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Unravelling the food-web structure of the subterranean invertebrate communities of arid zone Western Australia

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INTRODUCTION

BIOGEOLOGICAL CONTEXT

- Subsurface invertebrate fauna appear in a range of near-superficial geological formations including karst and non-karst systems (Humphrey, 2009)
- Groundwater calcretes biogeochemistry (lack of light, low organic carbon and nutrients) shape composite subterranean communities, encompassing species at different stages of adaptation (4K species in WA (40 under immediate threat) (EPA, 2012)
- Invertebrate communities in these systems act as bioindicators and bioremediators, specially in polluted and contaminated environments (Boulton et al., 2008)

TROPHIC DYNAMICS

- The energy fluxes within calcretes are one of the most important factors for the understanding of the overall system functioning (Humphrey, 2008)
- The loss of individual food web components, caused by anthropic perturbations and climate change, is likely to have a considerable negative impact (Chapelle, 2001)
- Many of the invertebrate community functional aspects (trophic relationships, physiochemical parameters related patterns, ecological trends, etc.) are poorly understood in groundwater environments

OBJECTIVES

The study will involve Compound Specific Isotopic Analysis (CSIA: $\delta^{15}\text{N}$, $\delta^{13}\text{C}$, δD) of the trophic relationships and energy fluxes in groundwater environments of Yilgarn region. Three objectives:

- Recover quantified information about trophic position of various subterranean fauna
- Identify the energy sources within the ecosystem
- Investigate the ecological status of the ecosystems by using macroinvertebrates as biological indicators

MATERIALS AND METHODS

STUDY SITE

GEOLOGY

Yilgarn Craton: landmass of igneous and metamorphic rocks rich in gold. The calcretes of the area are secondary sedimentary deposits with a strong biochemical gradient, comparable to estuarine systems.

STUDY AREA

Western Shields (WA), region of Yilgarn (~700,000 Km²).
Two calcrete aquifers: **Sturt meadows (a)** and **Laverton downs (b)**

STABLE ISOTOPES ANALYSIS

CSIA	BULK ANALYSIS
Novel approach (especially in calcretes)	Long used
$\delta^{15}\text{N}_{\text{glu-phe}}$: centered values (+7.6‰)	$\delta^{15}\text{N}_{\text{bulk}}$: broad values (-2.1 to +9.2‰)
$\delta^{13}\text{C}_{\text{CSIA}}$: not affected by the uptake of tracer C-fragments	$\delta^{13}\text{C}_{\text{bulk}}$: overestimations of direct amino acid uptake
Detailed trophic discrimination	Imprecise/inaccurate trophic discrimination

+ advantage; - disadvantage

Steffan et al., 2013; Sauheitl et al., 2009

$\delta^{13}\text{C}$
Compound Specific

LC-IRMS

$\delta\text{D} / \delta^{15}\text{N}_{\text{glu-phe}}$
Compound Specific

GC-IRMS

WATER & STYGOFAUNA

WATER SAMPLES

- Hydrolab Quanta Multi-Probe Meter
 - T (°C)
 - pH
 - ORP (mV)
 - Specific cond (mS/cm)
 - Salinity (PPS)
 - DO (% & mg/L)
 - Depth (m)
- Methacrylate cylinder (Ø 50mm)
 - Total Nitrogen (TN) (mg/L)
 - Total Sulphur (TS) (mg/L)
 - Total Phosphorus (TP) (mg/L)
 - Total Organic Carbon (TOC) (mg/L)

AQUATIC INVERTEBRATES

- Taken by a weighted plankton net (mesh 250 mm)
- Sorted out under stereomicroscope and frozen

CSIA, FATTY ACIDS & STATISTICAL ANALYSIS

$\delta^{15}\text{N}_{\text{glu-phe}}$ enrichment: 0.5-1‰ per trophic level.

$\delta^{13}\text{C}$ enrichment: 7.6‰ per trophic level.

FURTHER ANALYSIS

- Biotic assemblages in the ecosystem (high taxonomic resolution and specificity)
- Community and ecosystem dynamics: multivariate non-parametric statistical approach (Cluster Analysis, NMDS, PCA, CCA, etc.)
- Association with environmental parameters: ordination techniques and General Linear Models (GLM)

Barcoding

FATTY ACIDS

SIGNIFICANCE

- First application of CSIA to subterranean ecosystems, providing a quantified trophic position for each organism analysed
- Information on the food web structure within groundwater ecosystems (environmental impact assessment and mining)
- Information on the energy source into groundwater ecosystems (base-line knowledge)
- Additional information on the taxonomy and biology of subterranean ecosystems (combined with genetic analysis)

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