

# Critically reading scientific papers

Meredith C. Schuman

The following are guidelines to effectively read a scientific paper.

(1) Summarize briefly what the authors claim. See also point (3).

Read the title and abstract. Summarize the claims in your own words or paste in the key sentences as a citation if they are very clear to you, for reference.

The author claims that the plenty leaf metabolite chemistry can be expressed in five chemical functional trait (see Q.3 below for reference), those can be classified into two groups:

1. Leaf chemical defense spectrum
2. Expression of leaf longevity

The author also claims that those two groups are independent of traditional plant trait, which lead to new topic in metabolic specialization to investigate at.

(2) What are the authors' hypotheses (or questions), tests (or ways they attempt to answer the questions), and conclusions? Are these supported? See also point (3).

Read the last paragraph of the introduction; methods & results; first & last paragraphs of the discussion.

➔ Pay special attention to **figures** and **tables**, both in the **main** and in the **supplementary**! Are these clear? Does their organization make sense to you? What is the take-home message of each one?

There are two alternative hypothesis which the author hypothesizes:

1. if the metabolome varies colinearly with functional traits, then it offers a biochemical validation of the functional trait concept (colinear= correlated, this tells us that the chemistry and classical traits tell the same story).
2. if the metabolome varies orthogonally to functional traits, then it describes dimensions of plant life-history variation missed by existing functional traits. (independent= uncorrelated, which means metabolites support something different than the physical traits).

The author collected leaf metabolites found in 457 tropical and 339 temperate species. Those chemical properties were then reduced from 21 to 5 which are as follows: molecular weight, aromatic atom count, hydrogen bond acceptor count, polarity ( $X \log P$ ), C hybrid. ( $sp^3:sp^2$ ) those five traits show typical chemistry plants metabolites (those properties were clustered through hierarchicalclustering;Ward) **Ref. Fig. 1**, After that PCA analysis was done to reveal the dominant patterns in leaf chemistry, which resulted in two major axes (defense linked to aromaticity and A-polarity, and longevity linked to molecular size and saturation) these two axes appeared both in tropical and temperate species, showing that the patterns are global. The author then compared the metabolic traits to classical traits as in Fig. 4, the heatmap shows that metabolic traits and classical traits form separate clusters and are mostly uncorrelated. The author concludes that this Fig.4 supports the orthogonality hypothesis.

- ➔ Summarize the authors' line of argument in your own words and note whether you think their arguments are supported, and why or why not (or if you can't judge because something is unclear).

The authors argue that leaf chemistry might show plant differences that normal plant traits cannot. Author test this on tropical and temperate plants and finds two main chemical axes (defense and longevity). These axes do not match classical traits, meaning metabolomics adds new information. The figures and statistics strongly support authors argument (especially Fig. 4 which supports orthogonality hypothesis).

### (3) Note anything you think is either especially well done, interesting, or unclear.

Do this while addressing points (1) and (2) above and then reading the rest of the paper.

Just make free notes here. You can sort them later if needed.

According to Walker et al. (2023),

Found in Abstract:

- “distilling metabolite chemistry into five metabolic functional traits reveals that plants vary on two major axes of leaf metabolic specialization—a leaf chemical defense spectrum and an expression of leaf longevity”
- “metabolic traits vary orthogonally to life-history strategies described by widely used functional traits. The metabolome thus expands the functional trait concept by providing additional axes of metabolic specialization for examining plant form and function.”

Something which I found confusing is what if the author considered different environments than tropical and temperate like extreme cold environments would the tests support his argument or would it be something new (new correlation, than orthogonality), as a reader I must assume generality which is in my opinion a little bit questionable.

### (4) Summarize your thoughts about and understanding of the paper.

The following very useful suggestions come from the [eLife assessment](#) model.

Answer these questions: for whom is this study of interest? What are the authors' aims? What did they do (measure/observe/analyze) in what system? How well does the evidence support the conclusions?

**Example:** “This **landmark** study provides a comprehensive morphological and molecular description of the majority of documented neuronal cell types in the mouse cortex. This provides an extraordinary resource that will be invaluable to the whole neuroscience community. The methodology for combining expansion microscopy with spatially resolved transcriptomics across tissues is **exceptional** and establishes a new standard in the field.”

Use standardized terminology

For breadth of interest (and potential breadth of impact):

**Landmark:** findings with profound implications that are expected to have widespread influence

**Fundamental:** findings that substantially advance our understanding of major research questions

**Important:** findings that have theoretical or practical implications beyond a single subfield

**Valuable:** findings that have theoretical or practical implications for a subfield

**Useful:** findings that have focused importance and scope

For strength of support:

**Exceptional:** exemplary use of existing approaches that establish new standards for a field

**Compelling:** evidence that features methods, data and analyses more rigorous than the current state of the art

**Convincing:** appropriate and validated methodology in line with current state-of-the-art

**Solid:** methods, data and analyses broadly support the claims with only minor weaknesses

**Incomplete:** main claims are only partially supported

**Inadequate:** methods, data and analyses do not support the primary claims

This paper is important for botanic and environmental studies it shows orthogonality of metabolic and classical traits found in leaf metabolites which may reveal new information in the field of studies of ecology and plants. The author supported arguments with PCA correlation analysis to show that metabolic traits form their own independent axes of variation. The conclusion of the paper opens up a promising topic of research which may change the way scientists classify and understand plants.