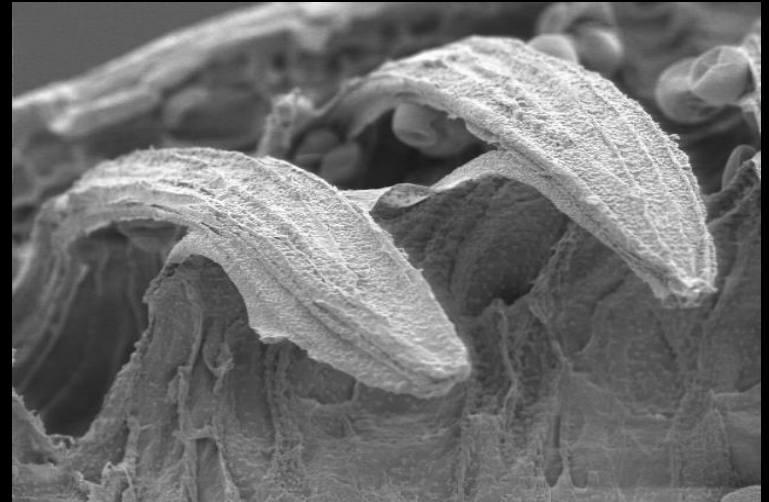


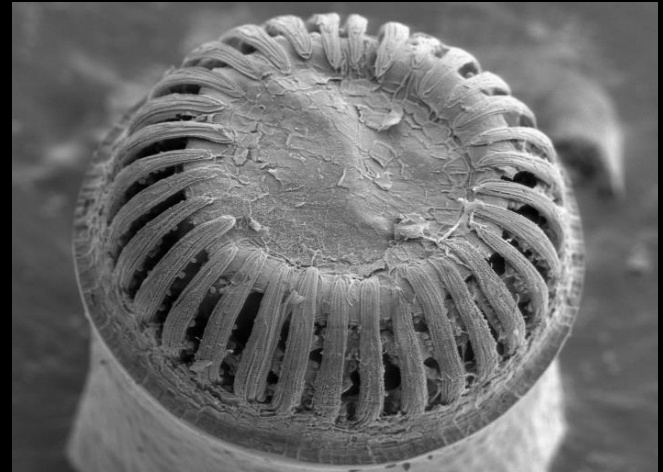
Snowbed Bryophytes – Monitoring & Taxonomy



Royal
Botanic Garden
Edinburgh

Neil Bell (n.bell@rbge.ac.uk)

What exactly are “bryophytes”..?



What exactly are “bryophytes”..?

- Probably an artificial group evolutionarily (i.e. not monophyletic)
- 3 distinct lineages: **mosses, liverworts & hornworts**
- **Green land plants** in which both the gametophyte and the sporophyte generations are prominent and multicellular. **The gametophyte is dominant** and the sporophyte is unbranched with only a single sporangium



Mosses: Bryophyta



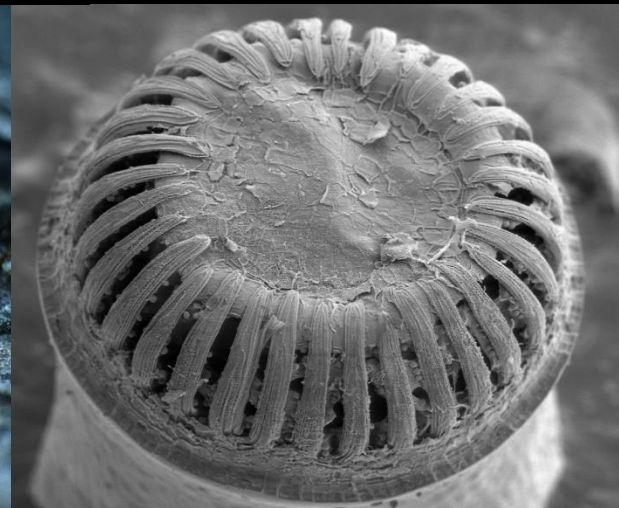
Liverworts: Marchantiophyta

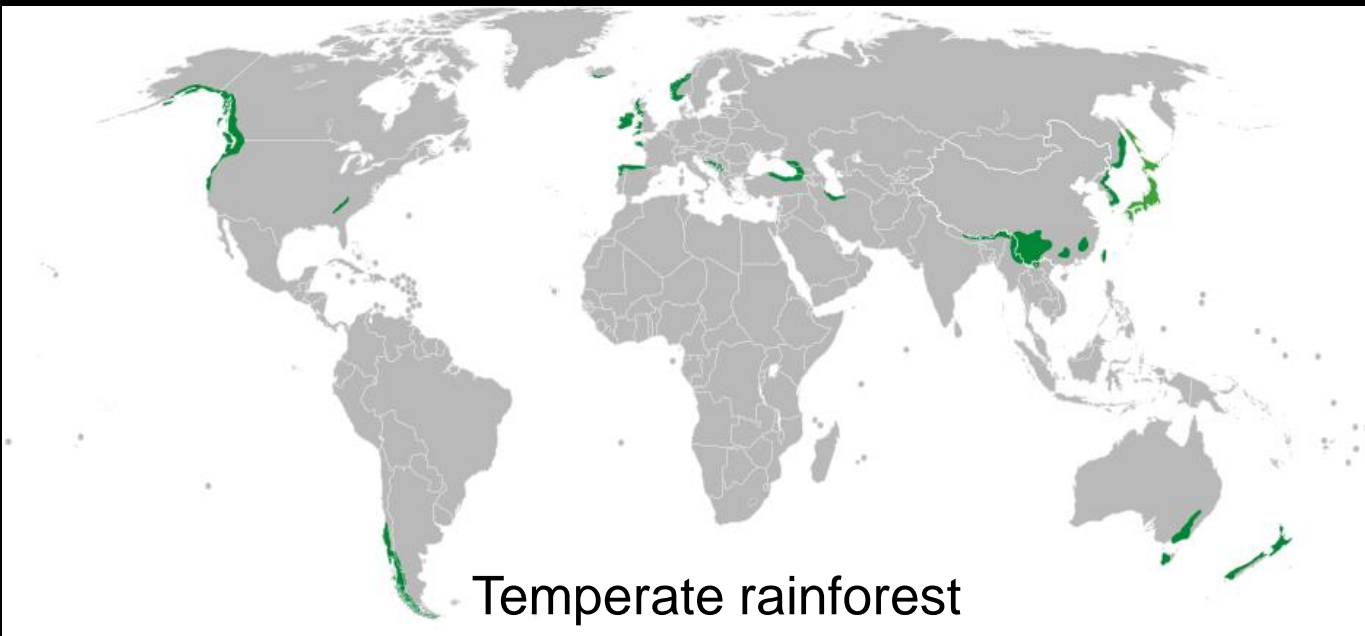
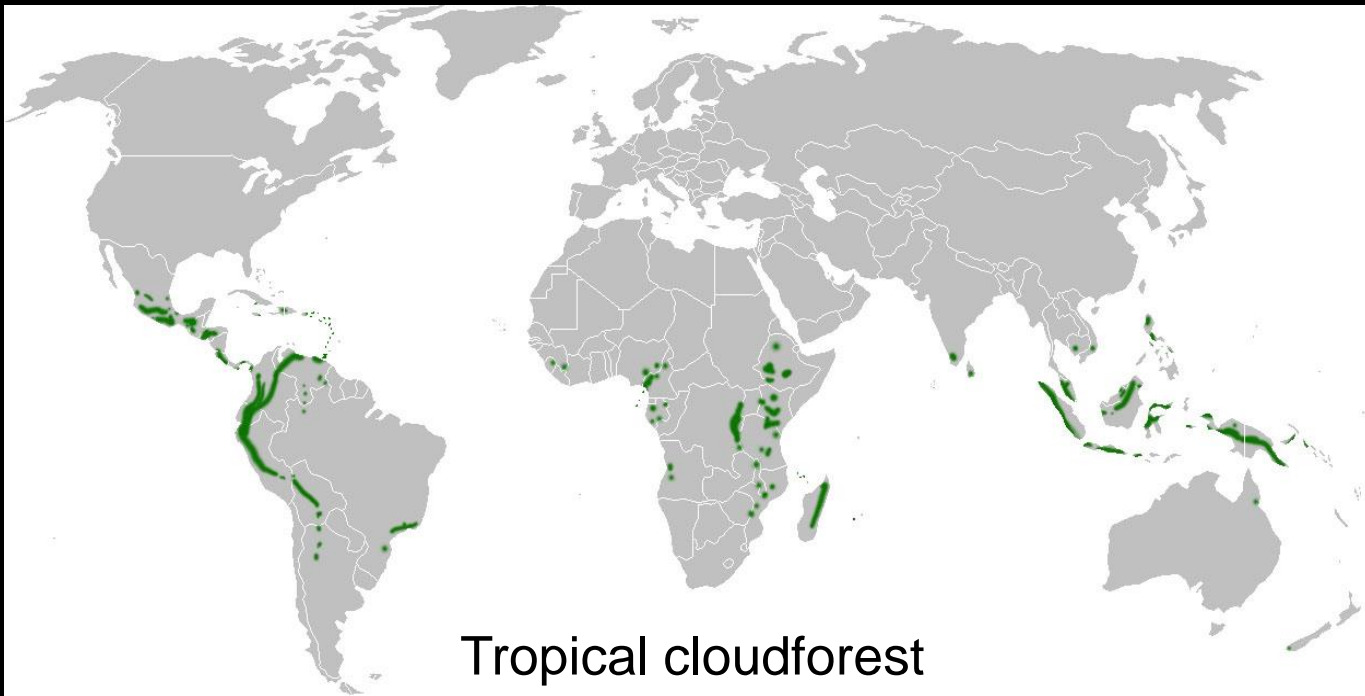


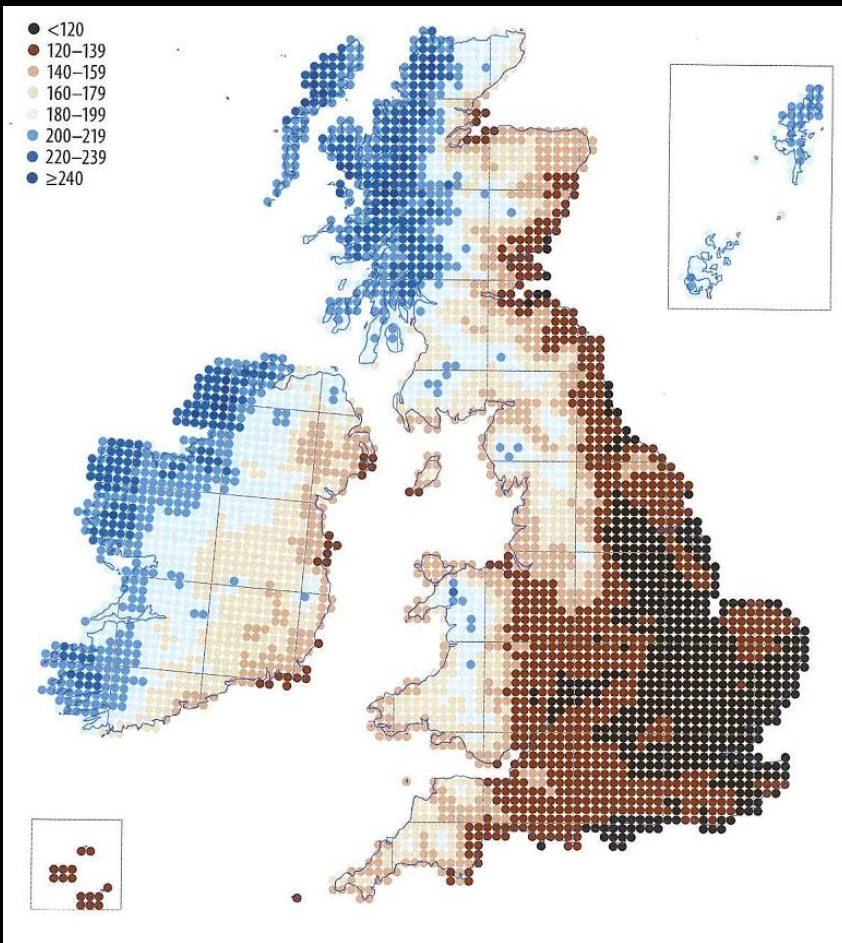
Hornworts: Anthocerotophyta

Bryophytes as native Scottish plants

| | SCOTLAND | EUROPE | GLOBAL |
|-------------------|----------|---------------|-------------------|
| TRACHEOPHYTES | ~1,600 | ~11,000 (15%) | ~300,000 ? (0.5%) |
| BRYOPHYTES | ~900 | ~1,650 (55%) | ~15,000 ? (6%) |

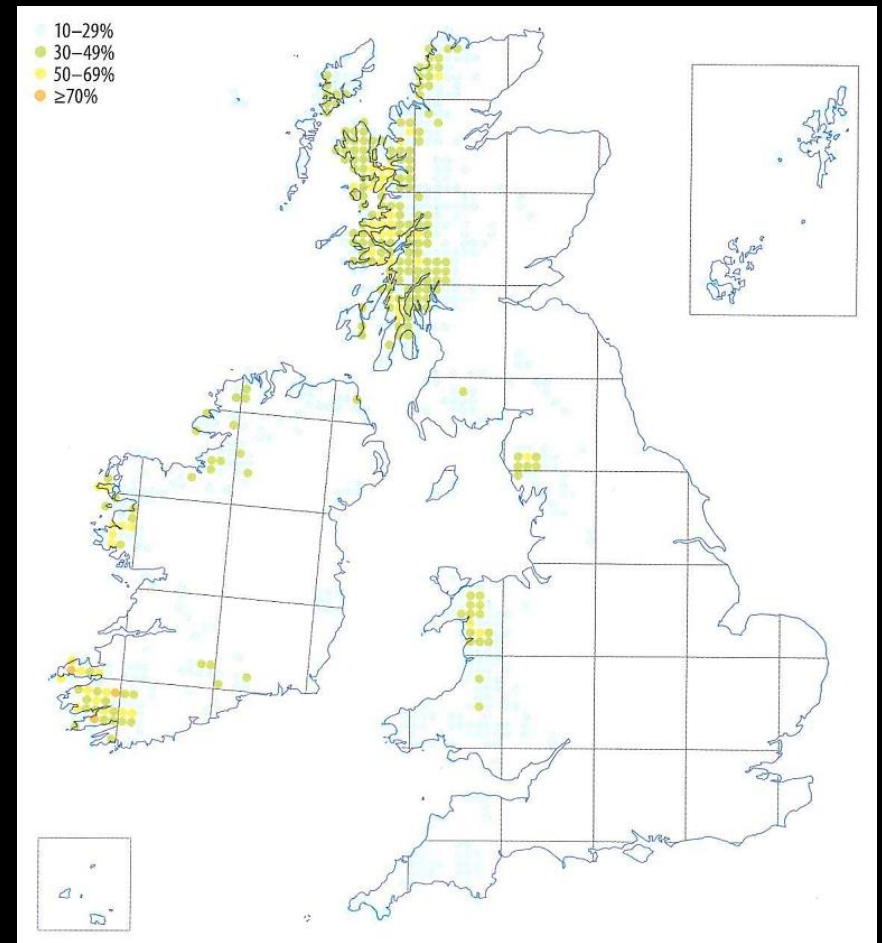






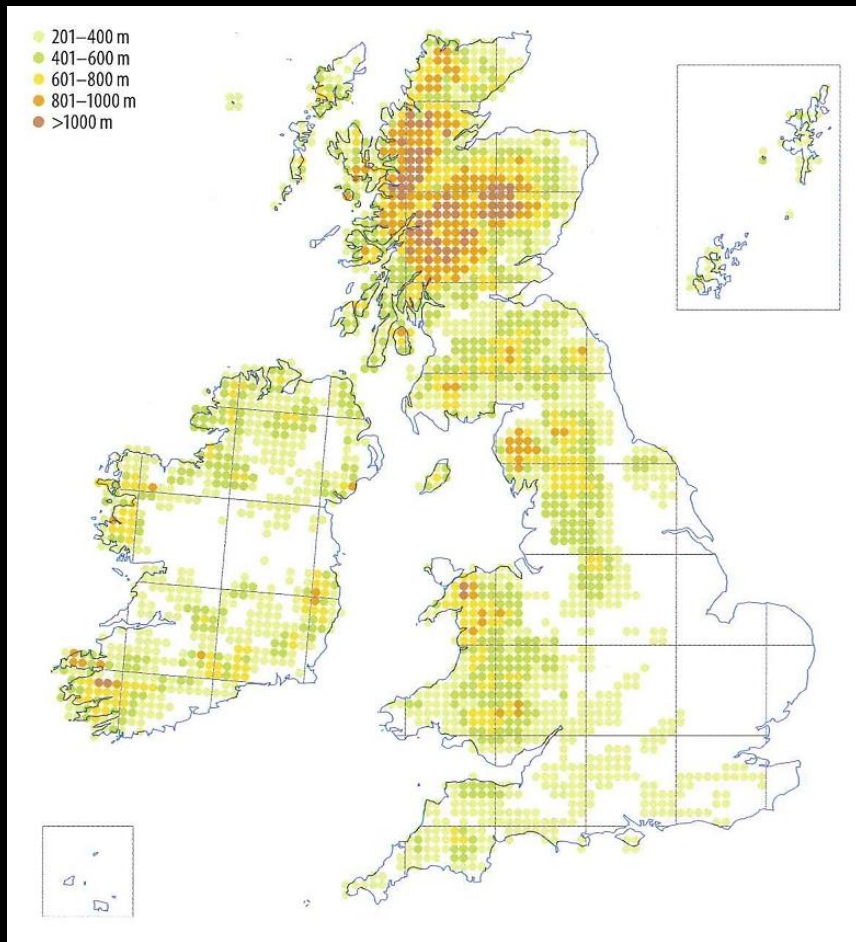
Wet days per year

(Mean number of days per year 1981-2010 with >1mm rain)



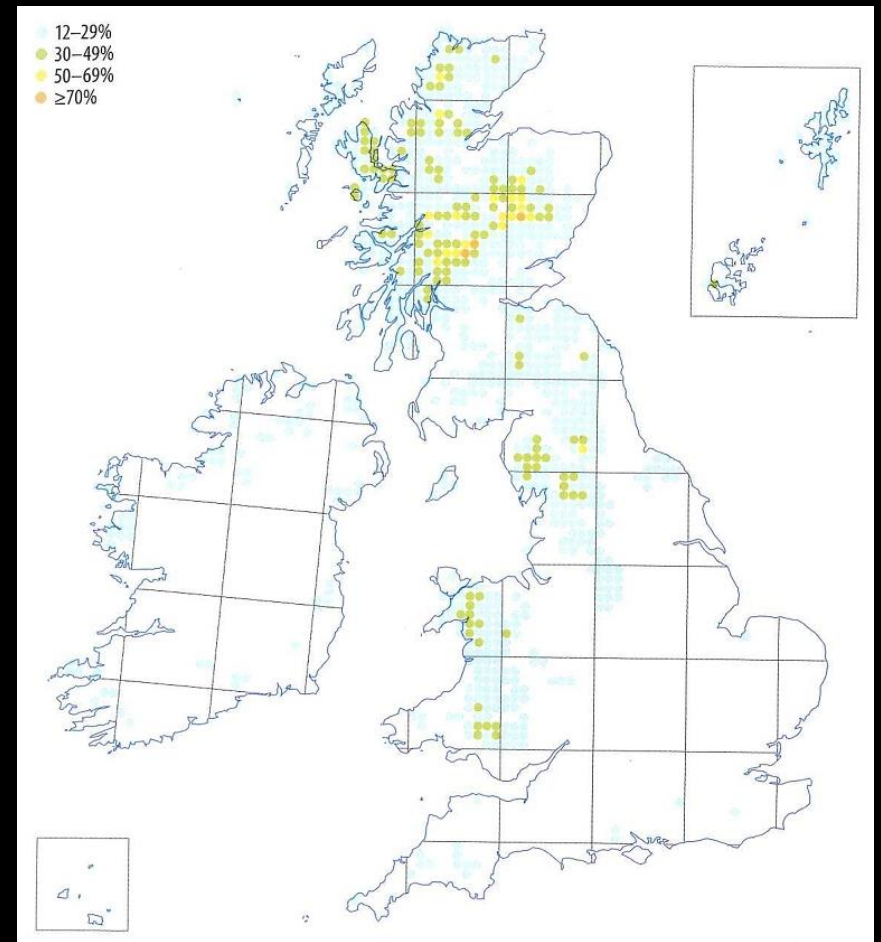
Hyperoceanic bryophytes

(Percentage of the element in each hectad with Hyperoceanic ranges – hectads <10% not mapped)



Altitude

(Maximum altitude of each hectad – contains Ordnance Survey data © Crown copyright and database right 2014)



Boreo-arctic montane spp.

(Percentage of the element in each hectad – hectads with <10% boreo-arctic montane species not mapped)

From Atlas of British and Irish Bryophytes – Copyright © British Bryological Society







Polytrichastrum sexangulare



Conostomum tetragonum



Pleurocladula albescens



Kiaeria falcata

Photos by David Genney

Expected latitudinal shifts; mountain top species run out of space



Monitoring – Bryophytes and Lichens

Scottish snowbeds, extremely vulnerable to climate change
Listed as a 'national indicator', climate change risk

The screenshot shows the ClimateXchange website interface. The main heading is "RISK: Generalist species more able to cope than specialist species - snow-bed species". Below this, there is a table showing the level of risk/opportunity for the years 2020s, 2050s, and 2080s, categorized by Risk and Opportunity. The risk levels are High, Med, and Low. The opportunity levels are Low, Med, and High. A legend on the right explains the indicator icons, including trend directions (Upward, Downward, No significant, No trend possible) and confidence levels (Low, Medium, High). Below the table, there is a section titled "Adaptation at a glance:" which states that species of mosses and liverworts (bryophytes) which grow in areas with late-lying snow - snow beds - in Scottish mountains are a conservation priority. They are specialised for the kind of conditions found in these areas and, in Scotland, are found at the edge of their natural area of occurrence. This means they are not able to move to areas with more suitable conditions as the climate changes.

| | Risk | | | Opportunity | | |
|-------|------|-----|-----|-------------|-----|------|
| 2020s | High | Med | Low | Low | Med | High |
| 2050s | High | Med | Low | Low | Med | High |
| 2080s | High | Med | Low | Low | Med | High |



Generalist species more able to adapt than specialists

NB16a - abundance /frequency of specialist and generalist species: snow-bed species

Monitoring – Bryophytes and Lichens

1989/90 first snowbed survey (58 sites)



Monitoring – Bryophytes and Lichens

1989/90 first snowbed survey (58 sites)



2007/8 second snowbed survey
(22 sites)
(permanent transects)



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Monitoring – Bryophytes and Lichens

1989/90 first snowbed survey (58 sites)



2007/8 second snowbed survey
(22 sites)
(permanent transects)

2014/15/16
third survey
(training apprentices)



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1989 => 2007/8: Quadrat data

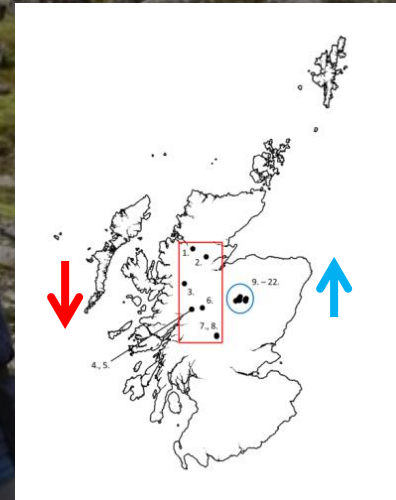
- Only tentative evidence for change in snowbed community composition, but significant shifts in frequency of certain species



Moerkia blyttii
(snowbed specialist)



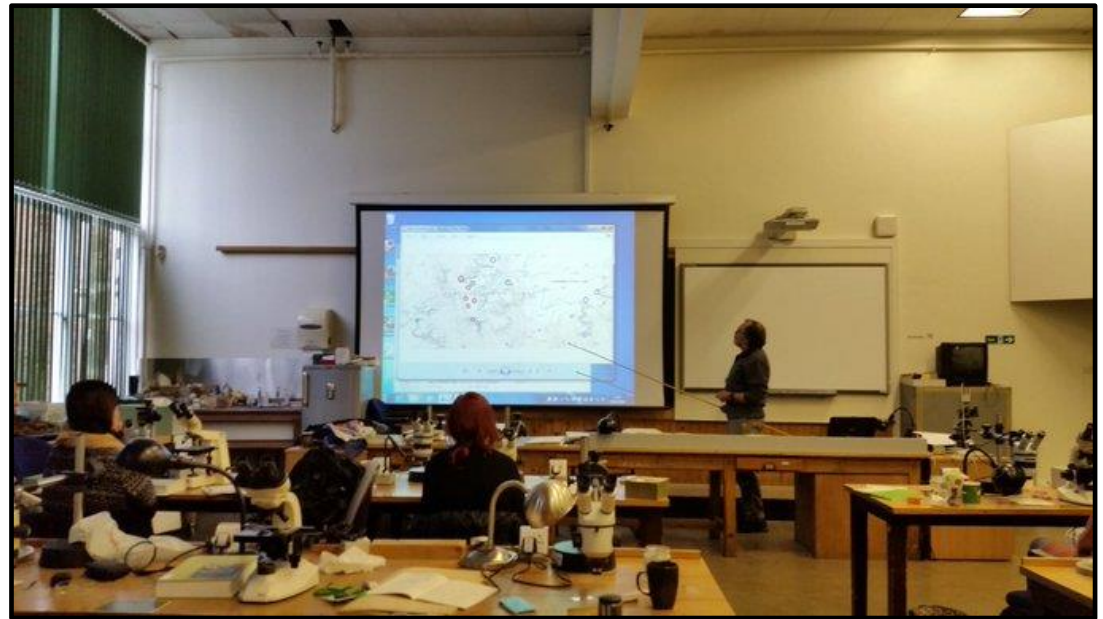
Polytrichastrum sexangulare
(snowbed specialist)



Preliminary results: 2014-2016 repeat transect monitoring

- Time gap probably too short to show any dramatic changes even if strong environmental pressures are at work, however:
 - Increase in frequency of some widespread vascular plants in core snowbeds
 - Increases also in some non-specialist bryophyte species
 - Overall, a decrease in frequency of obligate snowbed bryophyte species

TRAINING



Snowbed workshop at RBGE, February 2016

Snowbed trainees with Gordon Rothero (back) in Cairngorms
(From left: Oliver Moore, Claire Rickerby & Julie Smith)

RBGE Corporate Plan

Outcome 10: To have equipped professional horticulturalists and biodiversity scientists with the skills to address biodiversity loss nationally and internationally, and to safeguard plant heritage and culture

Bryophytes which in Scotland are largely restricted to snowbeds

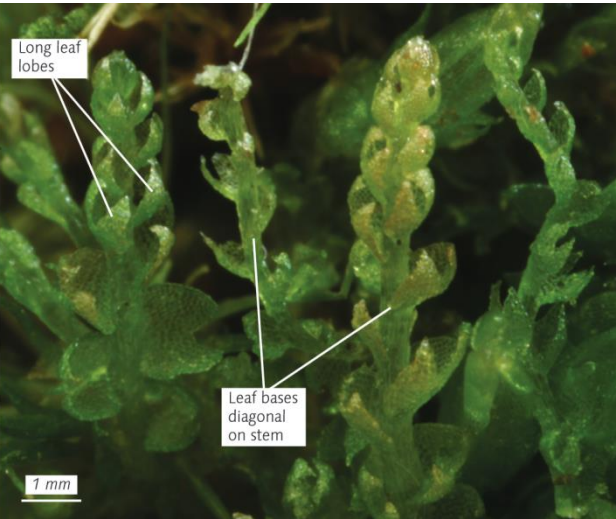
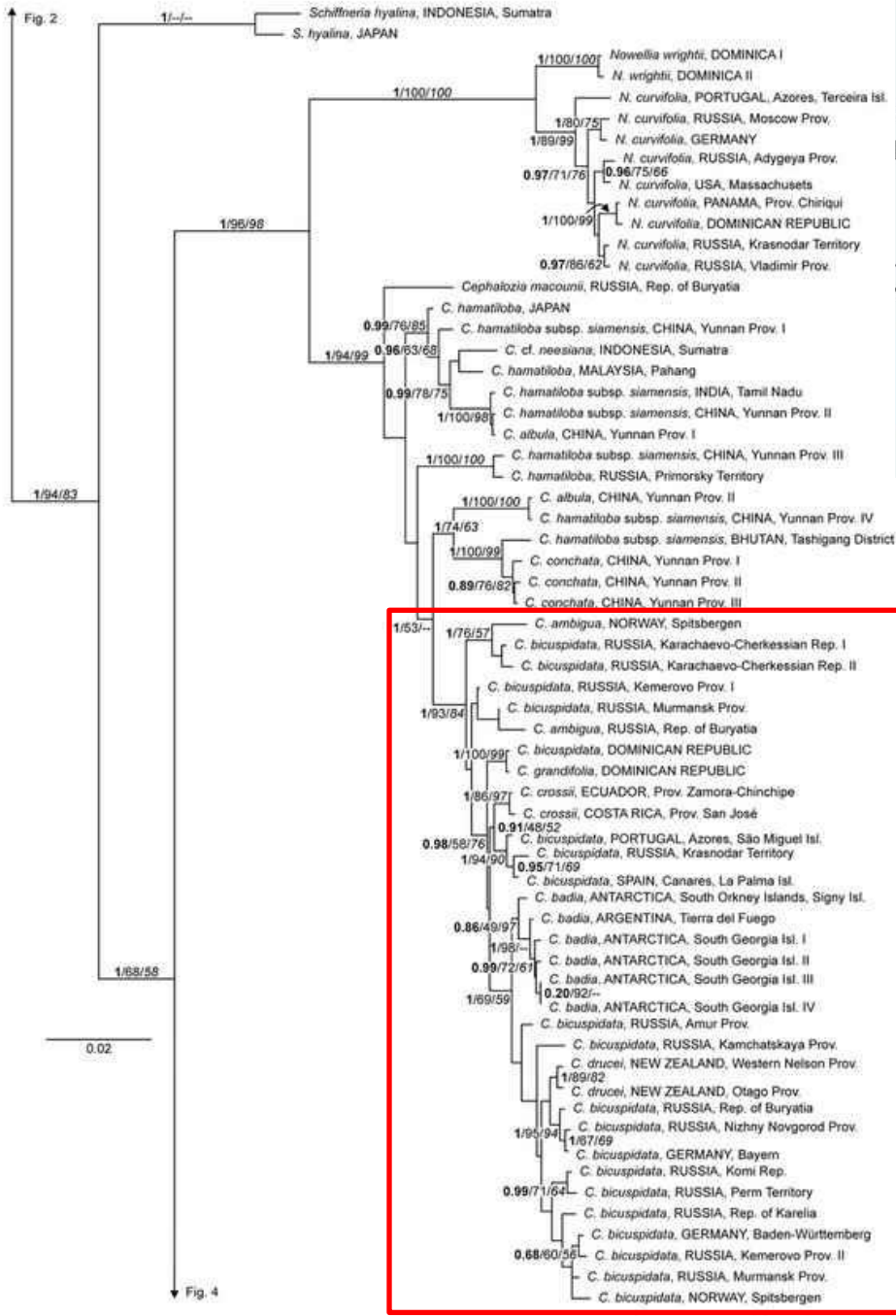
| Species | RDB Threat category | Status |
|--------------------------------|----------------------------|-------------------|
| <i>Andreaea blyttii</i> | Near threatened | Nationally rare |
| <i>Andreaea frigida</i> | Vulnerable | Nationally rare |
| <i>Andreaea nivalis</i> | Near threatened | Nationally rare |
| <i>Andreaea sinuosa</i> | Vulnerable | Nationally rare |
| <i>Cephalozia ambigua</i> | Vulnerable | Nationally rare |
| <i>Conostomum tetragonum</i> | | Nationally scarce |
| <i>Gymnomitrium apiculatum</i> | Vulnerable, S8 | Nationally rare |
| <i>Hygrohypnum molle</i> | Vulnerable | Nationally rare |
| <i>Kiaeria falcata</i> | | Nationally scarce |
| <i>Kiaeria glacialis</i> | | Nationally scarce |
| <i>Kiaeria starkei</i> | | Nationally scarce |
| <i>Lophozia opacifolia</i> | | Nationally scarce |
| <i>Marsupella arctica</i> | Vulnerable | Nationally rare |
| <i>Marsupella boeckii</i> | Vulnerable | Nationally rare |
| <i>Marsupella brevissima</i> | | Nationally scarce |
| <i>Marsupella condensata</i> | Near threatened | Nationally rare |
| <i>Marsupella sparsifolia</i> | Vulnerable | Nationally rare |
| <i>Marsupella stableri</i> | | Nationally scarce |
| <i>Moerckia blyttii</i> | | Nationally scarce |
| <i>Nardia breidleri</i> | Near threatened | Nationally scarce |
| <i>Pleurocladula albescens</i> | Near threatened | Nationally scarce |
| <i>Pohlia ludwigii</i> | | Nationally scarce |
| <i>Polytrichum sexangulare</i> | | Nationally scarce |
| <i>Scapania paludosa</i> | | Nationally scarce |
| <i>Sciuro-hypnum glaciale</i> | Near Threatened | Nationally rare |
| <i>Sciuro-hypnum starkei</i> | Endangered | Nationally rare |

Bryophytes which in Scotland are largely restricted to snowbeds

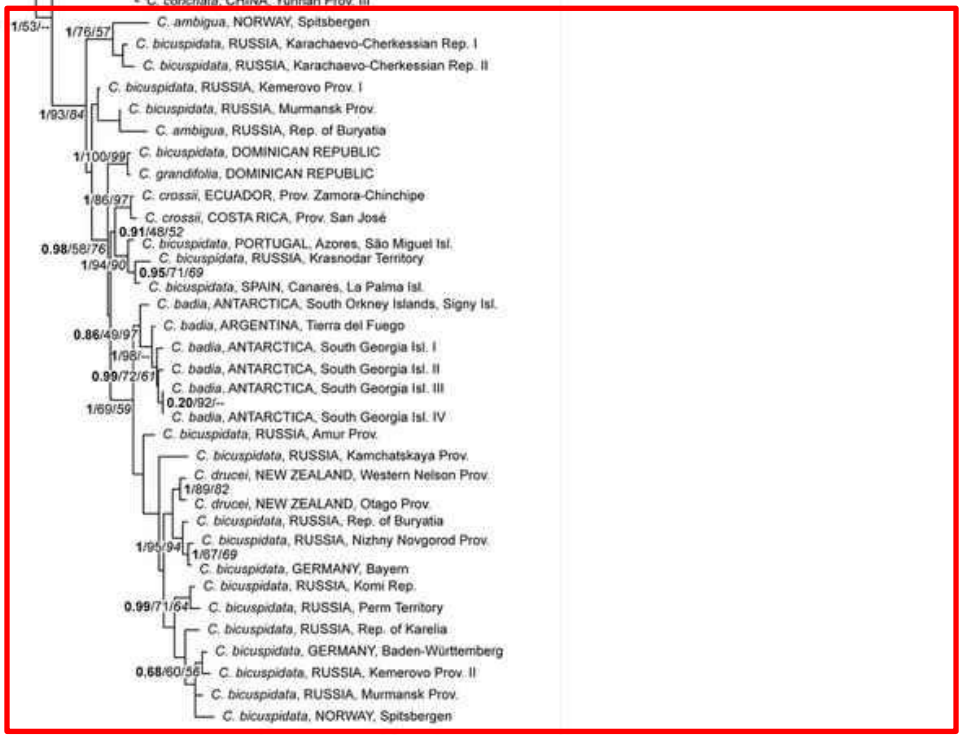
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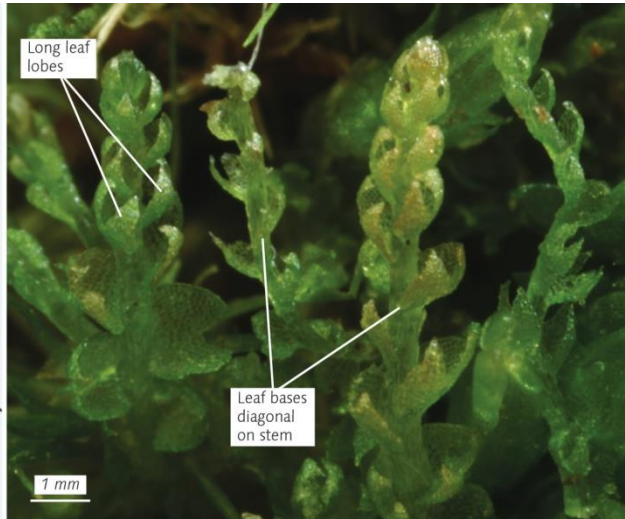
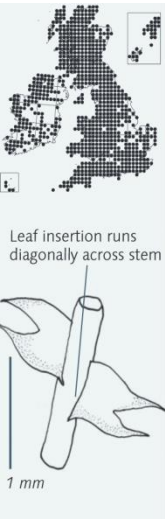
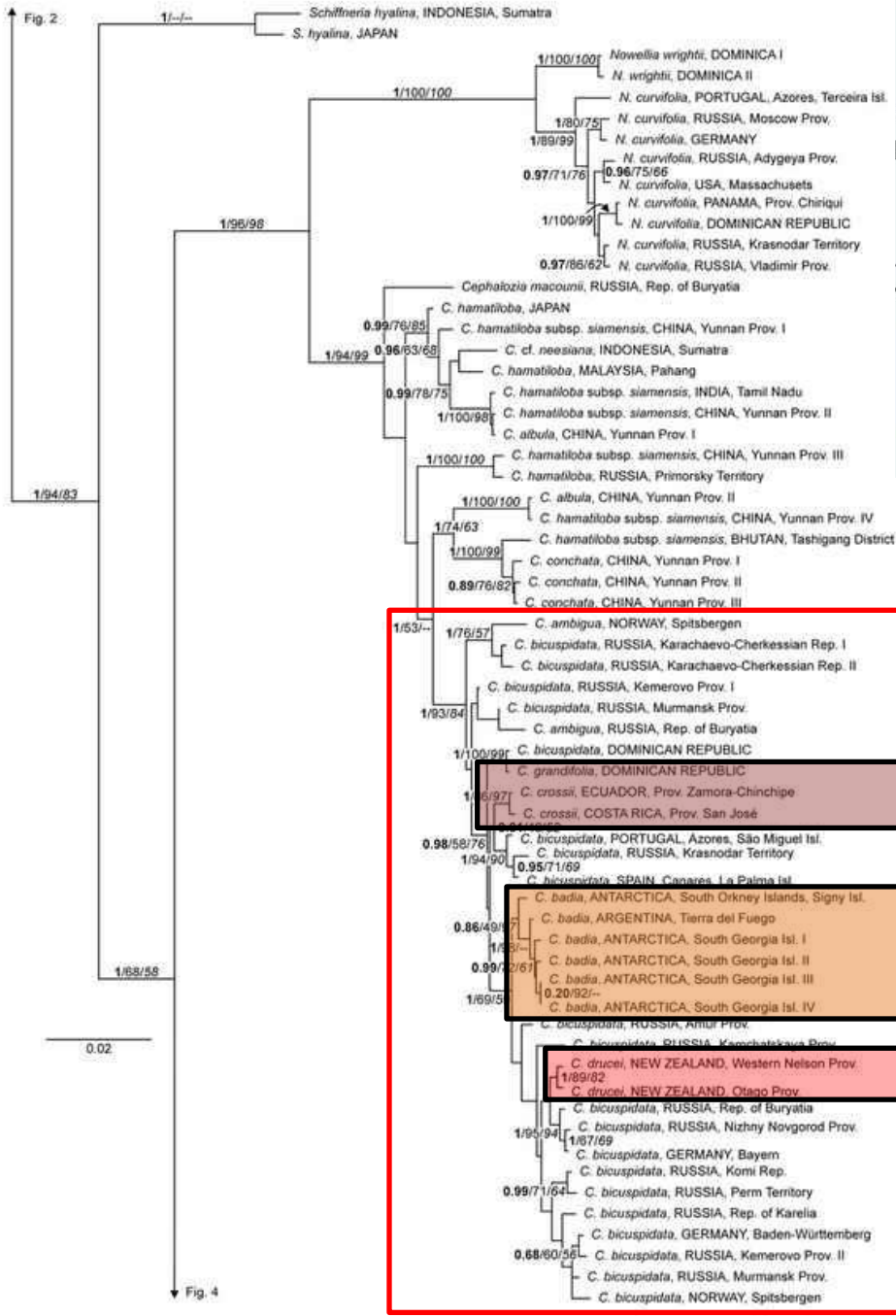
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Cephalozia bicuspidata species complex



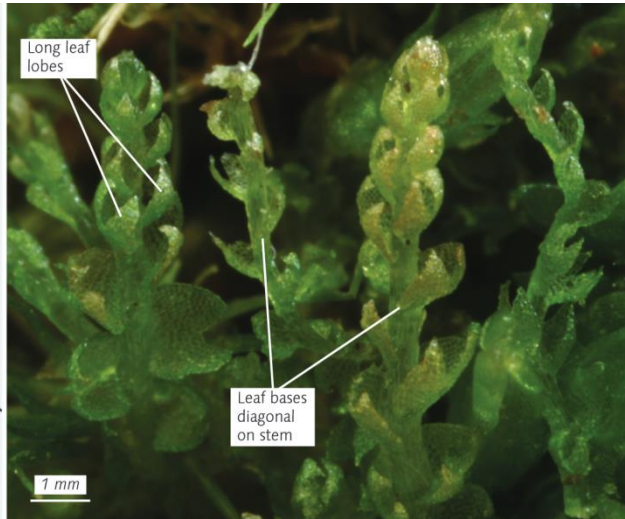
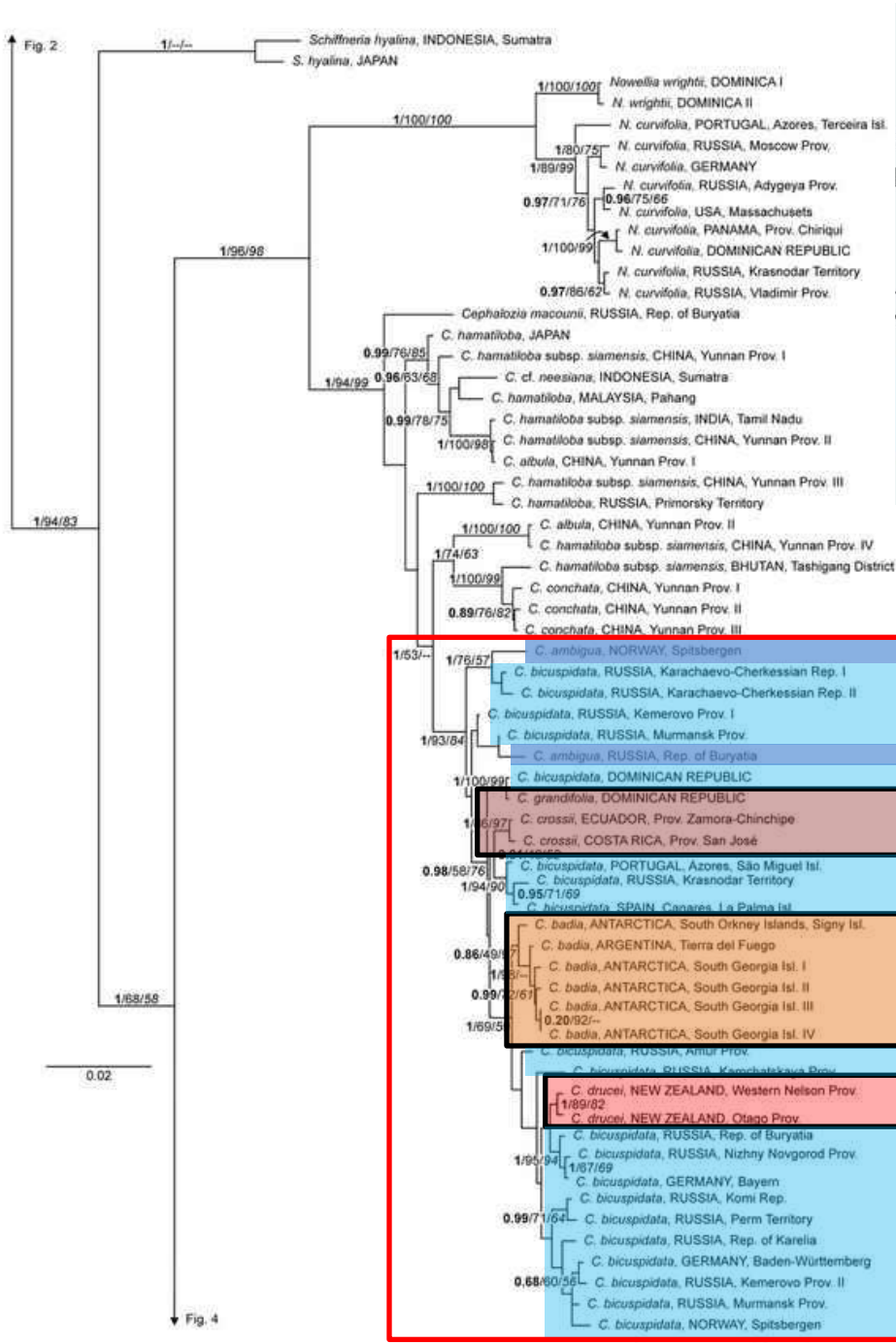


Cephalozia bicuspidata species complex

C. crossii & C. grandifolia (neotropics)

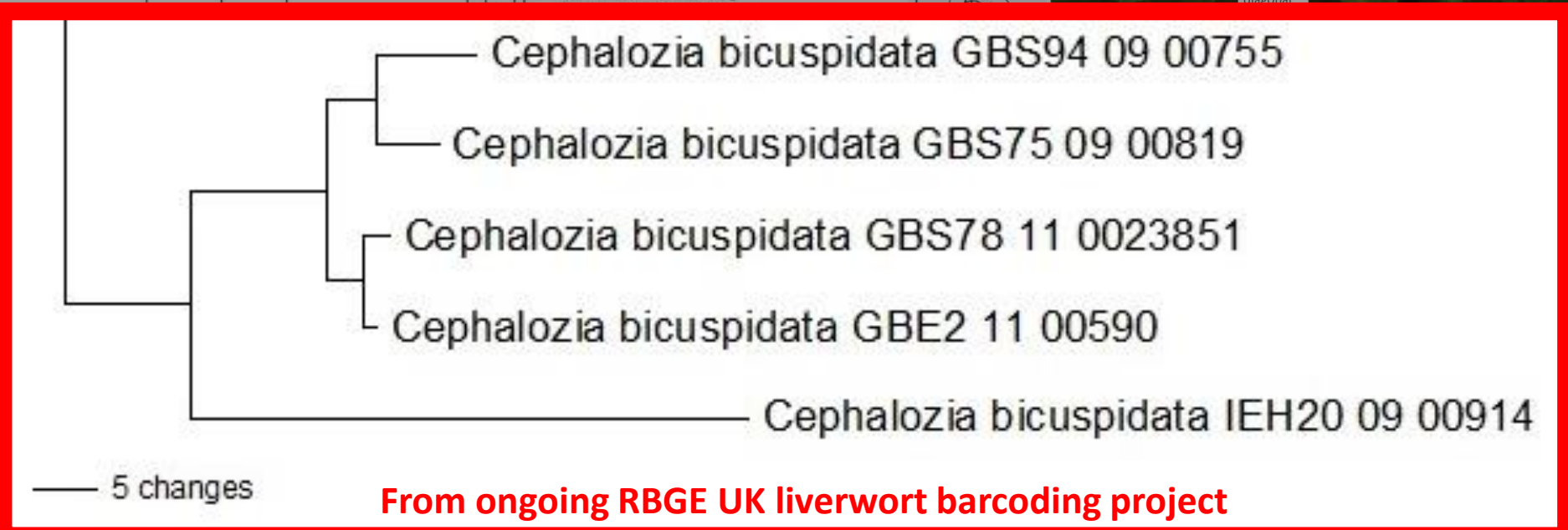
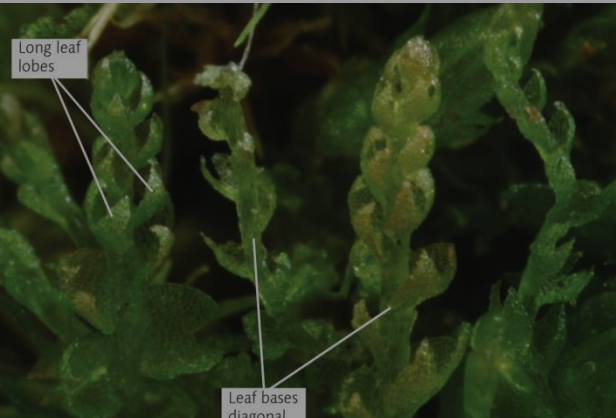
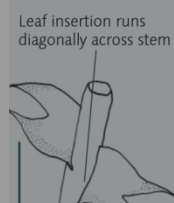
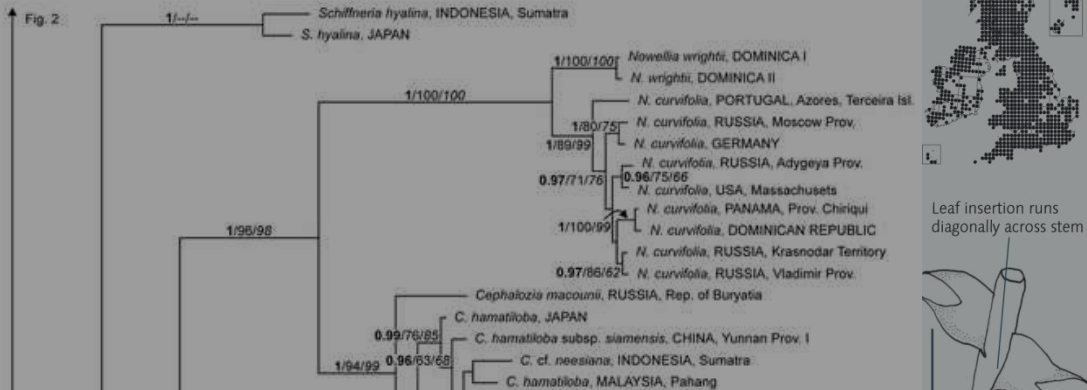
C. badia (Antarctic)

C. drucei (New Zealand)



Cephalozia bicuspidata species complex

- C. ambigua*
- C. bicuspidata*
- C. ambigua*
- C. bicuspidata*
- C. crossii* & *C. grandifolia* (neotropics)
- C. bicuspidata*
- C. badius* (Antarctic)
- C. bicuspidata*
- C. drucei* (New Zealand)
- C. bicuspidata*



C. bicuspidata

C. drucei
(New Zealand)

C. bicuspidata

Acknowledgements

- **Scottish Snowbed Vegetation Monitoring Network**

(David Genney, Gordon Rothero, John-Arvid Grytnes, Rebecca Yahr, Chris Ellis, John Birks, David Long)

- **Snowbed Trainees & Volunteers**

(Julie Smith, Clare Rickerby, Oliver Moore, Rory Whytock, Tom Edwards, Sharon Yardy, Sara McBride)



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Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

