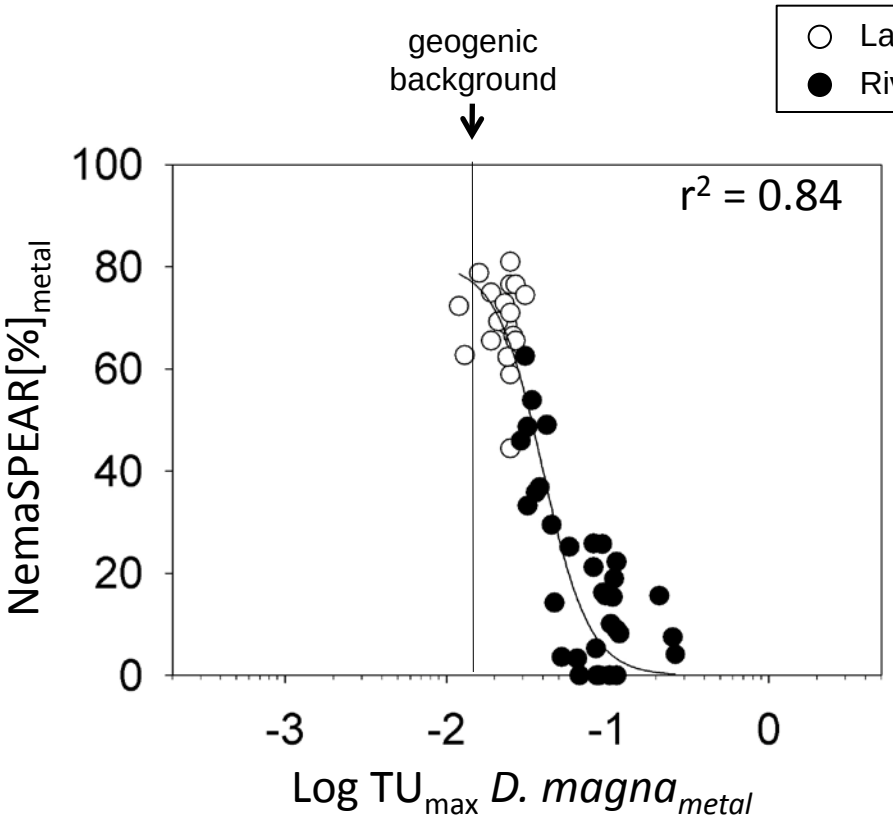
Independent data set

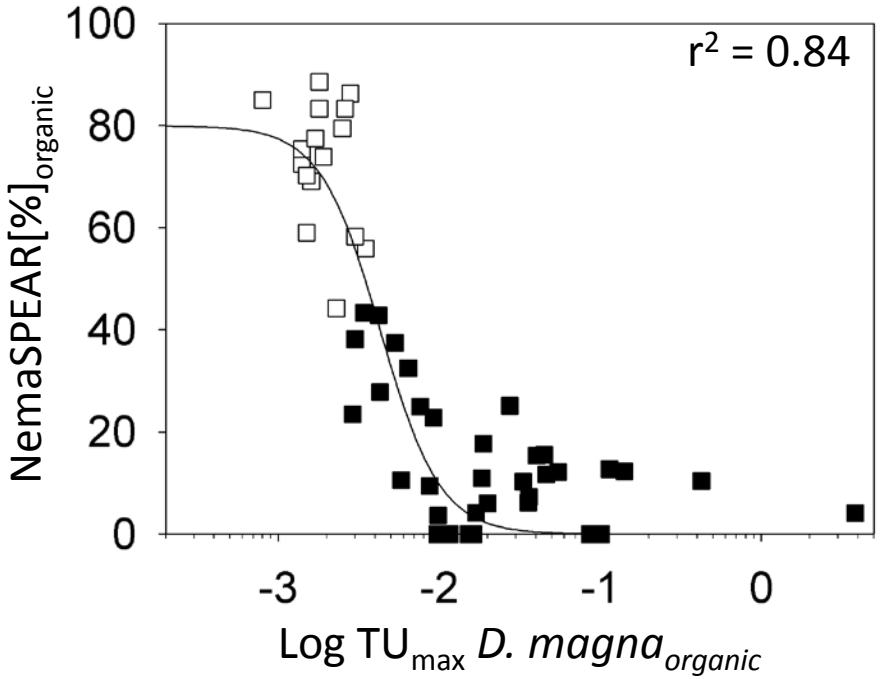


Experimental data:
Microcosm experiments with
- Cd (metal)
- Ivermectin (organic chemical)

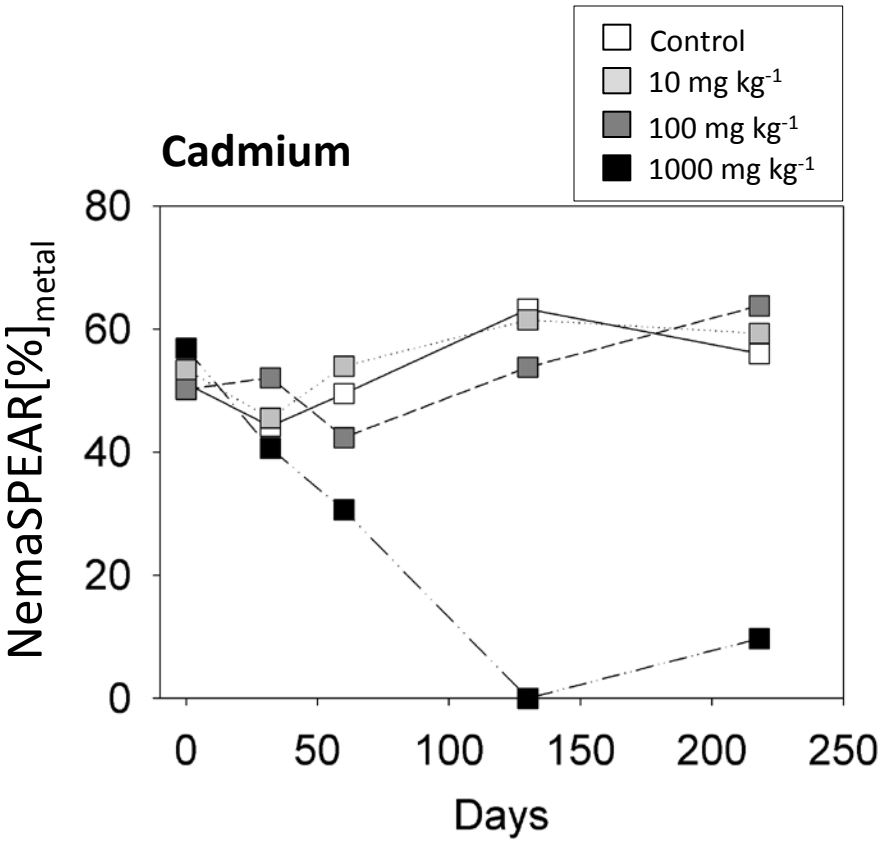
NemaSPEAR: Independent Data-Set

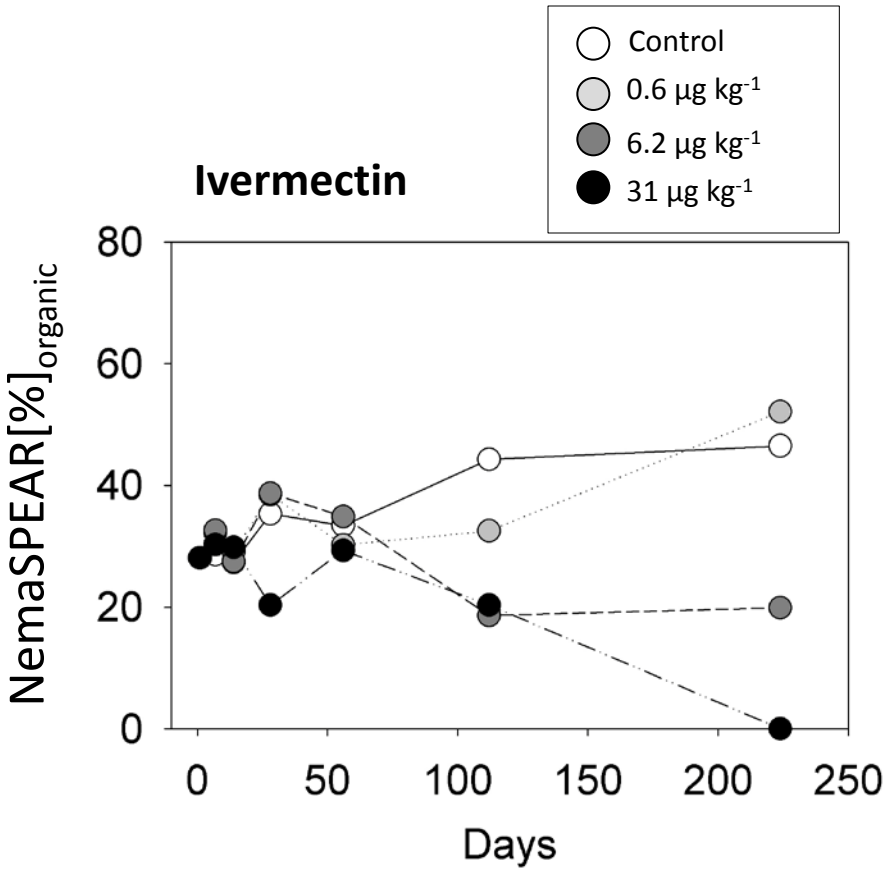
→ Independent data set: all 53 single samples





NemaSPEAR: Microcosm-Experiment





Brinke et al. (2011):
Environ. Toxicol. Chem., 30, 427-438

Brinke et al. (2010):
Aquatic Toxicology, 99, 126-137

Summary and Outlook

- There is a need for tools to assess effects of chemical pollution on communities in soft sediments. Meiofauna is more suitable than macrofauna.
- On the basis of a 9 year study of nematode communities in rivers and lakes, indicator species were revealed that are sensitiv to chemical stress
- A new index was developed according to the SPEAR-Index: the **NemaSPEAR-Index.** Two types of contamination were distinguished: metals and organic pollution; NemaSPEAR[%]$_{metal}$; NemaSPEAR[%]$_{organic}$
- The NemaSPEAR index could be validated with independent data sets from field and experimental studies.
- We need more field and experimental studies to validate the index. Doubtful cases (i.e. rarely occurring species) might get a different classification.
- Helpful tool for assessing the ecological status in soft sediments that often are the hotspots for chemical contamination

Höss et al. 2011, Environment International (in press)

Many Thanks

Ines Hehl & Nicola Reiff

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for your attention