



DEPARTMENT OF BIOSCIENCE
AARHUS UNIVERSITY, FACULTY OF SCIENCE AND TECHNOLOGY

Evaluation of collembolan trait performance as effect indicator of environmental change

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VIII ICSZ Coimbra

Krogh, P.H. & Petersen, H.

7-8-2012

Outline

- > **The concept of *traits***
- > **A collembolan trait database**
- > **The Vulcan project**
- > **Empirical evidence from the VULCAN project**
- > **Conclusions**



The *trait* concept

- > Taxonomic characters are functionally arbitrary and unrelated to responses to the environment
- > Ecological and morphological traits are functionally related to the environment
- > Traits can more easily be assigned to unidentified species than taxonomic units
- > The composition of traits may be stable across habitats while the species composition changes



Collembolan adaptations to climate

Individual level

- > **Cuticular properties**
 - > Scales
 - > Thickness
- > **Behaviour**
 - > Vertical migration, diurnal and seasonal
 - > Feeding
- > **Physiology**
 - > Heat and drought biochemical protectants

Community level

- > **Species composition**
 - > Species with traits tolerant to climate change should prevail

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<h2>Trait database v. 1.0: Morphological traits</h2>			
Trait	Coding		
No. of ocelli	0 - 8		
Body size (max.)	mm, to the nearest 0.1 mm		
Body pigmentation level (max)	0 white, 1 lightly, 2 intensely		
Body pigmentation pattern	0 absent, 1 present, 2 spotted		
Modified hairs or scales	0 absent, 1 present		
Furca development	0 absent, 1 reduced, 2 fully developed short, 3 f.d. long		
Antenna estimated length	0 short, 1 medium, 2 long		
Antenna: Head Ratio (max)			
Antenna/ body ratio			

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<h2>Ecological traits</h2>			
Trait	Coding		
Life form (morphological) <i>sensu</i> Gisin (1943, 1947, 1948)	1 epedaphic/ Atmobios; 2 hemiedaphic-xerophile 3 hemiedaphic-mesophile; 4 hemiedaphic hydrophile; 5 euedaphic		
Life form (Rusek 1989)	1 Atmobios 2 Ba epigeonts 3 Bb hemiedaphobionts 4 Bc1a large euedaphobionts with furca 5 Bc1b large euedaphobionts without or reduced furca 6 Bc2a medium euedaphobionts with furca 7 Bc2b medium euedaphobionts without or reduced furca 8 Bc3a small euedaphobionts with furca 9 Bc3b small euedaphobionts without or reduced furca		
Vertical habitat preference lifeform <i>sensu</i> (Gisin)	1 epedaphic, 2 hemiedaphic, 3 euedaphic		
Habitat preference	1 plant, 2 soil surface, 3 soil 0-10 cm depth		
Moisture preference	0 xeroresistant, 1 xero-mesophilic, 2 indifferent, 3 mesophilic, 4 meso-hydrophilic ¹		
Habitat width	0 steno, 1 steno/eury, 2 eury and eury/syn ¹		
Trophic position	1 microbivore, 2 herbivore/ pollen feeder, 3 predator and microbivore		
Mode of reproduction	0 generally parthenogenetic, 1 bisexual, 2 both modes occur		
Phenology	1 univoltine, 2 bivoltine, 3 multivoltine		
Mouthparts	1 sucking, 2 grinding, 3 piercing		
Metabolic rate corrected for weight	1 low, 2 medium, 3 high		
Weight of progeny relative to weight at maturity	Quantitative ratio		




1Makkonen et al. (2011) SBB

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Hypothesis: Collembolan life-forms respond in a *trait* manner to environmental impacts

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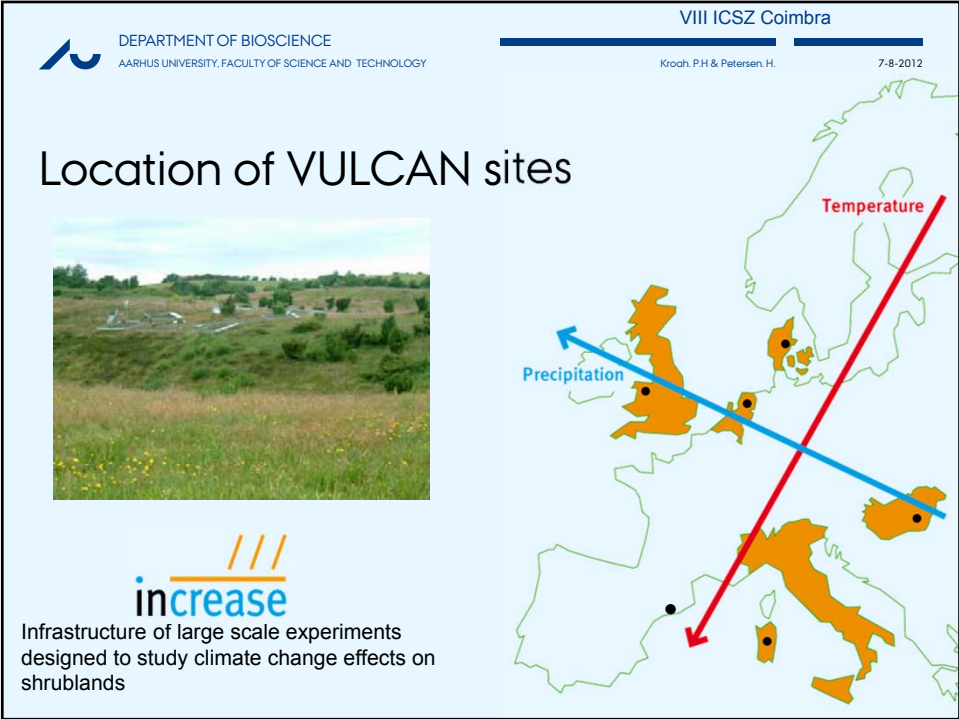
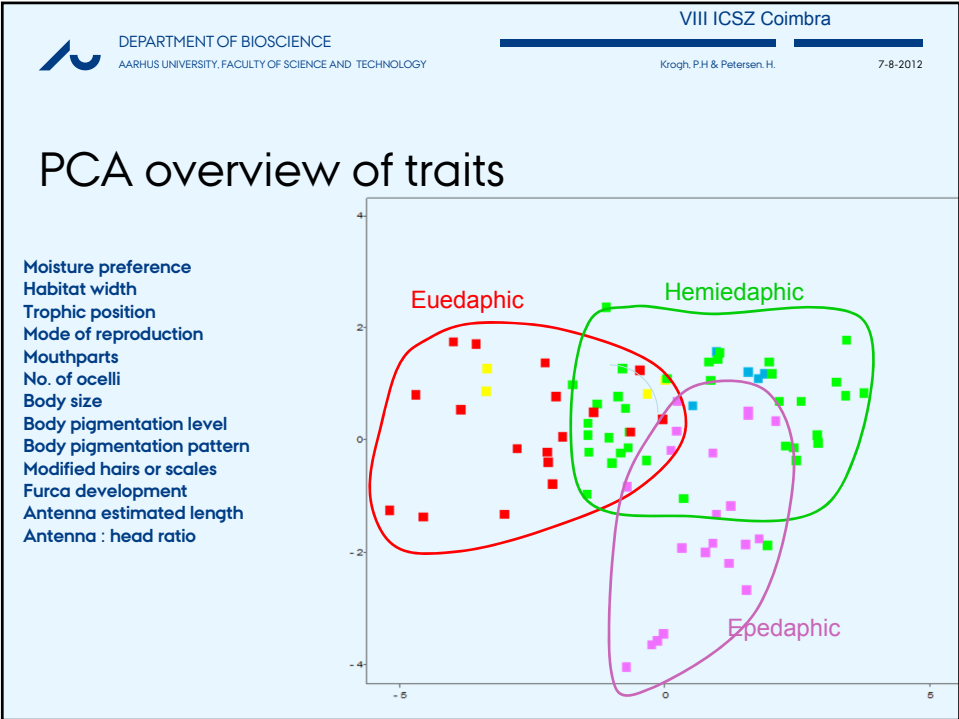
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Contrasting ecological properties of life forms

Table 1. Contrasts between properties distinguishing epedaphic and euedaphic Collembola. Modified from Petersen (1980)

<i>life form</i>	<i>epedaphic</i>	<i>euedaphic</i>
<i>vertical distribution</i>	soil surface/litter	soil pores
<i>size of specimens</i>	large	small
<i>reproduction</i>	bisexual small progeny many eggs seasonally defined	parthenogenetic large progeny few eggs throughout year
<i>metabolic activity</i>	high	low
<i>food</i>	high quality dispersed	low quality omnipresent

Petersen, H. (2002). General aspects of collembolan ecology at the turn of the millennium. *Pedobiologia*, 46: 246-260.





The VULCAN experiment 2001-2004

Vulnerability assessment of shrubland ecosystems in Europe under climatic changes (VULCAN)

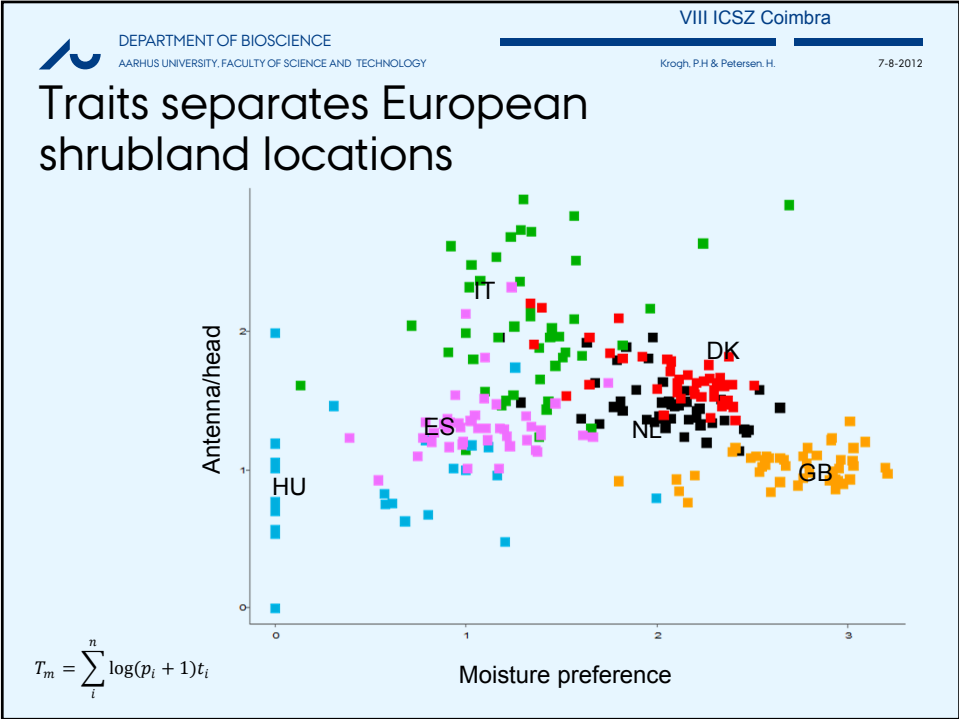
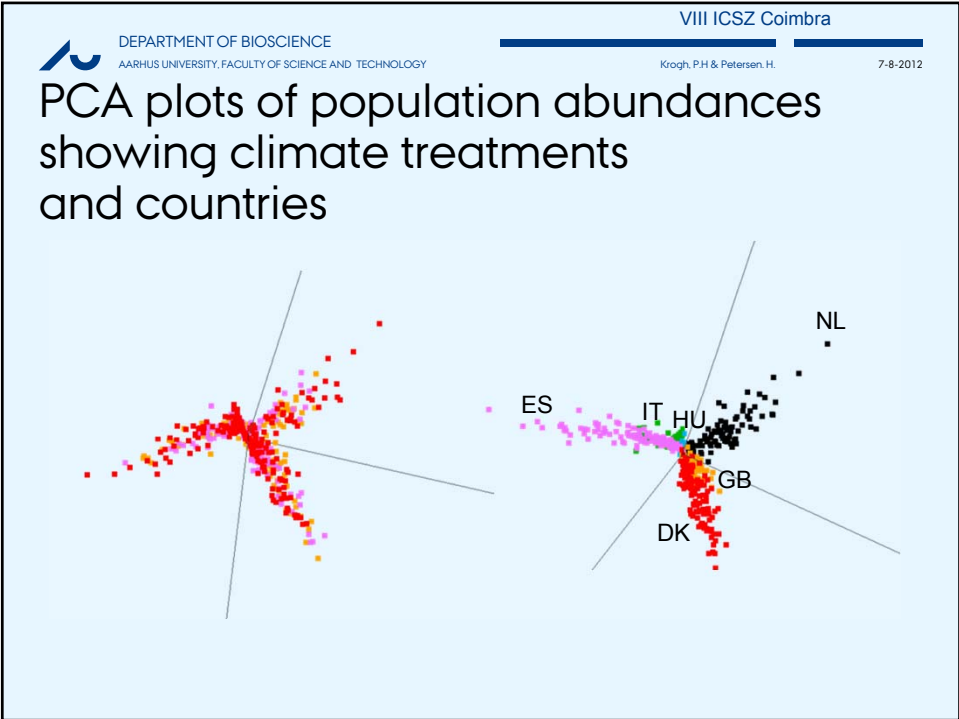
- > A transect of six European shrubland locations
- > Experimental climatic treatments of
 - > Warming: 0.3 to 1.3 °C in April to June 2003
Reflective curtains are drawn across the plots at night thus preventing heat loss.
 - > Drought: Reduced precipitation between 9.9% and 92.6%.
Plots are protected from rain by a rain cover for 1-2 months in the growing season

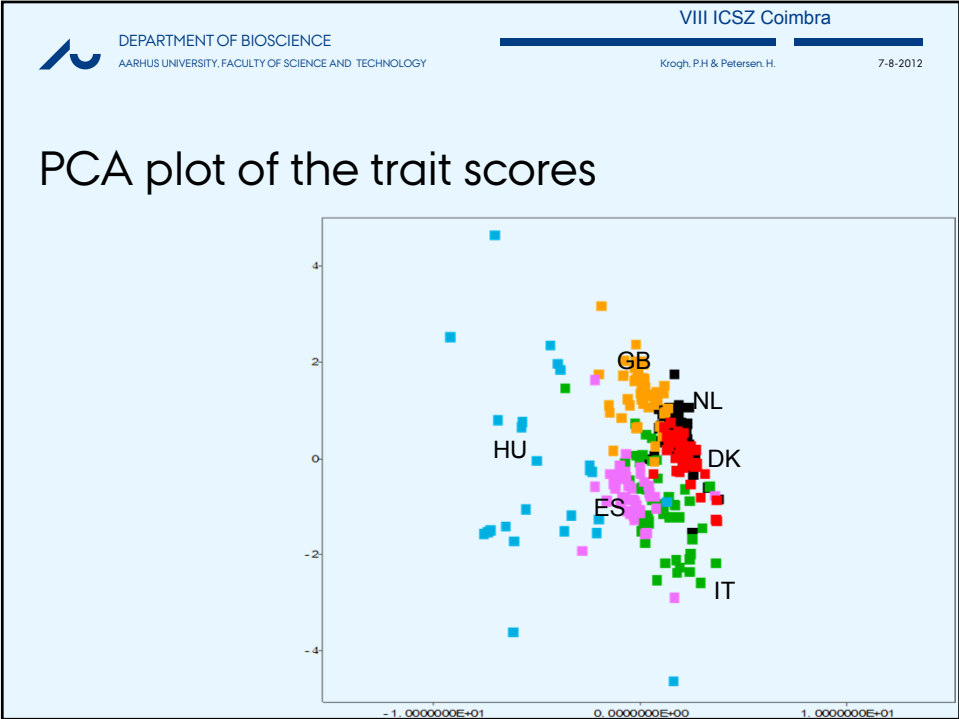
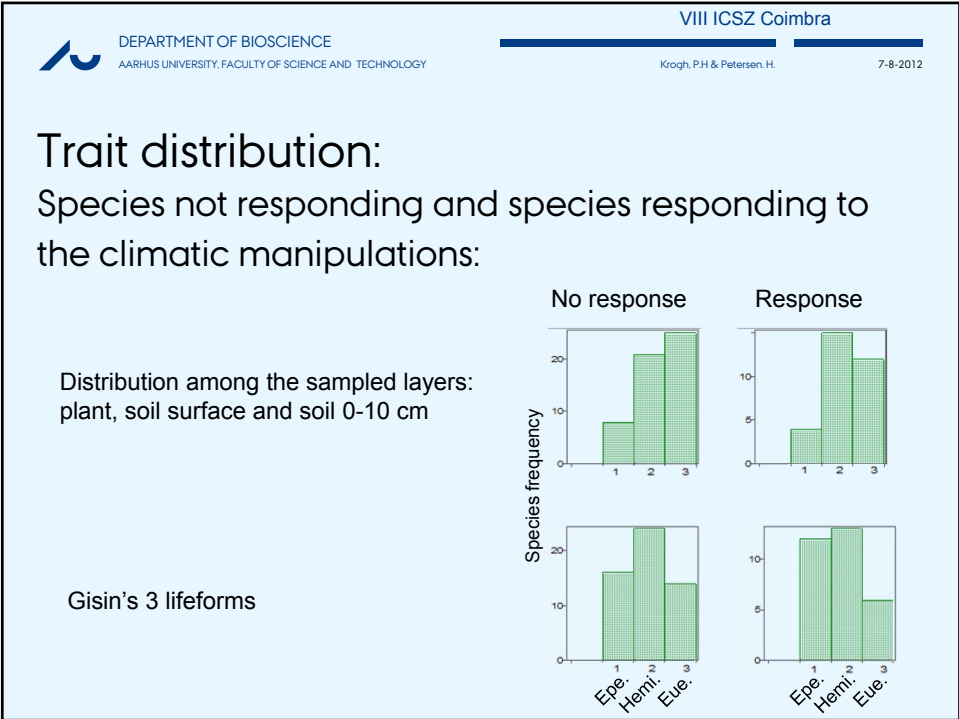


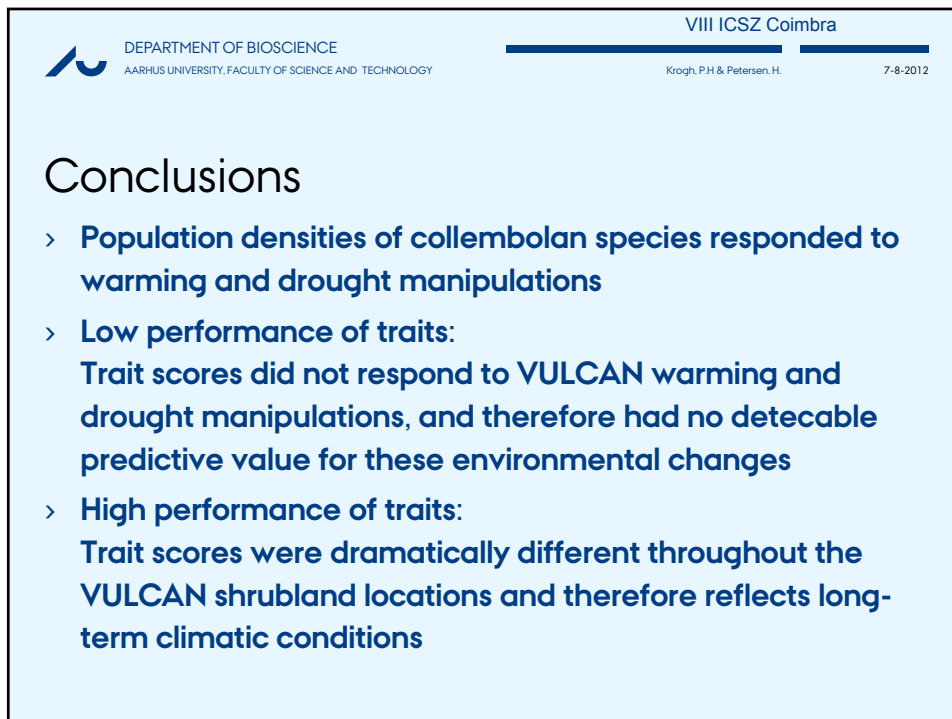
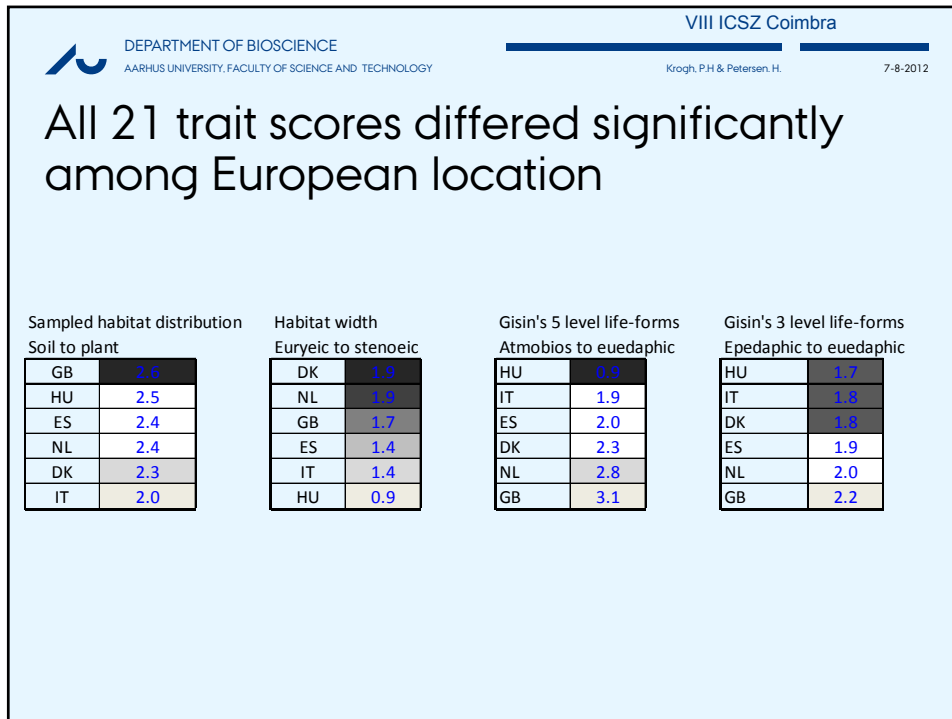
Seventeen collembolan species responded to the climate treatments according to statistical analyses

Country	C	W	D
DK <i>Isotomiella minor</i>	1098	415	693
DK <i>Entomobrya nicoleti</i>	9417	10659	5030
DK <i>Deuterosminthurus pallipes</i> f. <i>repanda</i>	24	124	5
DK <i>Sminthurus nigromaculatus</i>	526	346	193
GB <i>Micranurida pygmaea</i>	494	614	119
GB <i>Folsomia brevicauda</i>	10109	6559	1898
NL <i>Ceratophysella granulata</i>	702	124	0
NL <i>Micranurida pygmaea</i>	1973	640	507
NL <i>Pseudisotoma sensibillis</i>	720	53	53
NL <i>Lepidocyrtus cyaneus</i> / <i>violaceus</i>	613	180	421
NL <i>Pogonognathellus</i> (2 spp)	187	454	17
NL <i>Megalothorax minimus</i>	987	1821	0
NL <i>Sminthurinus aureus</i>	648	230	8
NL <i>Heterosminthurus</i> cf. <i>claviger</i>	137	49	32
NL <i>Sminthurus nigromaculatus</i>	837	147	469
SP <i>Protaphorura</i> cf. <i>quercetana</i>	958	364	160
SP <i>Mesaphorura</i> sp.	3697	1385	3653
SP <i>Isotomiella minor</i>	1120	0	160
SP <i>Folsomides parvulus</i>	3333	987	293
SP <i>Entomobrya</i> cf. <i>quinquelineata</i>	1059	202	286

Petersen (2011) SOIL ORGANISMS Volume 83(3)











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- > **ECOMARG (Danish EPA)**
- > **Colleagues at XVI ICSZ** A yellow smiley face emoji with a wide, open-mouthed grin.