

HOW “GREEN” IS OUR AIR?

Lichens, liverworts, mosses and algae as proxies for air quality in the Tellus Border region



Usnea subfloridana



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Physcia tenella with pink *Illosporopsis christiansenii*

ABSTRACT

Twig samples collected during the Tellus Border project were screened as part of the EpiAir study (Fig.1). Biomonitoring of lichens and algae that grow on twigs (epiphytes), is used to assess the environmental health of rural air quality, *i.e.* eutrophication, in this region of Ireland. There is evidence that the alga *Desmococcus olivaceus* is very common and that pollution-sensitive epiphyte species in the Tellus Border region suffer from excessive deposition of airborne nitrogen leading to the success of pollution-tolerant species at the expense of pollution-sensitive species.

INTRODUCTION

Since Nylander’s report on lichens in Paris in 1866, epiphytes have been used as bioindicators of air quality in urban areas but less so in rural parts. In Ireland certain greenhouse gases *e.g.* ammonia (NH₃) are not monitored directly (Fig.2) but are modeled on the basis of animal numbers plus other pollution sources. Ireland has an obligation to meet our Gothenburg Protocol commitment. However, according to a government strategic document “Food Harvest 2020” the number of animals in Ireland is planned to almost double during this time. These two goals seem mutually exclusive. To examine whether the nitrogen threshold for environmental health has already been exceeded in the Tellus Border Region, we examined 700 twig vegetation sample packets collected as part of this major geochemistry study. These twig samples were studied for their epiphytic species. Lichens, fungi, mosses, liverworts and algae were identified during this the EpiAir project.

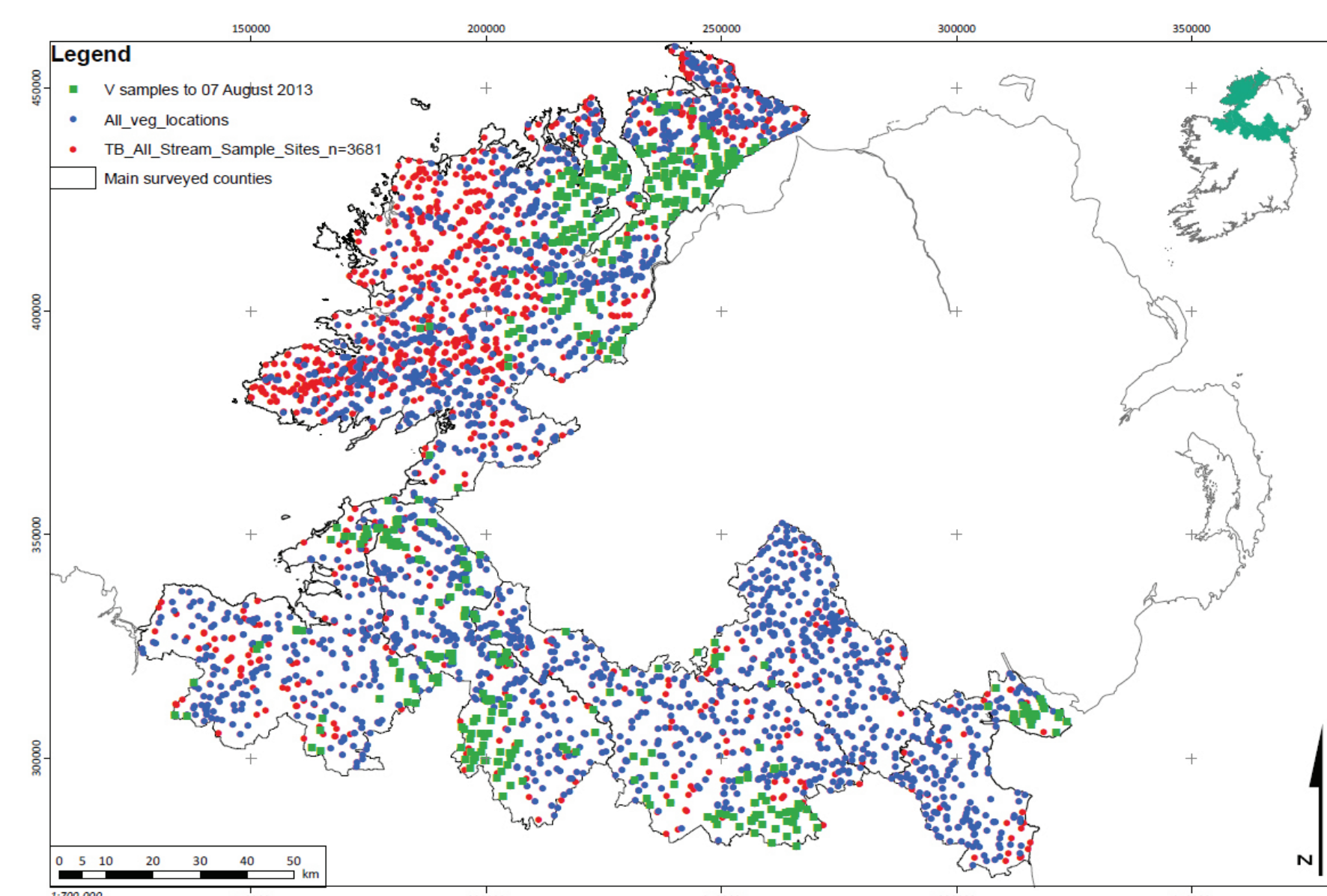


Fig. 1. Location of vegetation samples selected for study during the EpiAir project

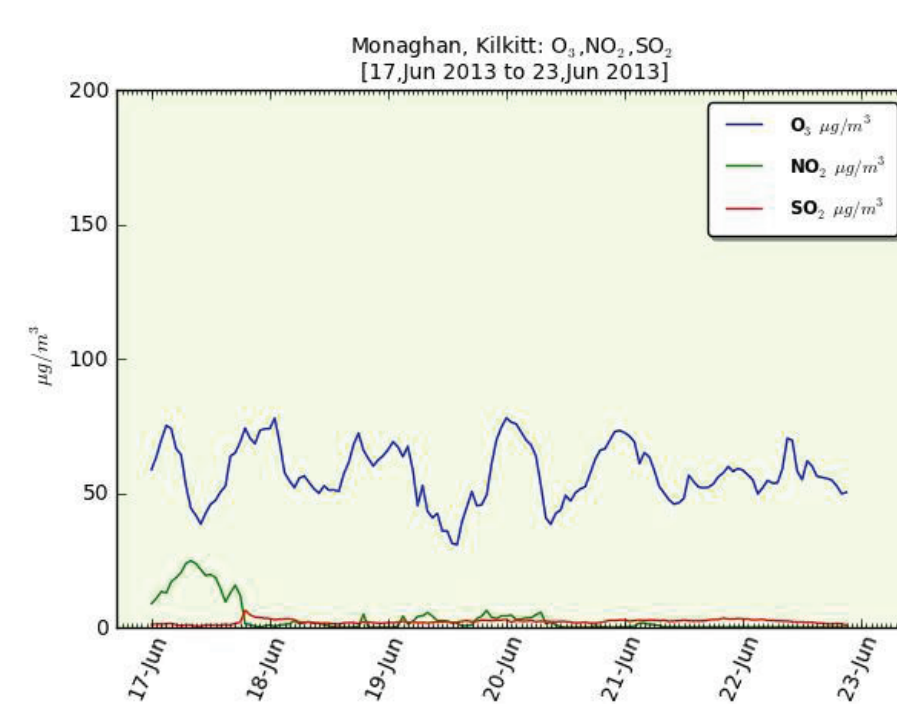


Fig. 2. Output of data from Kilkitt, the only EPA air pollution monitoring station in the Tellus Border Region



METHODS

Vegetation samples were collected following the British Geological Survey G-BASE sampling strategy (Johnson 2005). 25% of the total 2,870 sample packets were documented. Host tree was recorded. Twig material was investigated using taxonomic and genetic methods. A x10 to x40 stereoscope and a Nikon 80i Eclipse compound microscope were used to screen and identify epiphytic species. These species identifications were databased along with background environmental data supplied by Tellus Border project. Genetic work was used to elucidate particular species of interest difficult to differentiate using traditional morphological examination.

RESULTS

1. Host relationships with epiphytes

Latin name of host	Vernacular name	Packets
Salix spp.	Willow	177
Crataegus monogyna	Hawthorn	79
Fraxinus excelsior	Ash	69
Alnus glutinosa	Alder	68
Corylus avellana	Hazel	61
Acer pseudoplatanus	Sycamore	46
Prunus spinosa	Blackthorn	26
Picea sitchensis	Sitka Spruce	39
Betula pubescens	Birch	22
Sorbus aucuparia	Rowan	18
Fagus sylvatica	Beech	16
Quercus petraea	Oak	11
Others	Others	78

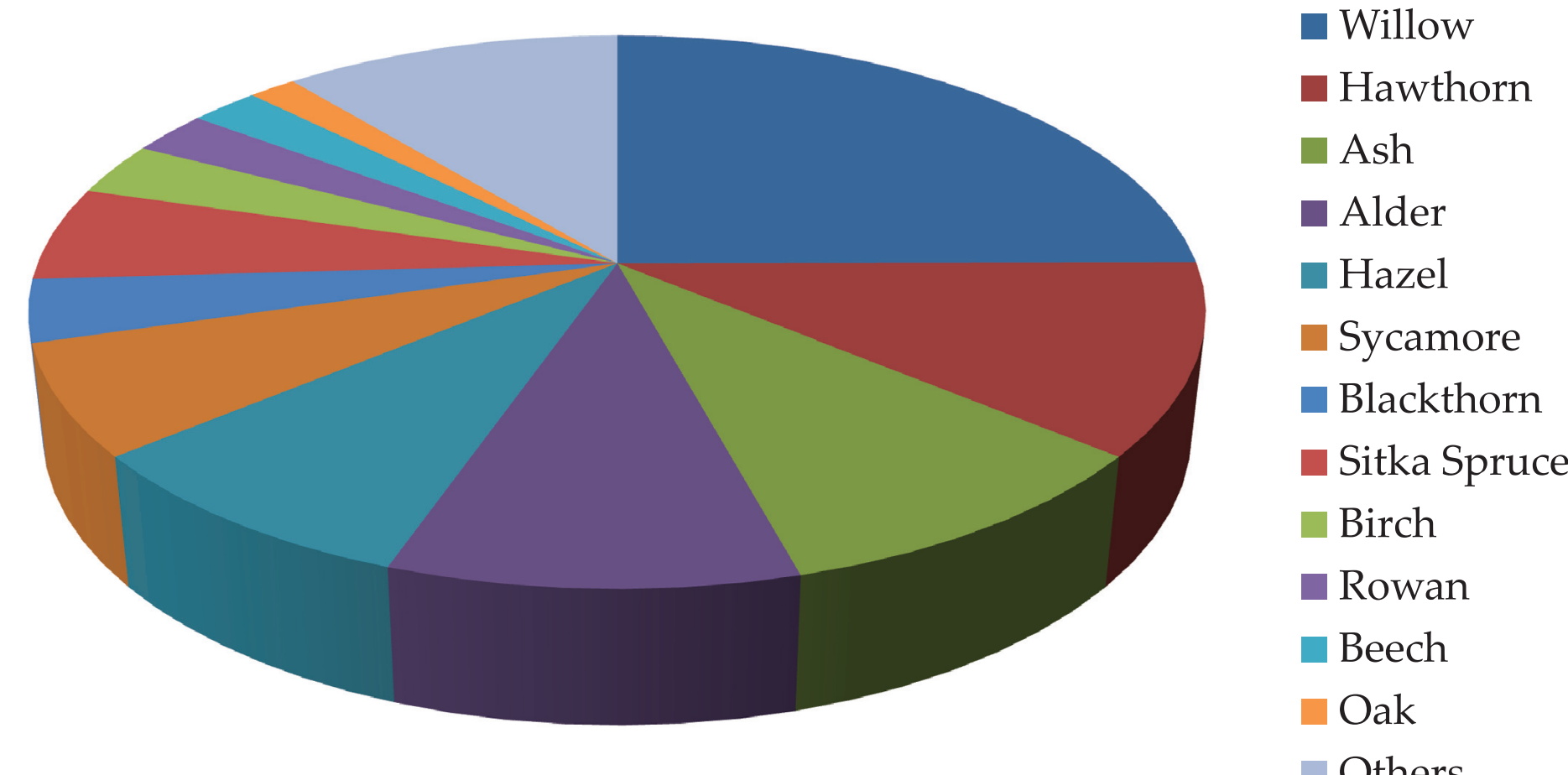
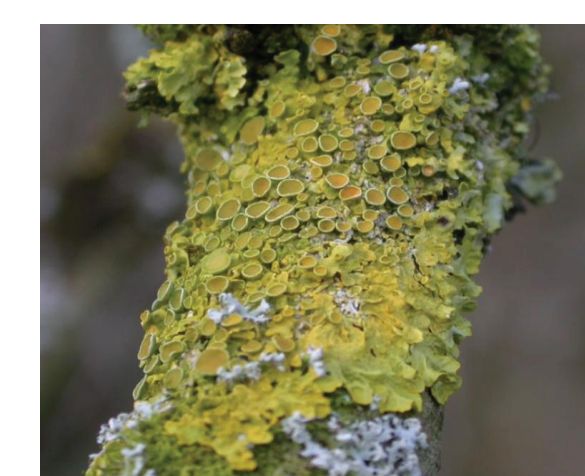


Fig. 3. Number of each host tree species sample examined reflecting the riparian nature of the sites visited

2. Nitrophytic vs Oligotrophic (pollution-sensitive) species

Eutrophication is caused by excess nutrients such as nitrogen deposition. Nitrogen in the form of ammonia is mainly produced by the agricultural sector. Ireland’s national emission ceiling for ammonia under the NEC Directive is 116 kilotonnes (kt) (EPA 2011). Based on modelled data, we are currently within 9kt of this threshold. Deposition of NH₃-N is relatively high in the midlands *e.g.* Monaghan. Kluizenaar & Farrell in 2000 considered that there was a strong indication the critical load of nutrient nitrogen would be exceeded in sensitive areas. The epiphyte species composition data demonstrates that this is the case in some parts of the Tellus Border Region.



Xanthoria parietina

Epiphyte species	Observations
<i>Desmococcus olivaceus</i>	535
<i>Lecidella elaeochroma</i>	331
<i>Lecanora chlarotera</i>	281
<i>Physcia tenella</i>	246
<i>Opegrapha atra</i>	242
<i>Xanthoria parietina</i>	130
<i>Phaeographis smithii</i>	101
<i>Ramalina farinacea</i>	97
<i>Melanelia subaurifera</i>	68
<i>Parmotrema perlatum</i>	59
<i>Pertusaria leioplaca</i>	47
<i>Parmelia sulcata</i>	43
<i>Caloplaca ferruginea</i>	30
<i>Arthonia cinnabarina</i>	28
<i>Usnea subfloridana</i>	22
<i>Candelariella reflexa</i>	21
<i>Normandina pulchella</i>	21
<i>Evernia prunastri</i>	3
<i>Pannaria rubiginosa</i>	1

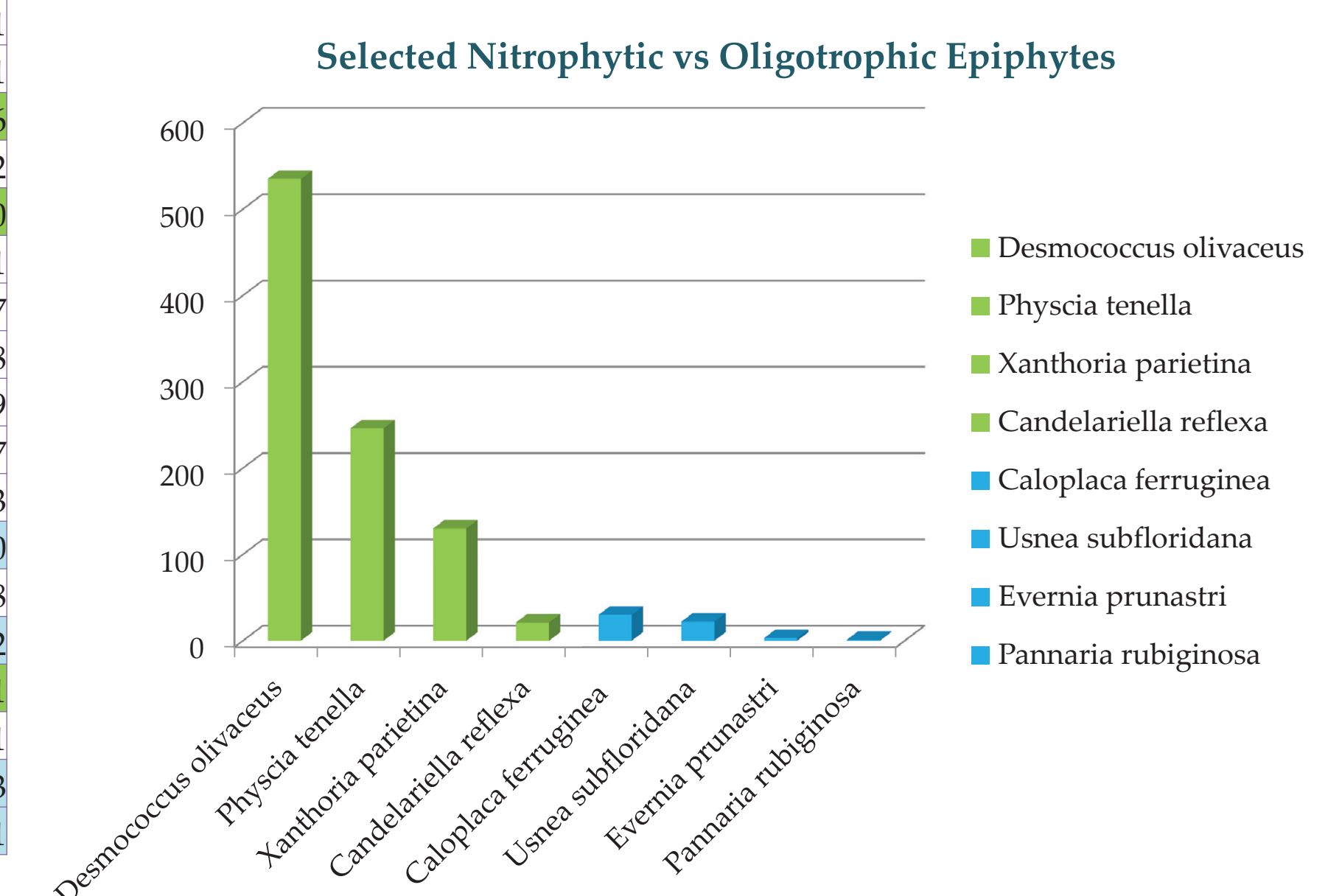
■ Nitrophytic ■ Oligotrophic



Caloplaca ferruginea



Fig. 4. The spreading of slurry releases ammonia and other pollutants (photo: G. Mullen)



3. Observations of particular species – losses and gains



Fig. 5. The nitrogen pollution sensitive lichen *Evernia prunastri* is now less common in the Irish landscape than it was a century ago, based on records made by Matilda Knowles (1929)

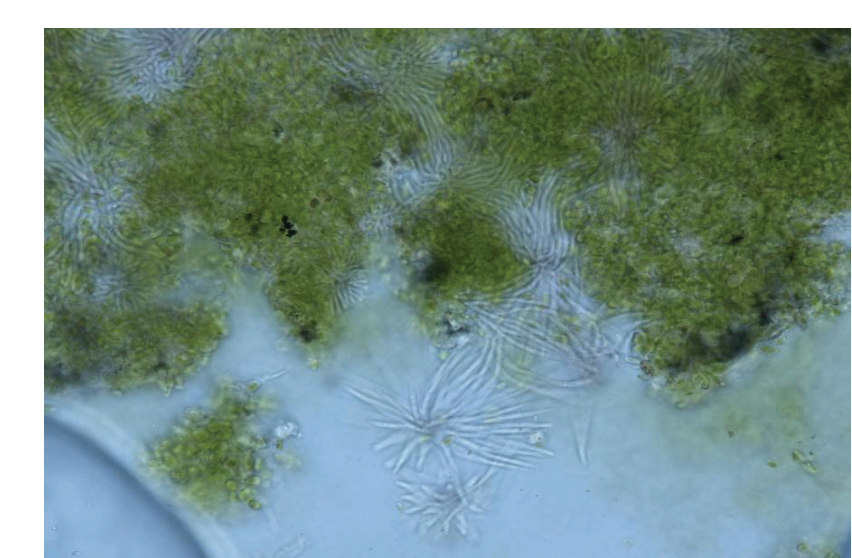


Fig. 6. New Irish record of *Psammia stipitata* an algicolous fungus

DISCUSSION & CONCLUSIONS

Eutrophication in rural Ireland is driven by excess nitrogen deposition. Ammonia is a major contributor of this nitrogen enrichment. While we have focused on the impact on biodiversity, implications for human health from long-term high exposure to ammonia include decreased lung function and increased bronchial responsiveness to histamine (Vogelzang *et al.* 1998; 2000). Agricultural ammonia emission modelling tools need fundamental improvement (Ji-Qin *et al.* 2011). Monitoring of ammonia in the Irish landscape would be beneficial.

Willow is the most common host tree sampled as riparian zones were the focus of the Tellus Border geochemistry study using the BGS G-BASE sampling strategy. *Lobaria* cyanobacterial lichens are very rare in the Tellus Border region at <1% presence on 3-11 year old twigs.

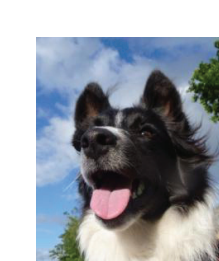
Well-attested nitrophytes are consistently among the most common species on twigs studied from the Tellus Border region. This study demonstrates a disturbing decline of oligotrophic epiphyte species in rural Ireland.

There is a distinctive “aerial green algal bloom” on 75% of the vegetation samples examined during the EpiAir project.

KEY REFERENCES

- EPA 2011. Ireland’s trans-boundary gas emissions in 2011.
- Kluizenaar, Y. de & Farrell, E.P. 2000. FERG Report Number 55 &57. EPA, Dublin.
- Knowles, M.C. 1929. The lichens of Ireland. PRIA, Dublin.
- Van Herk, C.M. 1999. Mapping of ammonia pollution with epiphytic lichens in The Netherlands. Lichenologist 31:9-20.

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