Insects Role Changes in Streams Under Shifting Environment and Climate

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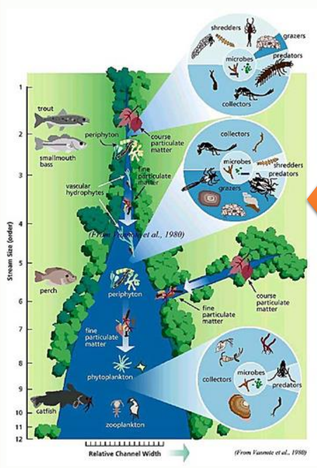
Abstract

Functional diversity (Variety of roles the organisms play in the environment) quantifies the value and range of organismal traits influencing species roles and performance in ecosystems. Aquatic insect functional diversity has been examined previously, but not in the context of strong environmental and climate gradients. We quantified and tested differences in three primary components of functional diversity of stream insects along an altitude gradient: Functional Richness (FRic), Functional Evenness (FEve) and Functional Divergence (FDiv). 24 small streams in three adjacent basins were studied; spanning an elevational range of 2000-3500 m.

Our results showed that only FRic differs significantly with altitude, and this pattern of change remains constant across basins.

What is the role of Aquatic Insects?



In streams

Young Mayfly

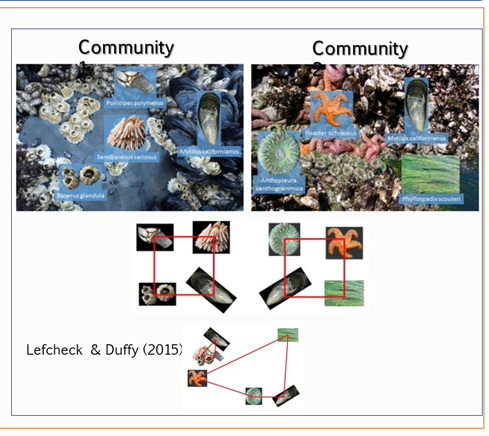
On land

Adult Mayfly

Background: Functional Diversity (FD)?

What is it?
Value, spread, distribution and abundance of the functional traits in ecosystems.
(Díaz *et al.*, 2007)

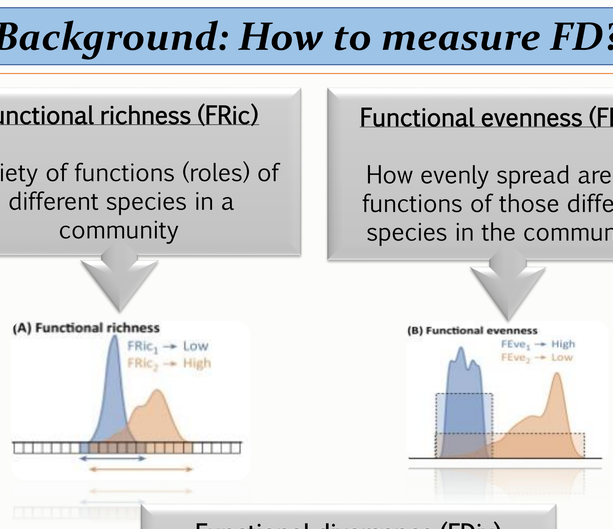
Why the interest?
- Influence organismal performance
- Ecosystem functions



Background: How to measure FD?

Functional richness (FRic)
Variety of functions (roles) of different species in a community

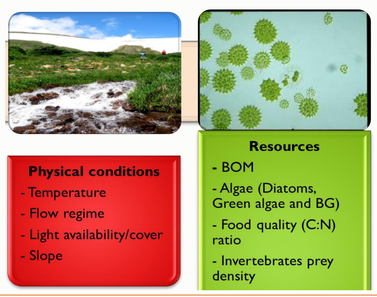
Functional evenness (FEve)
How evenly spread are the functions of those different species in the community.



Functional divergence (FDiv)
How different are the species in terms of the roles they play in the stream.

Source: Adapted from Villéger et al., 2008 & Carmona et al., 2016; Mouillot et al., 2013

Why measure Diversity along elevation?



- Higher elevations = less variety of species and less similar to lower elevations.
- Food (resources) and water temperature change as elevation increases.

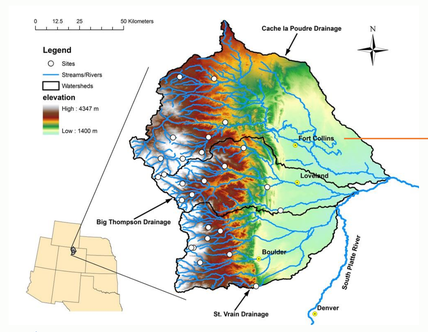
Main Question?

Is the functional diversity (FD) [Variety of roles/functions] of aquatic insect communities changing along an elevation gradient in mountain streams?

Hypothesis

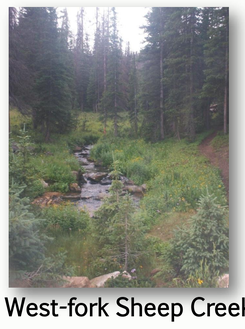
All aspects of Functional Diversity of Aquatic Insects will have a significant change with increasing elevation, because food resources and water temperature are changing drastically along the elevation range in mountain streams.

Methods



Elevation

Source: Harrington (2014)



West-fork Sheep Creek

Beaver Creek

Killpecker Creek

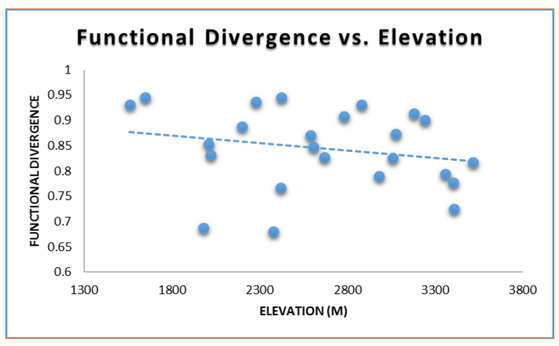
Elkhorn Creek

- 24 streams total
- 200 meter elevation bands ranging from 1500m-3500m
- Replicated in 3 drainages.

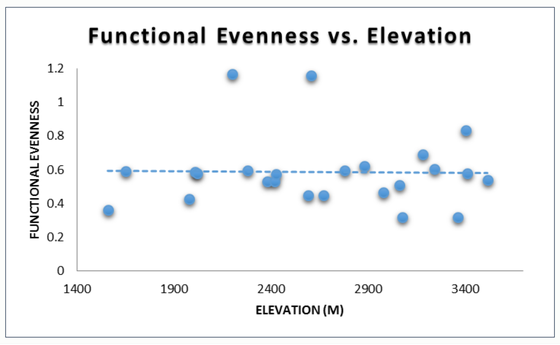
- Analysis of variance (ANOVA) on indexes' values to test the hypothesis of variation along the altitudinal gradient.

Results / Discussion

- Different among drainages and elevation (p <0.05)
- Marked decline with increasing elevation.



- Marginal differences among drainages and elevation (p=0.05).
- Slight decline with increasing elevation.



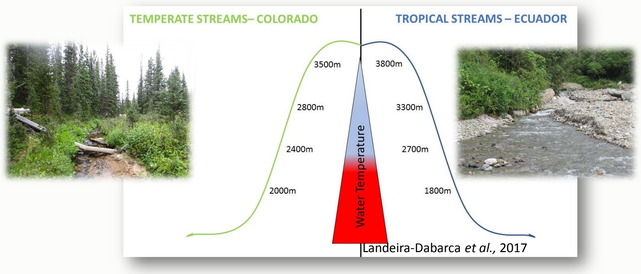
- No observed change with elevation (p>0.05)

Implications

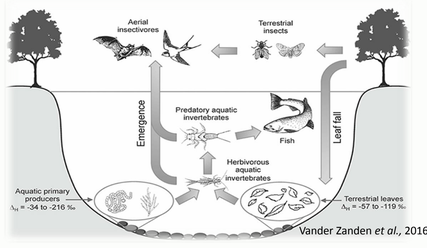
- The variety of roles (Functional Richness) that Aquatic Insects perform in the environment, changes with increasing elevation in Rocky Mountain Streams
- The change in these functions does not depend solely on species identity, but also on changes in food resources and water temperature along the elevation gradient.
- Further analysis is required to understand the mechanisms and variables that affect the diversity of roles of insects in streams.

Work in progress and Future Directions

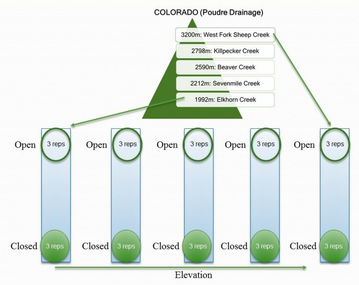
Future work will include:
- Analysis of Changes in FD along the gradient of resources.
- Context of results along gradients comparing mountain temperate streams vs. tropical mountainous streams:



- Changes in diets of insects (Food webs) along the gradient and the impact on stream food webs and function:



- Relationship of Functional Diversity with canopy cover and water temperature.



- Impact of disturbances amplified by climate change on aquatic insect functional roles, and stream ecosystem functions; particularly in more sensitive tropical systems.

Example: Different flood impacts!

Flood in a temperate mountain stream (2013)

Flood in a tropical mountain stream (2016)

Acknowledgements

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