

$\delta^{15}\text{N}$ in lichens reflects the isotopic signature of ammonia source

Silvana Munzi,

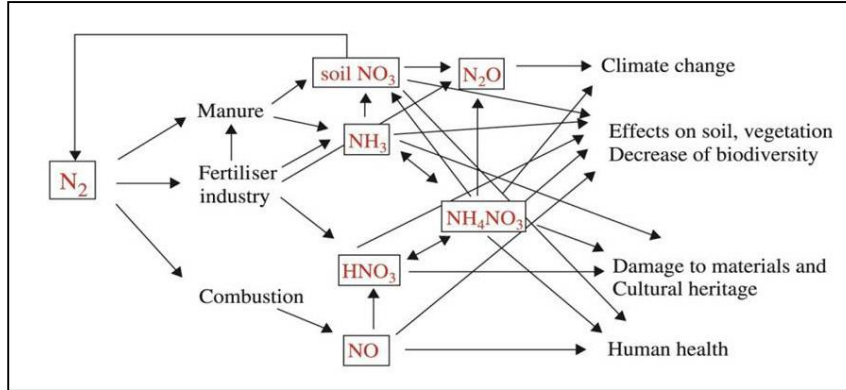
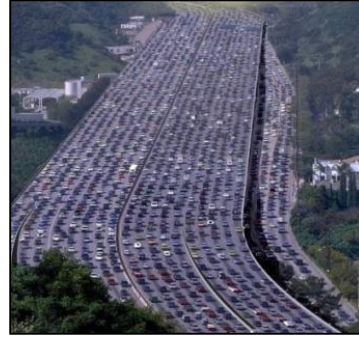
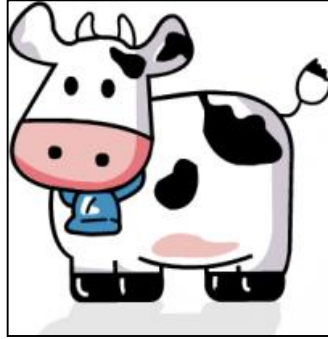
C. Branquinho, C. Cruz, C. Máguas, I.D. Leith, L.J. Sheppard, M.A. Sutton

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Biomap 8

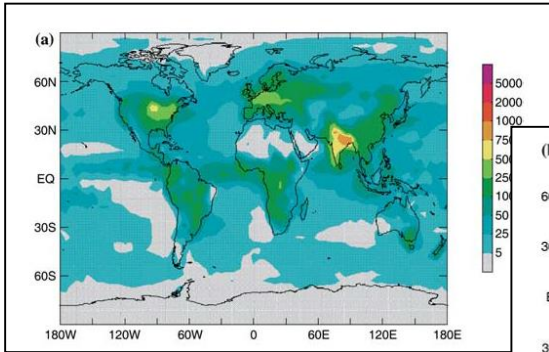
Joint Institute for Nuclear Research, Dubna, 02-07 July 2018



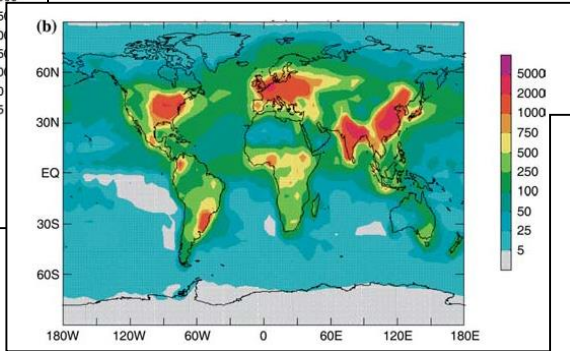




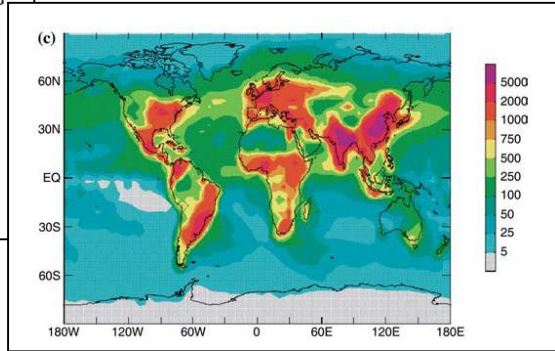
Total inorganic N ($\text{mg N m}^{-2} \text{y}^{-1}$)



1860



1990



2050



Global

Regional



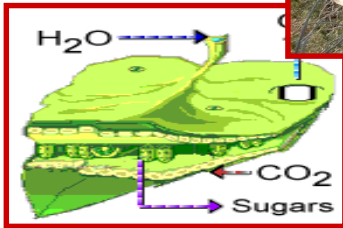
Ecosystem



Plant



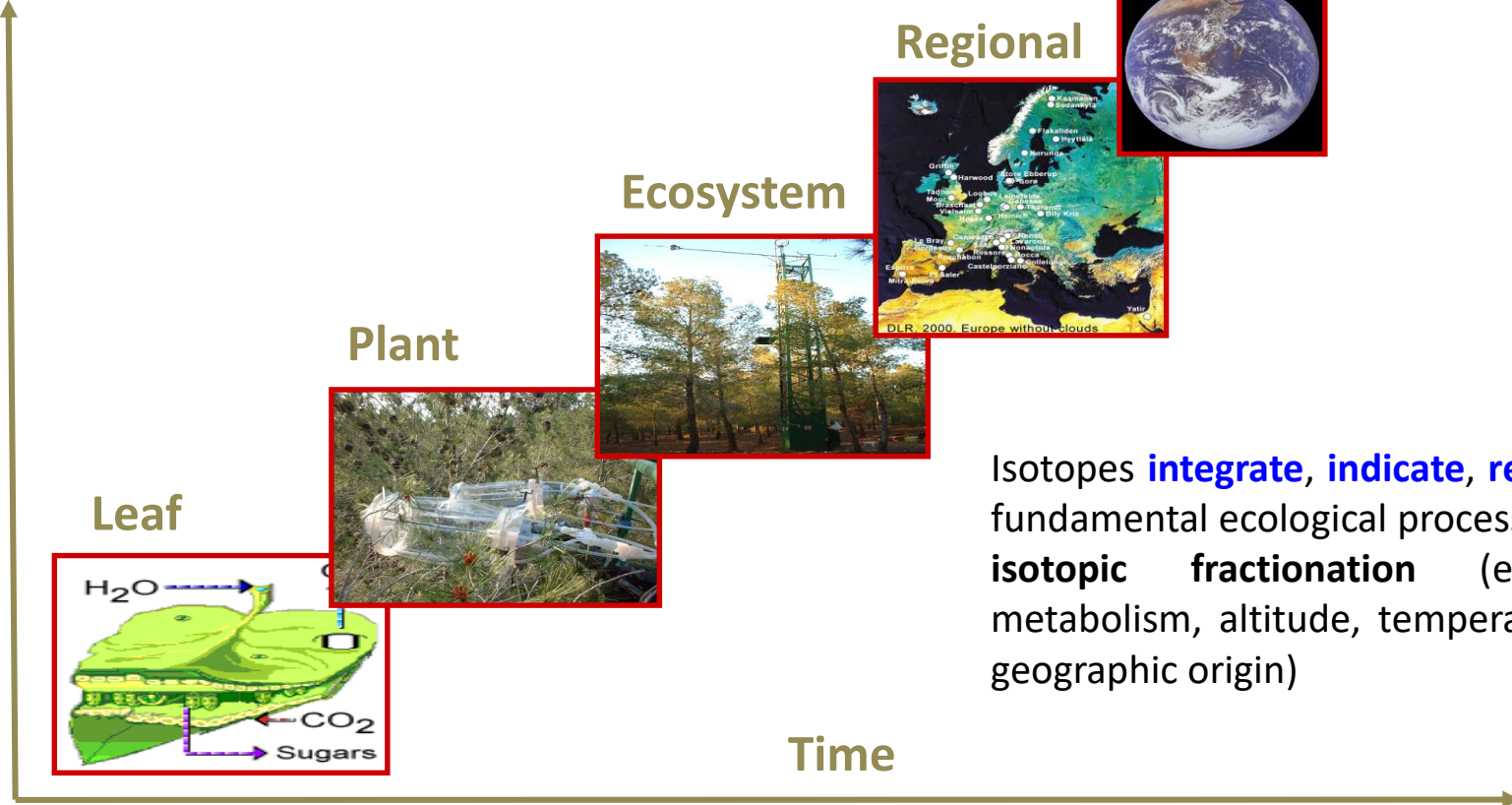
Leaf



Isotopes **integrate**, **indicate**, **record** and **trace** fundamental ecological processes through the **isotopic fractionation** (e.g. enzymes, metabolism, altitude, temperature, land-use, geographic origin)

Time

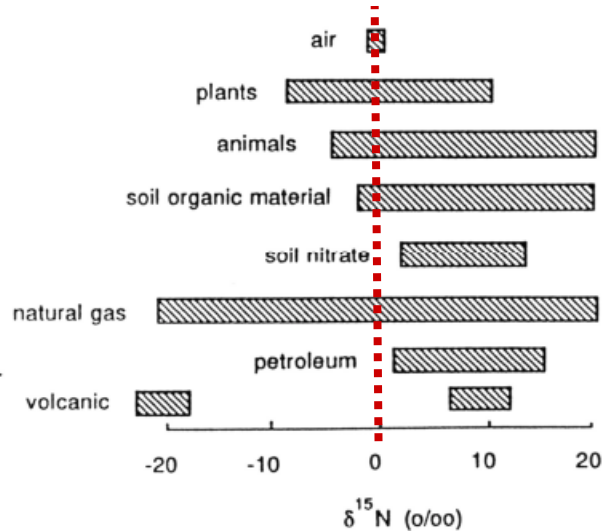
Space





**Depleted
(Lighter)**

**Enriched
(heavier)**



Why such a large range of variation?

- Differences in N sources
- N_{MIN} (NO_3^- , NH_4^+)
- ~~Denitrification?~~
- ~~Plant uptake~~
- ~~Soil N_2 fixation~~
- ~~Soil~~



Isotopes in Environmental and Health Studies, 2013

Vol. 49, No. 2, 197–218, <http://dx.doi.org/10.1080/10256016.2013.748051>

Source attribution of agriculture-related deposition by using total nitrogen and $\delta^{15}\text{N}$ in epiphytic lichen tissue, bark and deposition water samples in Germany

Stefanie Boltersdorf* and Willy Werner

Environ Monit Assess
DOI 10.1007/s10661-014-3736-3

Lichens as a useful mapping tool?—an approach to assess atmospheric N loads in Germany by total N content and stable isotope signature

Stefanie H. Boltersdorf • Willy Werner

ISSN 1067-4136, *Russian Journal of Ecology*, 2012, Vol. 43, No. 3, pp. 185–190. © Pleiades Publishing, Ltd., 2012.
Original Russian Text © L.G. Biazrov, 2012, published in *Ekologiya*, 2012, No. 3, pp. 170–176.

Stable Nitrogen Isotopes ($\delta^{15}\text{N}$) in Thalli of the Lichen *Hypogymnia physodes* along a Altitudinal Gradient in the Khangai Plateau, Mongolia

L. G. Biazrov

Atmospheric Environment 40 (2006) 498–507

Heathland vegetation as a bio-monitor for nitrogen deposition and source attribution using $\delta^{15}\text{N}$ values

R.A. Skinner^{a,*}, P. Ineson^a, H. Jones^b, D. Sleep^b, I.D. Leith^c, L.J. Sheppard^c

Chemosphere 85 (2011) 393–398

Organic pollutants and their correlation with stable isotopes in vegetation from King George Island, Antarctica

Caio V.Z. Cipro^{a,*}, Gilvan Takeshi Yogui^b, Paco Bustamante^c, Satie Taniguchi^a, José L. Sericano^d, Rosalinda Carmela Montone^a



Whim Experimental Site – CEH



Dry Treatment



NH₃ released from a 10 m pipe at 1 m height when wind direction is 180–215° and speed is 2.5 m s⁻¹
NH₃ concentrations measured by passive samplers (ALPHA)

Wet Treatments



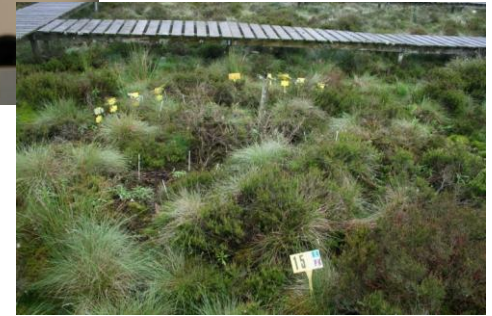
Two N forms: NaNO₃ and NH₄Cl
Three doses: 1, 3 and 7 times background value (8 kg N ha⁻¹ yr⁻¹)

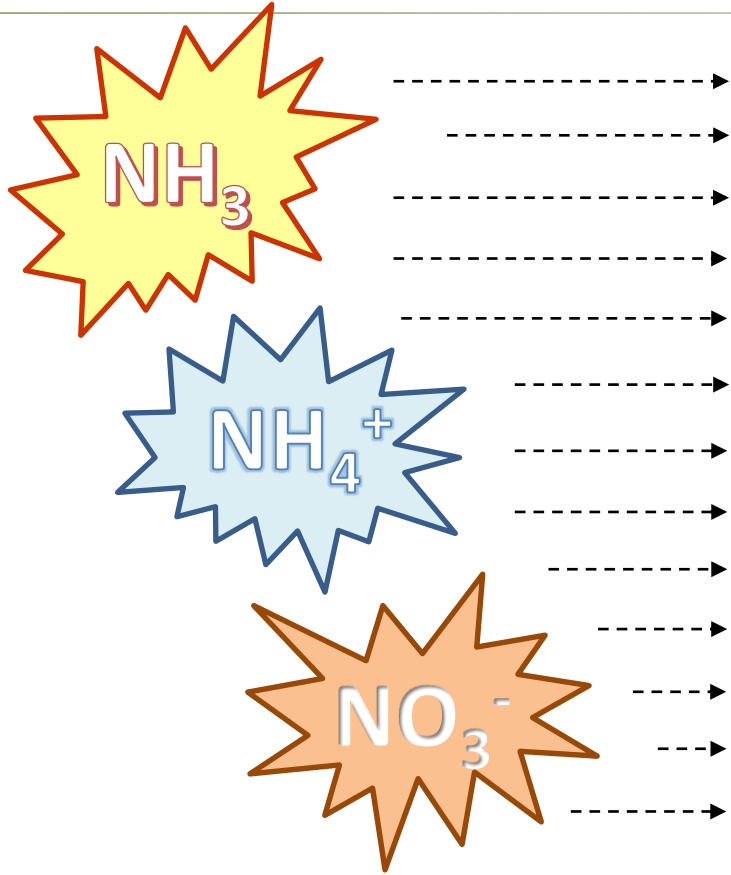


Xanthoria parietina
Transplant – 10 weeks wet;
3, 6 and 10 weeks dry



Evernia prunastri
Transplant – 10 weeks wet;
3, 6 and 10 weeks dry





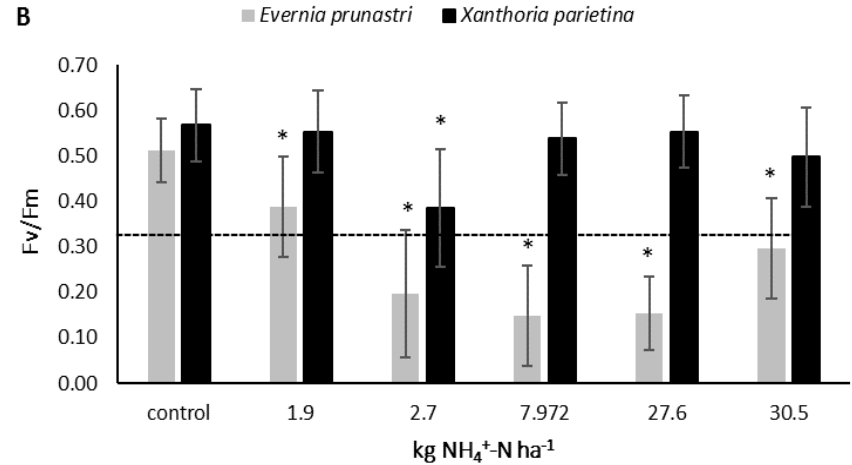
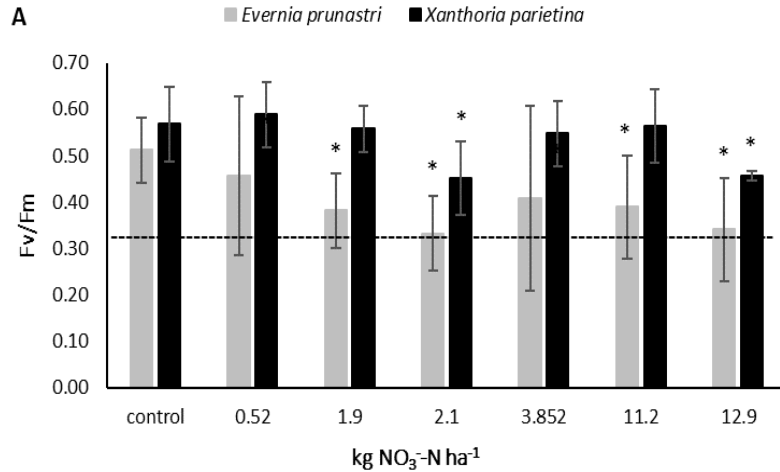
F_v/F_m
(health status
index)

$\delta^{15}\text{N}$

Total N



Chlorophyll *a* fluorescence – wet deposition

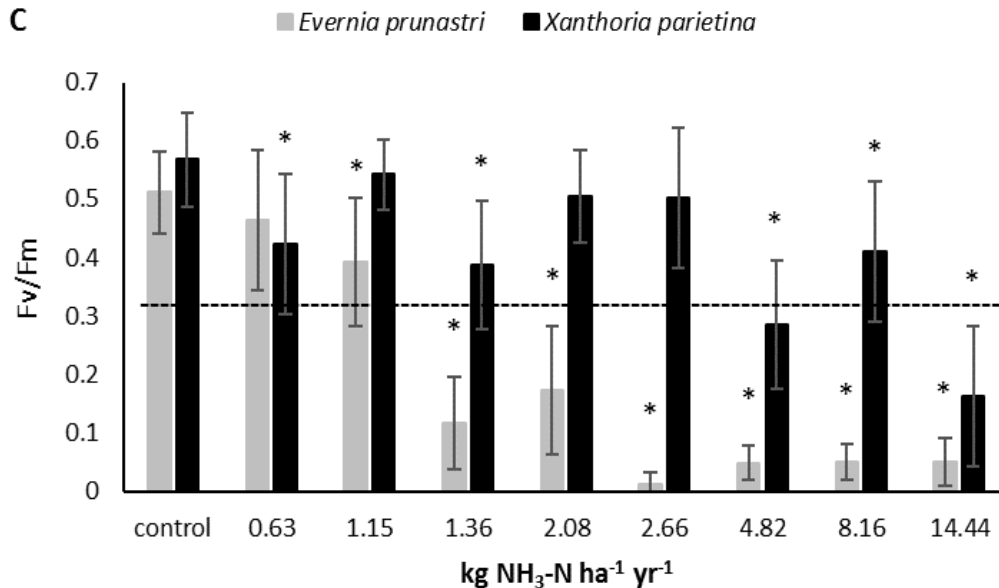


Dashed line represents the estimated lichen viability threshold for Fv/Fm

Modest effect of wet deposition on *X. parietina*, with occasional decreases in few treatments; in *E. prunastri* decreased in transplants already at low doses of ammonium and nitrate, even though samples remained viable in the case of NO₃⁻



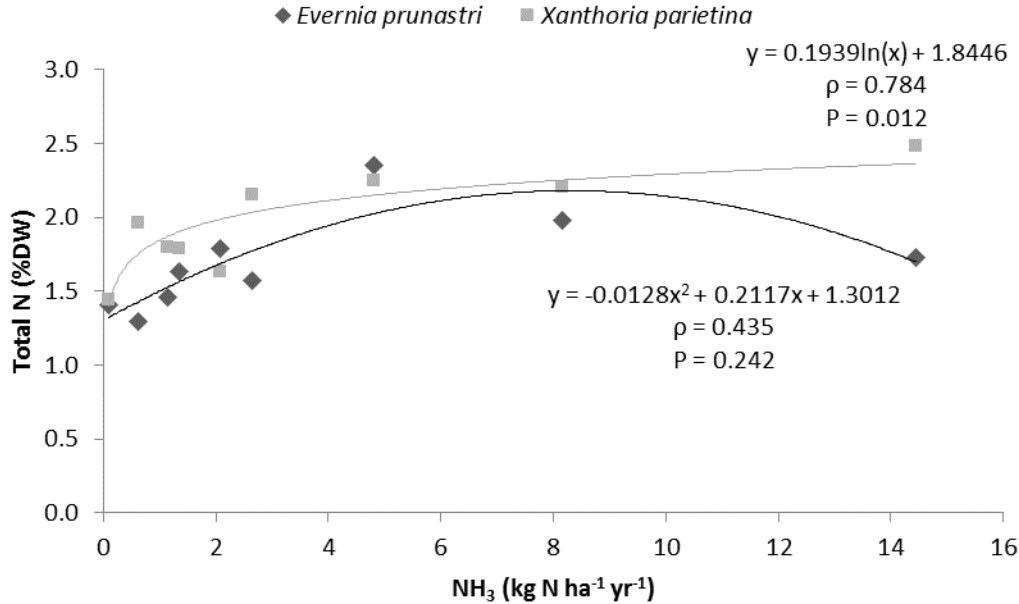
Chlorophyll *a* fluorescence – dry deposition



Dashed line represents the estimated lichen viability threshold for Fv/Fm

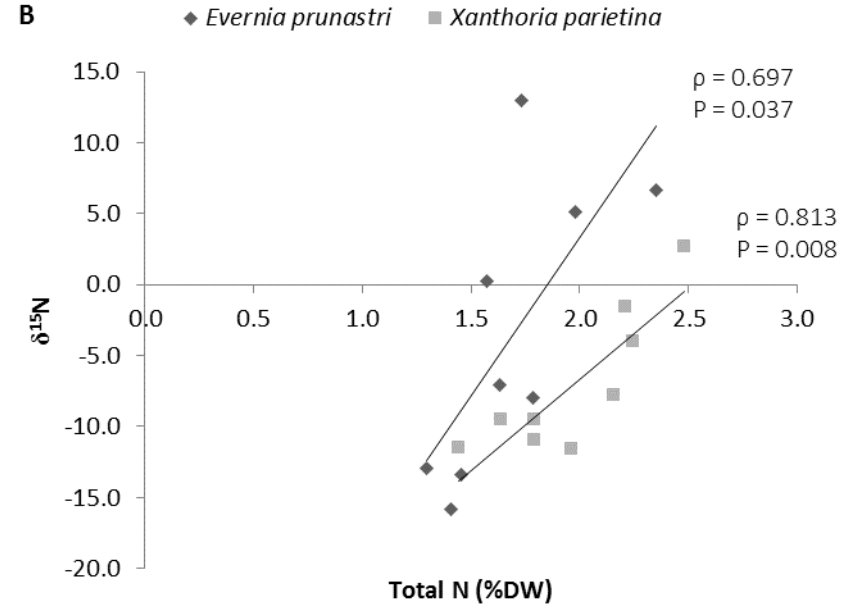
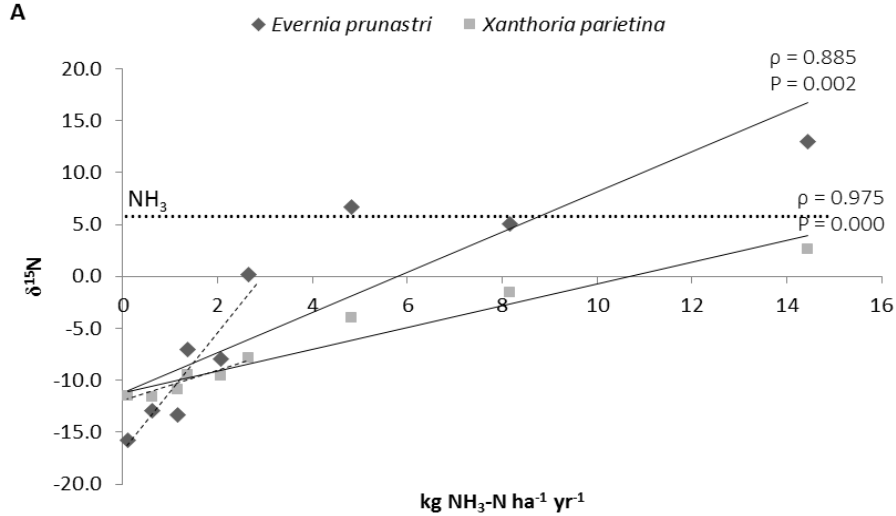
Exposure to mean concentrations of gaseous NH₃ equivalent to a deposition of > 1.2 kg N ha⁻¹ yr⁻¹ strongly affected photosystem II of *E. prunastri*

Xanthoria parietina exhibited decreased fluorescence values only at the highest depositions of ammonia (> 4.8 kg N ha⁻¹ yr⁻¹)

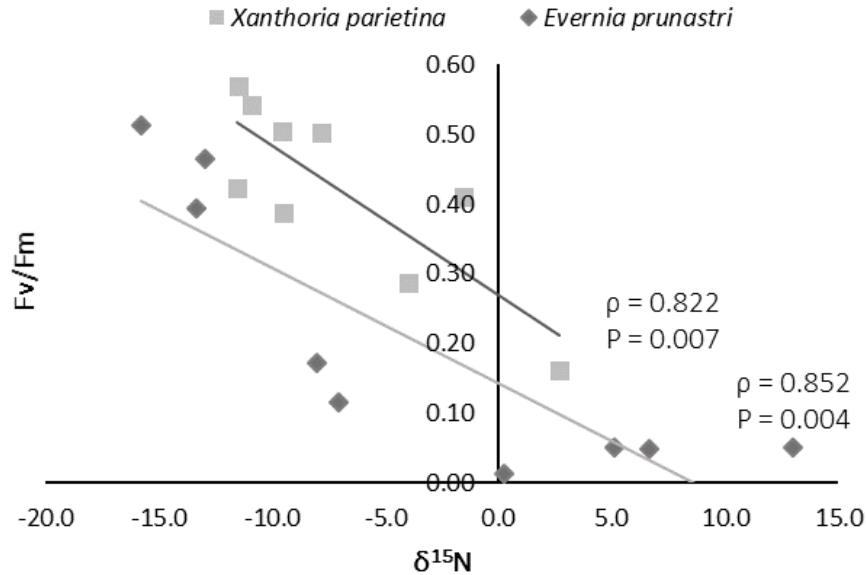


A similar increase in thalli N concentration when NH₃ was provided to both species

For *E. prunastri*, an initial increase was followed by a decrease in total foliar N above 5 kg N ha⁻¹ yr⁻¹, which appears to be reflective of a breakdown of this species at high NH₃ concentrations



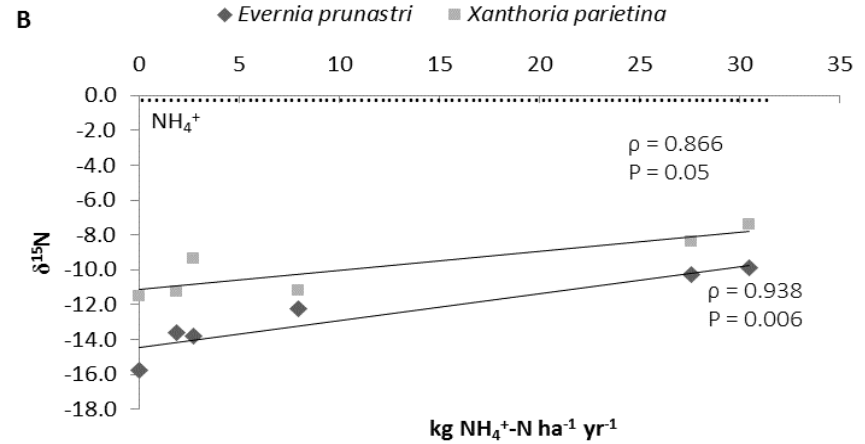
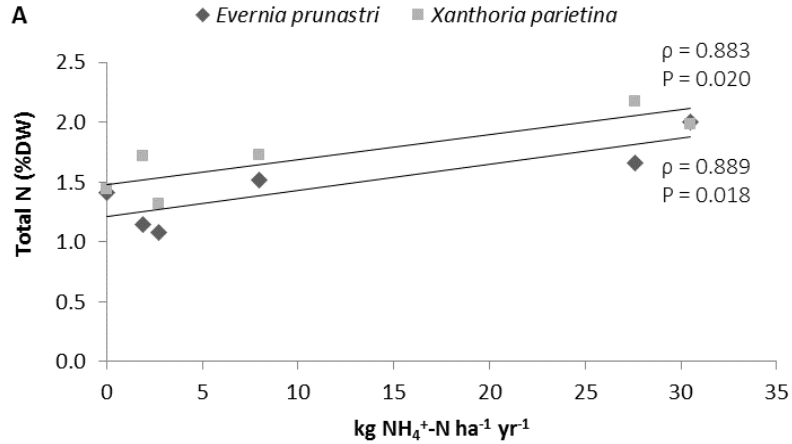
$\delta^{15}\text{N}$ in lichens responded to the $\delta^{15}\text{N}$ of the released atmospheric ammonia



The physiological performance of lichens (Fv/Fm) is significantly correlated with $\delta^{15}\text{N}$

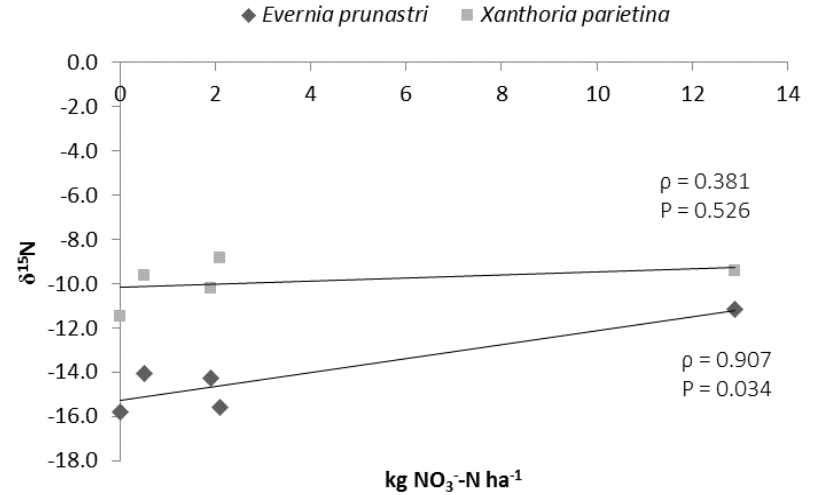
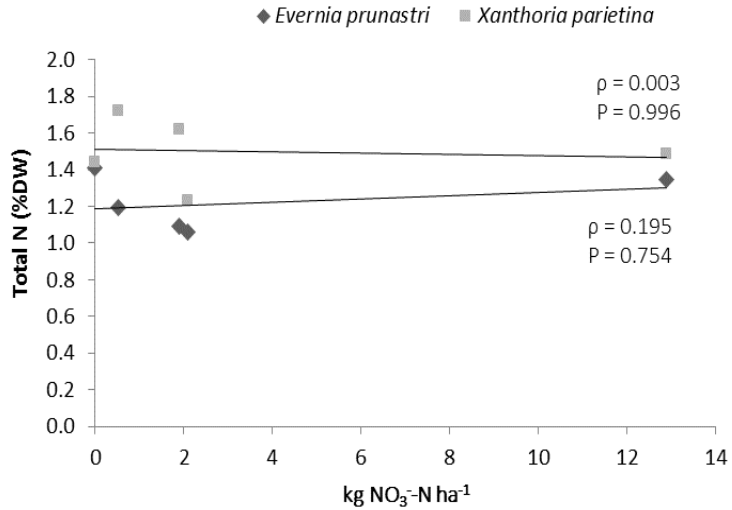


Wet deposition - NH_4^+





Wet deposition - NO_3^-



In case of NO_3^- only *E. prunastri* at the highest concentration showed a change in the isotopic signature



Conclusion

Lichen $\delta^{15}\text{N}$ can be used as indicator of nitrogen pollution and a surrogate of nitrogen atmospheric composition. In particular, $\delta^{15}\text{N}$ in tolerant species like *X. parietina* reflects atmospheric concentration of NH_3 .



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Thank you for your attention!