

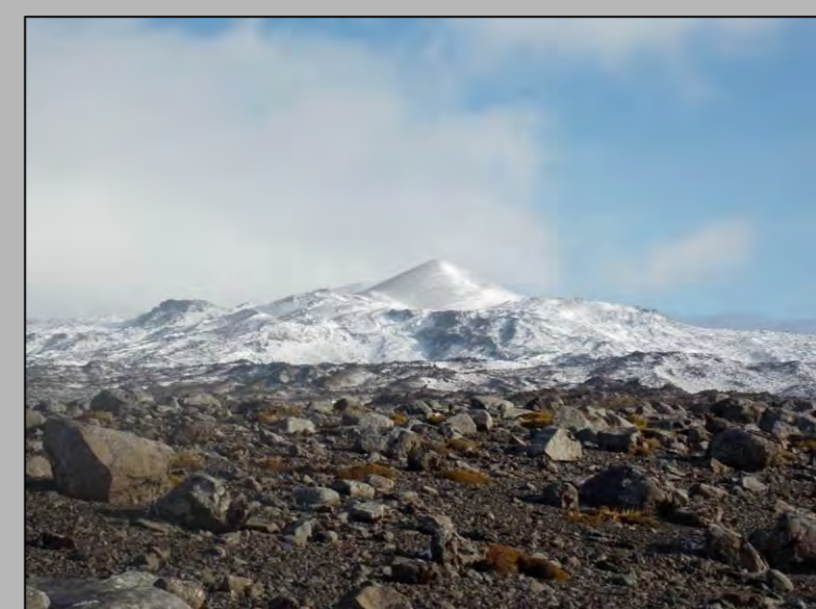
Chlorophyll Fluorescence Characteristics of Marion Island Bryophytes

Jacqueline Tonkie

Department of Botany & Zoology, University of Stellenbosch

1 Bryophytes on Marion Island

- Bryophytes (93 moss species and 44 liverwort species) form the major component of the lowland (tundra) and are overwhelmingly dominant in the upland (polar desert) vegetation types of the island. In contrast, there are only 23 indigenous vascular plant species.



- Bryophytes contribute significantly to ecosystem functioning, e.g.:
 - Primary production
 - Nutrient cycling
 - Food chains and animal interactions
 - Colonization of newly formed lava
 - Vascular plant facilitation

2 In search of the 'Holy Grail' → Plant functional types

PFTs = groups of species with similar **functional traits** that respond and exploit their environment in similar ways.

- The traits can be anatomical, morphological, physiological or phenological characteristics, and also life history strategies.
- These traits reflect trade-offs in design & function that enable a plant to function optimally in its environment.

Why are we interested in plant functional traits?

- Based on similarities in their traits, species can be grouped into **PFTs**.
- This reduces the complexity of plant community or vegetation studies compared with using individual species.
- It thus simplifies the construction of models of ecosystem functioning or to predict the effects of climate change, or other perturbations such as man's introduction of invasive alien organisms

3 Almost all efforts have involved vascular plants, little attention paid to bryophytes

Bryophyte quasi-functional type classifications proposed to date

1. Life form classification of Mägdefrau (1969, 1982), adopted by Glime (2007) and Hill et al. (2007) in BRYOATT

- Reflects strategies to avoid water stress and maximize photosynthesis

Cushion moss

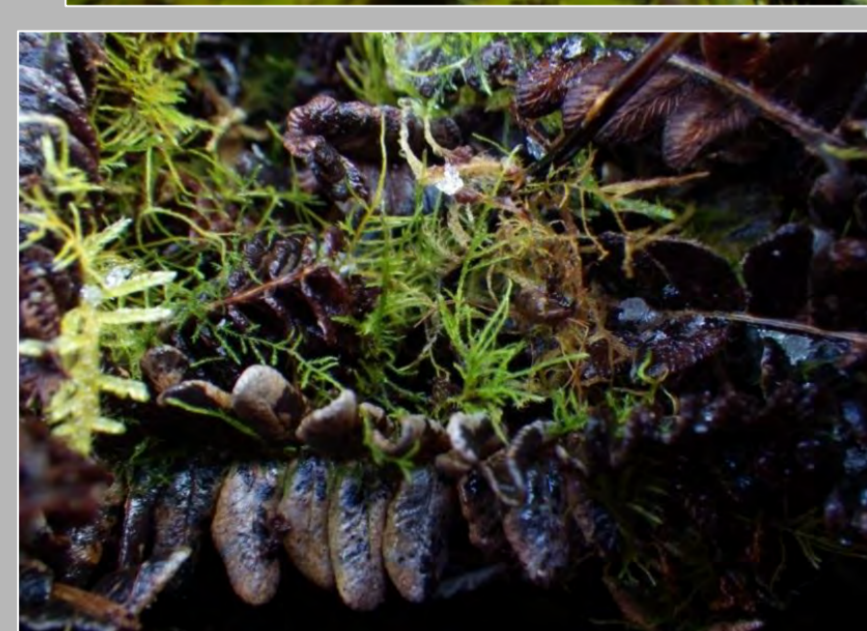
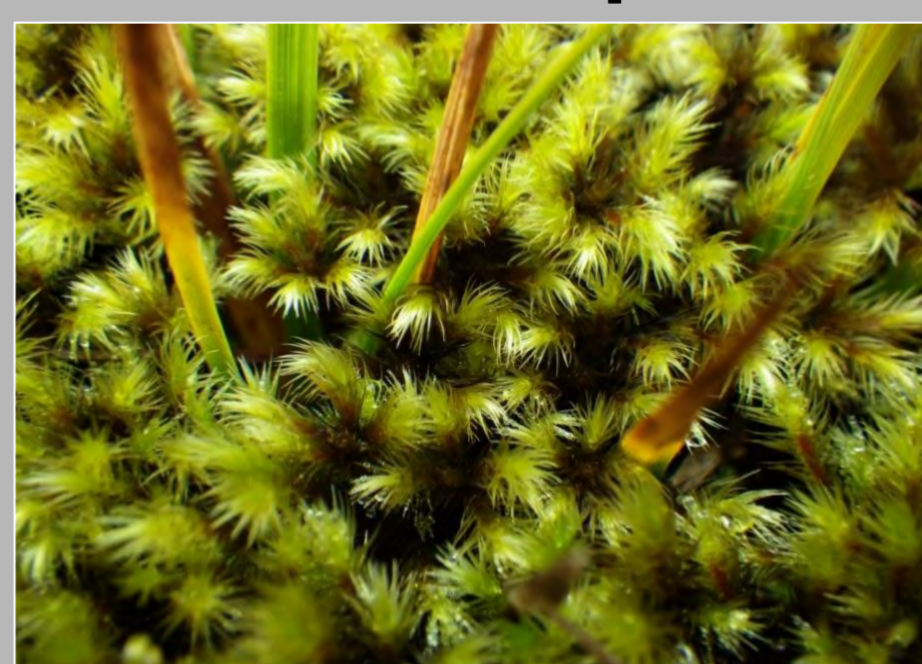


Tuft moss

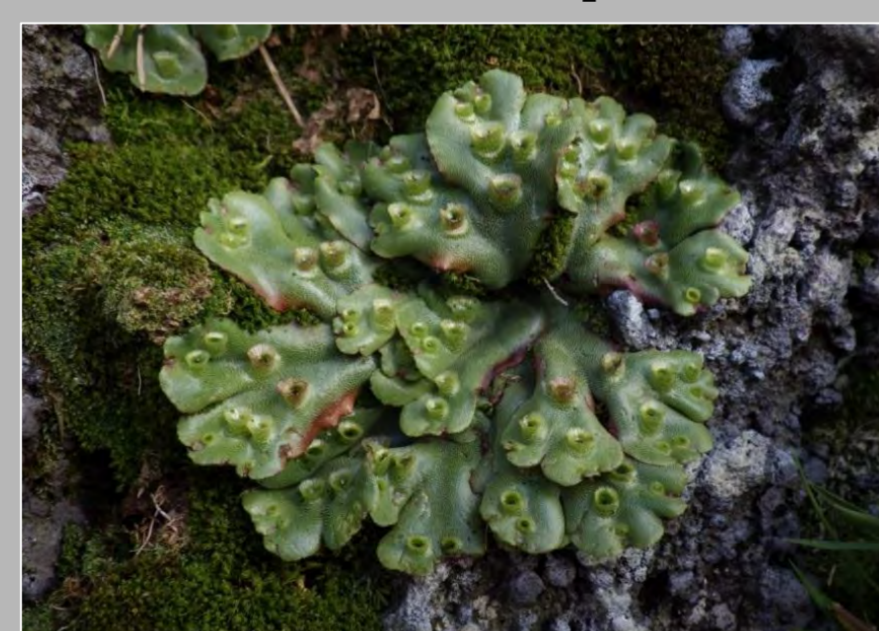


Scattered turf moss/ hepatic

Turf moss/ hepatic



Weft moss/ hepatic



Thallose hepatic

Rough mat moss



Smooth mat hepatic



2. Life strategy classification by During (1979)

- Life strategy considered to be a system of co-evolved adaptive traits representing reproduction and growth

3. Both classifications criticized as they depend on a limited set of traits with an implied functional significance. This has not been tested (Bates 1998)

4 What traits to measure when classifying bryophytes into PFTs?

Cornelissen et al. 2007 proposed a list of traits related to biochemical cycling that would enable an explicitly functional type of classification for bryophytes

They listed the conditions a functional trait must meet:

- Bear a relationship to plant function
- Be easy and quick to quantify
- Have standardized measurements
- Have consistent ranking when environment conditions vary

Concluded that chlorophyll fluorescence "may be the priority candidate for multi species screening for photosynthetic characteristics"

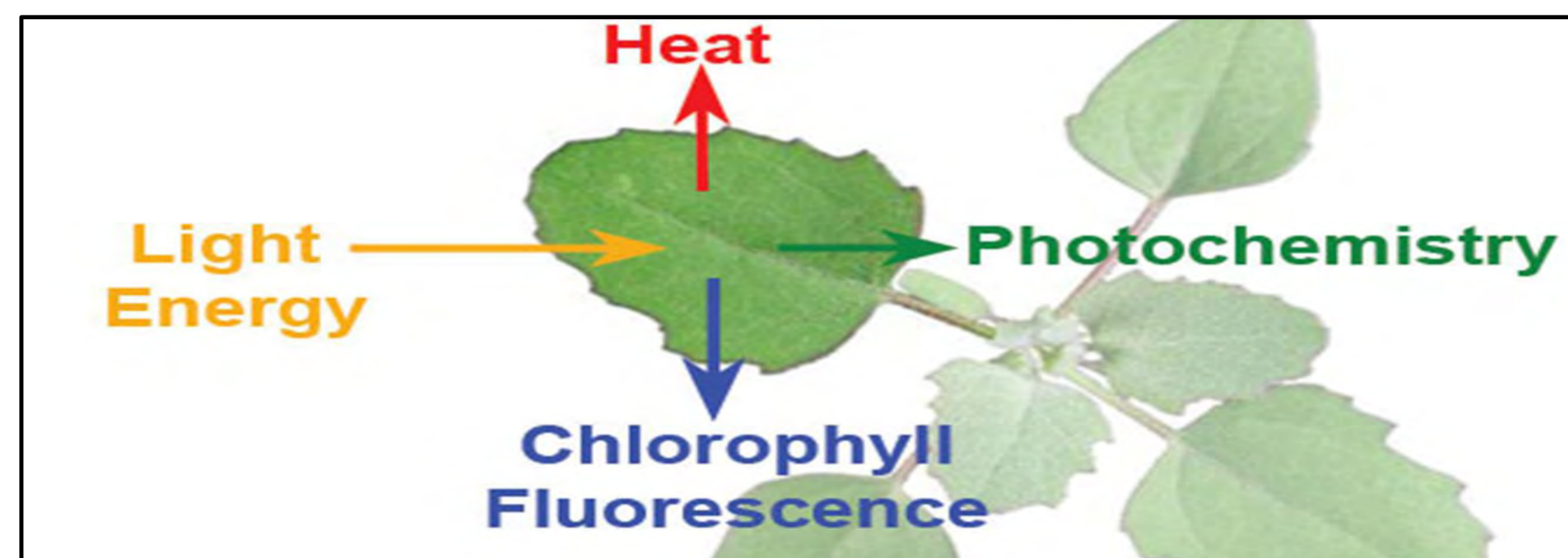
5 Chlorophyll fluorescence as a tool

Three fates of energy in a leaf

- Converted to chemical energy - **Photochemistry**
- Heat dissipation (regulated or non regulated) – **Non-photochemistry**
- Re-radiated as red light – **Chlorophyll fluorescence**

Technique measures chlorophyll fluorescence. Photochemistry and non-photochemistry are calculated from quenching analysis

Yields a suite of traits related to photosynthetic capacity that fulfil all the requirements that a functional trait must meet



6 A pilot study was carried out to assess the feasibility of grouping 35 of the island bryophyte species into photosynthetic functional types using chlorophyll fluorescence quenching analysis

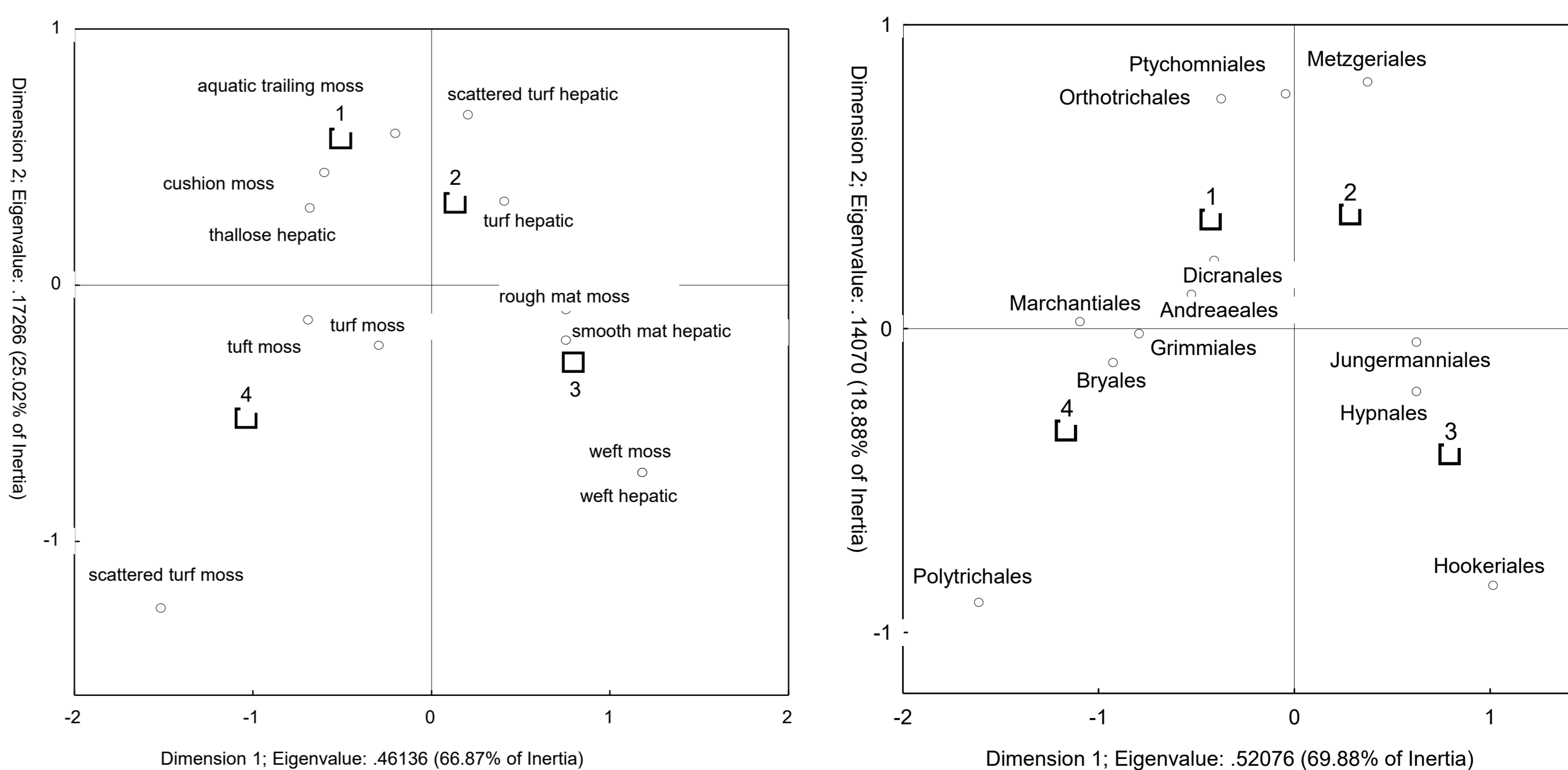
- A suite of 5 photosynthetic characteristics was derived from measurements of fluorescence yield at different light levels
 - The characteristics reflect the maximum photosynthetic capacity, light saturation of photosynthesis, ability to dissipate excess light energy as heat and vulnerability to photoinhibition
- The characteristics were subjected to univariate and principal component analysis and Ward's clustering method to group the species into photosynthetic types

Results

Seven photosynthetic types were observed using the univariate analyses, which reduced to four types using the multivariate analyses

Correspondence analysis shows:

- There is some phylogenetic structure photosynthetic type grouping
- Some associations between life form and photosynthetic type



Future research: Characteristics of the photosynthetic response to desiccation; gas exchange measurements of photosynthesis and water loss.