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Groundwater and Biodiversity

Bonn, 30.10.2008

Groundwater - the resource

- Drinking water
- Agriculture (e.g. Irrigation)
- Industry



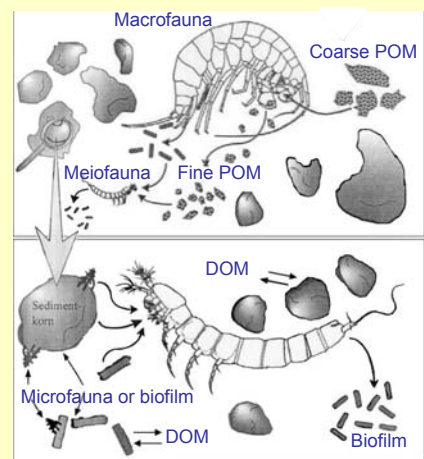
Groundwater - the biotope



Functioning of groundwater ecosystems

Key factors for groundwater ecosystems:

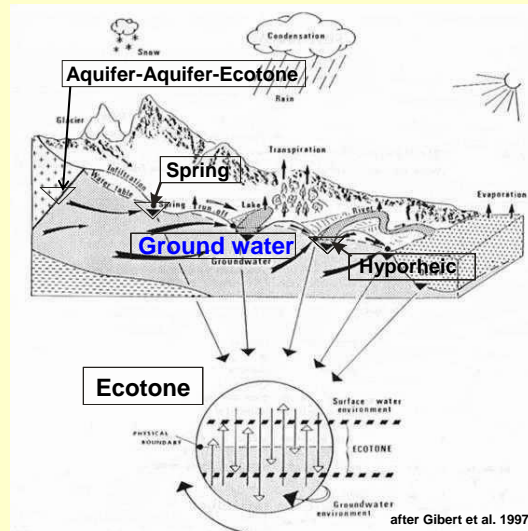
- Aquifer structure (hydraulic conductivity)
- Hydrological exchange
 - Oxygen
 - POM, DOM



CHO 2004

Groundwater as a part of the landscape

Ecotones
→ zones of high diversity



Groundwater ecosystems harbor:

- Microorganisms (Bacteria, Protozoa, Fungi) → see following talk (C. Griebler)
- Almost all major taxonomic groups of meiofauna encountered in surface waters
 - Crustaceans are most abundant
- Amphibean & fish in caves
- An impressive number of phylogenetically isolated animals and endemic species



Particularities of Groundwater

- darkness
- lack of photosynthetic primary production
- scarce food and oxygen resources (allochthonous import)
- heterotrophic and oligotrophic environment
- limited space
- highly adapted & diverse fauna

Particularities of GW-Fauna

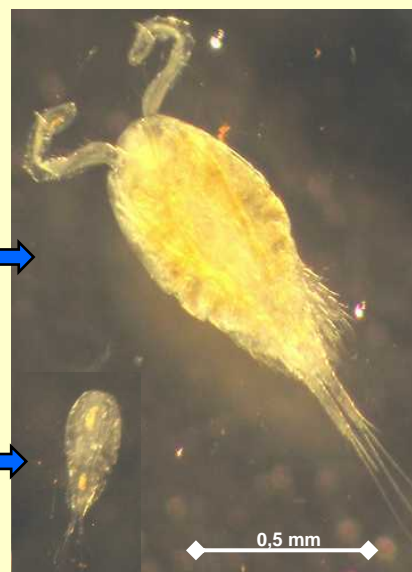
Adaptation to
darkness and limited pore space

- small & elongated
- absence of pigments and eyes

Surface →



← GW



Particularities of GW-Fauna

- reduced metabolism
- reduced reproduction rate
- extended life span

**Adaptation to
limited food supply**

GW



Bryocamptus c.f. rhaeticus

Surface



Acanthocyclops robustus

www.ulrichhopp.de

Particularities of GW-Fauna

Stygobiont = groundwater species

Stygophile = surface water species (able to live in the GW)

Stygoxene = surface water species (not able to live in the GW)

Stygobionts:

- high amount of endemits
- relicts (e.g. Bathynellids)
- living fossils
- scarce



Bathynella freiburgensis

Foto: A. Fuchs

Species richness in the GW

Metazoa:

~ 2,000 species in Europe known
50,000 – 100,000 species worldwide estimated

Cryptic species:

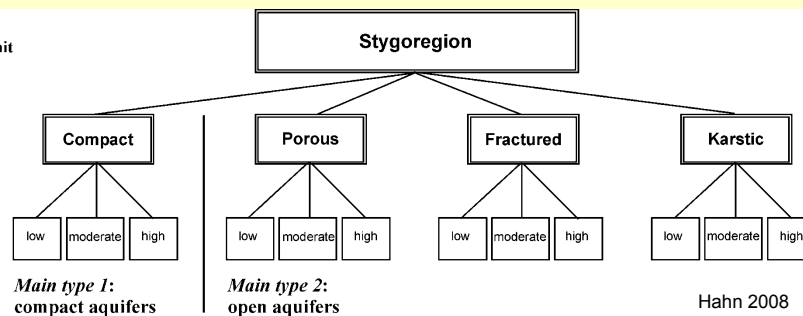
→ e.g. *Diacyclops languidoides* / *languidus* group

Biodiversity on different spatial scales

Macroscale:
Biogeographical unit

Landscape scale:
Hydrogeological
aquifer type

Local scale:
Hydrological
exchange with
surface water /
Alimony



→ Reference conditions for biodiversity
assessment are not defined up to now

Macro / continental scale

Northern Europe:

- few species
- mainly ubiquitous
- post-glacial recolonisers
- few endemic species

Central mountains:

- ca. 80% post-glacial recolonisers
- ca. 20% relicts
- distribution range limited on regions

Southern Europe:

- numerous species
- numerous relicts
- numerous endemic species

Macro / continental scale

Effects of ice ages

Distribution of Niphargidae

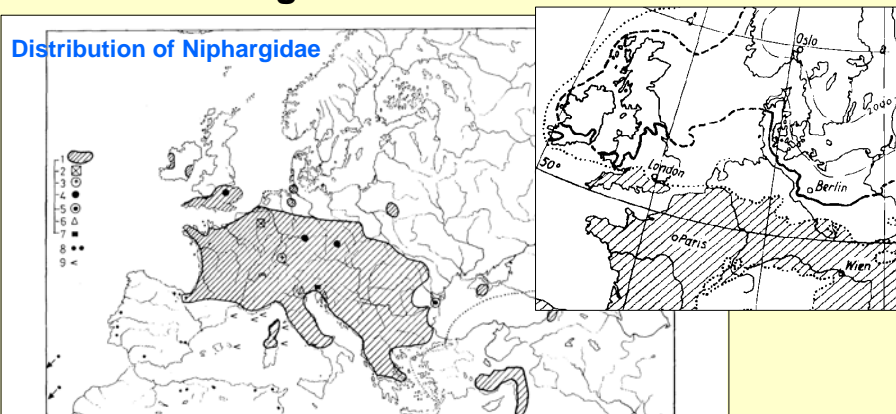


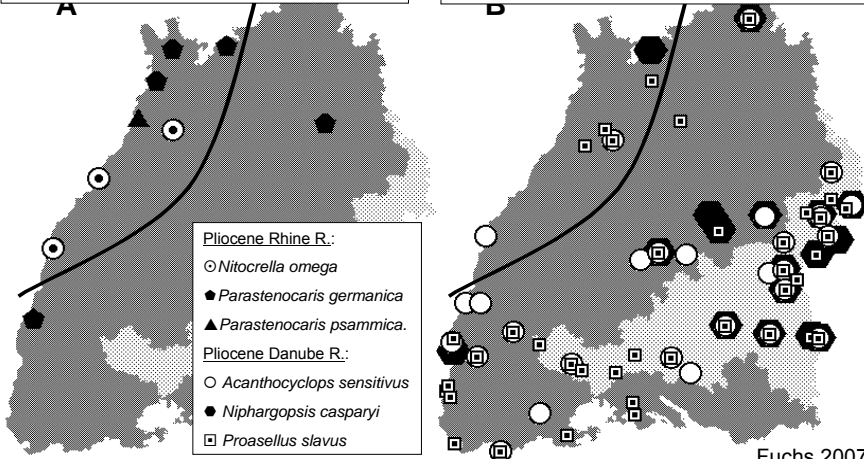
Fig. 336. Distribution of Niphargidae and of Pseudoniphargus.
Niphargidae: 1 – Niphargus; 2 – Microniphargus; 3 – Niphargopsis; 4 – Niphargellus; 5 – Pontoniphargus; 6 – Carinurella; 7 – Karamaniella.
Pseudoniphargus family group: 8 – Pseudoniphargus, freshwater occurrence; 9 – Pseudoniphargus, occurrence in polyhaline waters. Arrows indicate freshwater occurrence on the Azores and Madeira. The doubtful Bahyonyx from Ireland not mapped.
Map references: SCHELLENBERG, 1979; BOUSFIELD 1977; STOCK, 1980a.

Macro / continental scale

Effects of ancient river systems

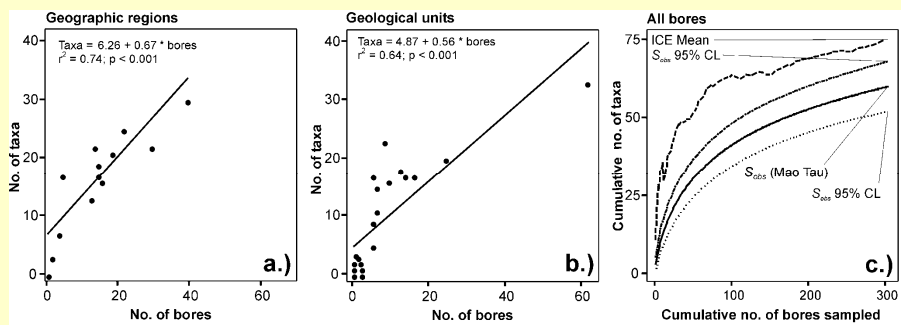
Species of the pliocene Rhine R.

Species of the pliocene Danube R.



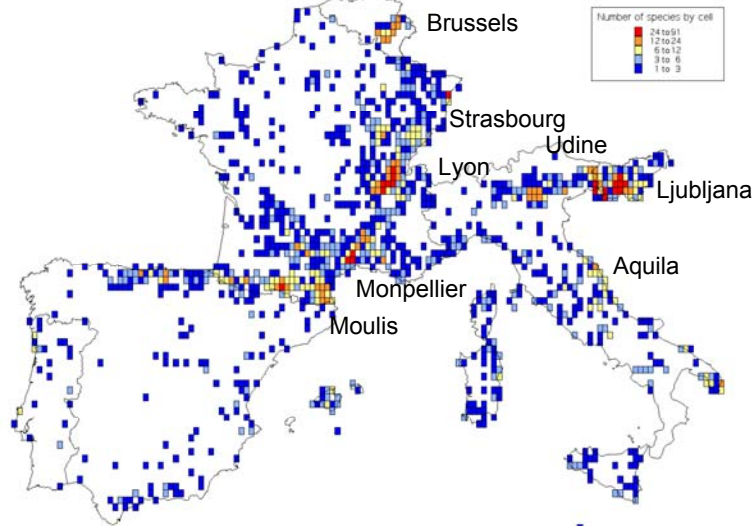
Landscape scale

- GW diversity strongly underestimated
- often comparable to regional surface water diversity



(Hahn & Fuchs 2008)

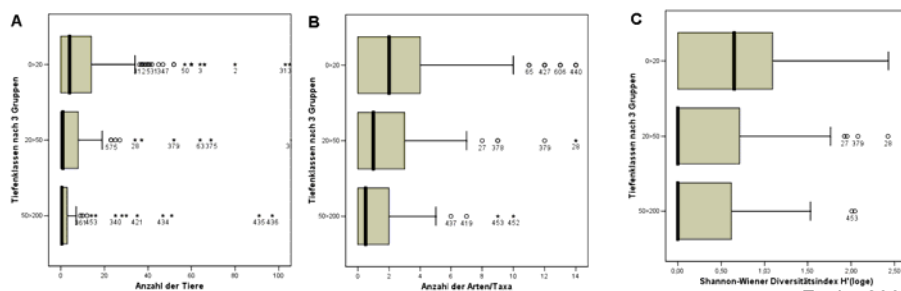
European PASCALIS project (2002- 2004)



Gibert et al. 2004

Local scale

- low site diversity
- $\bar{\emptyset}$ = 2-3 species
- 20 stygobiont species = hot spots of biodiversity
- abundance & diversity decreases with:
 - decreasing surface water contact
 - increasing depth



Fuchs 2007

Conclusions

- Groundwater is an important biotope
- Harbours a highly diverse and well adapted fauna
- Stygobionts are often relicts, living fossils & rare
- Key Factors for GW-ecosystems: → aquifer structure
→ hydrology (food & oxygen)
- Diversity strongly underestimated on a regional scale
- Knowledge about geographical distribution fragmentary

State of affairs

- EU-WFD & GWD focus on GW quality & quantity
- Ecosystems are not yet considered for implementation
- Reference conditions for biodiversity assessment
not defined until now
- No standards in assessment methods available
- Requirement: → Mapping of GW fauna
→ Red list of species & habitats
→ species & habitats in FFH annexes

Thank you!

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