

## Groundwater Faunal Diversity: constraints and Prospects



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## Groundwater Fauna: between the grains of sands

### ■ Interstitial life



### Groundwater Faunal Diversity:

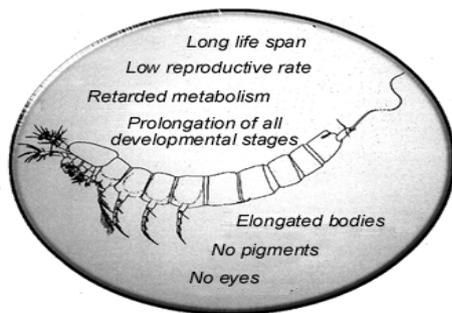
- Comprise the animals that live in underground water.
- Made up predominantly of crustaceans but also includes worms, snails, insects, other invertebrate groups,
- Two species of **blind fish** also reported from Australia (*Hancock PJ, Boulton AJ and Humphreys WF 2005, Hydrogeology Journal 13: 98-111*).
- Most species spend their entire lives in groundwater and are found nowhere else

### Representative groups reported so far :

1. Acari
2. Cyclopoida (Copepoda)
3. Ostracoda
4. Bathynella (Syncarida)
5. Elaphoidella (Copepoda1.
6. Parastenocaris (Copepoda)
7. Nematoda
8. Balcanella (Amphipoda)
9. Niphargus (Amphipoda)
10. Microcharon (Isopoda)
11. Stenasellus (Isopoda)
12. Larvae of Leuctra (Plecoptera)

### Characteristics of groundwater fauna:

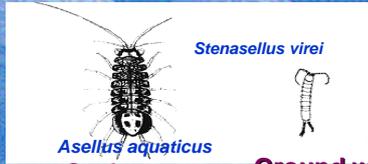
#### Characteristics of groundwater animals



### Comparison of life cycle data from two species of cyclopoid copepods:

Species on/in the	Surface	Ground water	References
Embryonic duration	1.5-2.5 days	12-26 days	Kumar and Rao, 1988, <i>Plankton Res.</i> , 10: 371-387
Juvenile Stages	6-10 days	120-280 days	Kumar and Rao, 1995 ( <i>Fresh water Biology</i> , 32: 487-501)
Moult	2-3 days	2-3 weeks	Ch & Diana, S. 2002 <i>Hydrobiologia</i>
Life expectancy	46-60 days	1.5-2 years	Kumar and Rao, 1999
Food habit	Algae and rotifers	Bacteria and detritus	Rao and Kumar, 2002, <i>Aquatic Ecol.</i> 36:
Starvation tolerance	12-16 days	45-68 days	Kumar and Tiwary, 2008, <i>Int. Review</i>

Comparison of life cycle data from two species of Isopoda from surface and ground water counterparts:



Life stages	Surface	Ground water
Marsupial stage	3 weeks	66 weeks
Juvenile stage	3 months	60-84 months
Egg production	Once per month	Every 2-4 years
Moult	Every 2-3 weeks	Once per year
Duration of moults	1,5 days	14 days
Life expectancy	1 year	15 years

Do they differ in their absolute number of offspring produced ?

- Their metabolism is reduced and the reproductive output is small compared with surface water organisms.

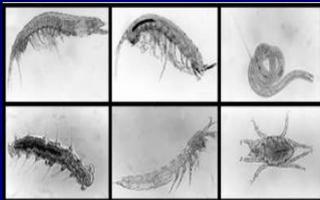
But

- due to the long life span of stygobionts the absolute number of offspring may be similar to that of surface water organisms

The Actors



Parastenocarididae



Clockwise from: *Antrobathynella stammeri* (Syncarida), *Niphargus kochianus* (Amphipoda), *Onchulus nollii* (Nematoda), *Troglochaetus beranecki* (Polychaeta), *Chappuisius inopinus* (Copepoda) and *Soldanellonyx monardi* (Acari)

Significance of exploring ground water diversity:

- The species are often closely related to those on other continents,
  - Patterns of affinities indicate their common origin on the ancient supercontinents of Gondwana and Pangaea,
- or
- In the Tethys ocean that eventually emerged from the east with the opening of the Atlantic Ocean about 200 million years ago (Humphreys 2000).

What do we learn from their requirement for permanent groundwater and their ancient origins ?

- The presence of stygofauna may indicate the long-term presence of suitable groundwater,
- Their presence is considered to predate the break-up of the super continents and to indicate the continuous presence of groundwater throughout the subsequent climatic oscillations (Humphreys 2000).
- more recent colonizers of groundwater, (subterranean diving beetles) invaded the groundwater 8-5 million years ago (Leys *et al.*, 2003). Thus, their loss will indicate that groundwater conditions have changed more or faster than in previous epochs.

Contribution of Stygofauna to the overall Biodiversity

- Groundwater fauna contribute substantially to the Biodiversity of Australia, (Schmidt 2005; Eberhard 2004; Hancock 2004) Morocco, (Fakher *et al.*, 1999), Germany, (Scimke, *et al.*, 1996, 98, 2002, 2004, 2009), France (Boutin, 1994), Italy (Diana, 2002) USA etc.
- In India: The study of the fauna of subterranean waters in India has only recently begun (Ranga Reddy, 2004; Holsinger *et al.*, 2006; Messouli *et al.*, 2007; Karanovic & Ranga Reddy, 2008).

## ➤ No. of species known in India:

- 8-10 species known.
- All are near Vijayavada, Andhra Pradesh (5 subsurface Krishna river bed exposed or submerged, all belonging to the genus *Parastenocaris*)
- Two *Hydrobathynella*: *H. schminkei*, *H. nagarjunai* (only two ground water eustygobionts) representatives from south Asia.
- Fortunately this year the Ministry of Environment and Forest has conferred "E. K. Janaki Ammal National Award for Animal taxonomy 2007 to the stygobiologist Prof. Y. Ranga Reddy.

## A key problem:

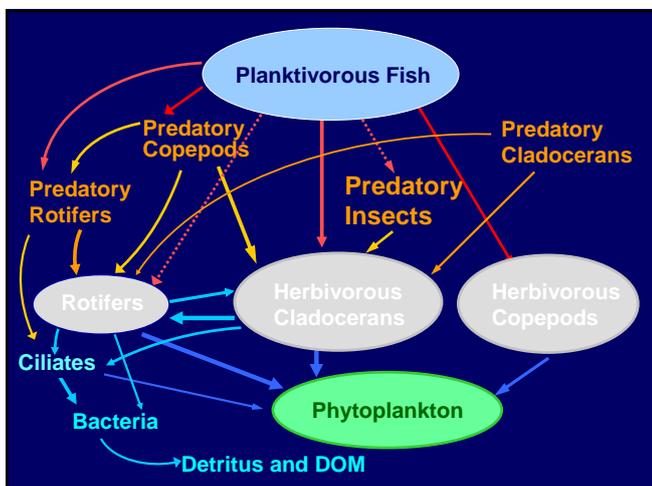
- Shortage of taxonomic capacity, in terms of both expertise and numbers.
- No common information pool to combine data that are gathered by numerous and disparate groups including government instrumentalities, academic centres and consultants.



Prof. Ranga Reddy with his award and medal conferred by the MOEF

## Ecology:

- Lack of light; no primary production,
- Groundwater food webs are almost heterotrophic,
- The production depends on the input of organic matter from the surface.
- **Unpolluted** groundwater systems have scarce trophic resources and their biocoenoses are delineated by **simple and few trophic links**.
- Most of the organic matter entering the groundwater habitat is mineralised by microorganisms,
- The microbes serve as food for secondary consumers,
- Predatory invertebrates mark the end of the food web.



## TROPICAL AQUATIC ECOSYSTEMS

- Nutrient recycling rates are faster.
- Food web structure, particularly at the intermediate level, is more complex and more variable (spatially and temporally).
- Nutrient levels in ground waters are more than the temperate systems

## LATITUDINAL TRENDS IN INVERTEBRATE ZOOPLANKTON PREDATORS

### Tropical lentic systems are characterized by

- & Absence of predatory cladocerans
- & Fewer species of predatory copepods
- & Uncommonness of *Chaoborus* (?)
- & Greater species diversity of aquatic insects and Hydracarina

## How does subterranean counterparts differ from epigeal aquatic diversity?

- No information on ecology, microbiology or physiology of subterranean fauna except a single study by Kumar and Rao, 2008
- Only 8-10 species are known to date.
- No Taxonomist available to identify a Stygofauna if encountered
- There are wide diversity of underground aquifers in Bihar and adjoining states with various sand granular sizes.
- Does our ground waters not support such life forms  
*If not? Why*  
If yes  
How are these affected by our activities on surface

## How many species are hidden



- ☞ With drying climate, salinisation of surface waters and increasing population,
- ☞ groundwater is becoming an increasingly important resource, one already over utilized in places.
- ☞ Stygofauna could be used in both monitoring and maintaining aquifer condition.



- ☞ All biotopes, wells, springs and river underflows, have to be prospected in this province with a continental climate.
- ☞ The fauna and ecology of wells and springs, stygobiologically interesting, are to be regularly investigated.
- ☞ The study should be focused mainly on the Paracarid Crustacea: Thermosbaenacea, Amphipoda Metacrangonyctidae, Isopoda and Copepoda.

we shall not cease from exploration and the end of all our exploring will be to arrive where we started and know the place for the first time through the unknown, remembered gate when the last of earth left to discover is that which was the beginning"

(T. S. Eliot)

**Thank you !**

