International Association of Bryologists (IAB) Conference

January 11-15, 2015

Omora Ethnobotanical Park - Universidad de Magallanes
Puerto Williams, Chile

&

Ecotourism with a Hand Lens
in the Miniature Forests of the Cape Horn Biosphere Reserve
January 10, 2015

ORGANIZING COMMITTEE
Bernard Goffinet, University of Connecticut
Francisca Massardo, Universidad de Magallanes - IEB
Andrés Mansilla, Universidad de Magallanes - IEB
Ricardo Rozzi, University of North Texas - Universidad de Magallanes - IEB
Mary Kalin-Arroyo, Universidad de Chile - IEB
Juan Armesto, P. Universidad Católica - IEB
Francisco Squeo, Universidad de La Serena - IEB
Lohengrin Cavieres, Universidad de Concepción - IEB

International Association of Bryologists
Chile 2015
Cape Horn Biosphere Reserve - Omora Park

ACKNOWLEDGMENTS

The organizers wish to express their gratitude to several institutions, organizations and colleagues that made it possible to organize this first international scientific conference in the Chilean Antarctic Province, Chile.

We thank the Universidad de Magallanes (UMAG) and in particular its President Dr. Juan Oyarzo, and its Vice-Presidents Dr. Jose Maripani, Ms. Elizabeth Jeldres and Dr. Andrés Mansilla, for the financial support. Also, the logistic and financial support from the Institute of Ecology and Biodiversity (IEB) and mediated by Dr. Mary Kalin and Dr. Juan Armesto, was critical to overcome the challenges to develop an international conference in Puerto Williams.

Support from the Gobernacion of Chilean Antarctic Province and the Governor, Mr. Patricio Oyarzo, was essential to garner national attention for this event. Likewise we thank the Municipalidad de Cabo de Hornos, the Mayor Ms. Pamela Tapia and the school Director, Mr. Francisco Fernandez, for allowing us to use the local school, Liceo Donald McIntyre Griffiths, as the main building to host this conference.

We especially thank the Armada de Chile, Distrito Naval Beagle and Tercera Zona Naval, for its extraordinary support and collaboration with relevant parts of the planned activities of the conference.

The Center for Environmental Philosophy, its Director Dr. Gene Hargrove, and its Assistant Director, Ms. Terry Tehan, provided the on-line system that allowed the participants to register from different parts of the world. The University of Connecticut facilitated the on-line submission of abstracts. The University of North Texas provided the web page. Both universities brought undergraduates and graduates students as attendants to this conference.

We thank the staff and researchers of the Omora Ethnobotanical Park and of the Programa de Conservacion Biocultural Subantartica, in Chile and the US. The Omora Park is one of the three research sites of the Chilean Long-Term Socio-Ecological Research network (LTSER-Chile), and part of the International LTER network (ILTER). They all contributed to making this conference a reality.

Finally, we want to thank to all the bussiness that were willing to collaborate with the conference: Lakutaia Lodge, Aerovias DAP S.A., Transbordadora Austral Broom S.A., Antarctica XXI, Australis, Fundación Fungi, RawNavarino, and Full Patagonia Tour.

ORGANIZING COMMITTEE

Front page. Cape Horn Archipelago evergreen forest by Paola Vezzani.

PROGRAM OVERVIEW

<table>
<tr><th>Hours</th><th>Sunday 11th</th><th>Monday 12th</th><th>Tuesday 13th</th><th>Wednesday 14th</th><th>Thursday 15th</th></tr>
<tr><td>9.00 - 10.30</td><td rowspan="2">Navigation to Wulaia bay
5.30 - 14.30</td><td>Oral session 1</td><td>Oral session 5</td><td>Oral session 6</td><td>Oral session 7</td></tr>
<tr><td>10.30 - 11.00</td><td>Tea & Coffee break</td><td>Coffee break & Box-lunch</td><td>Tea & Coffee break</td><td>Tea & Coffee break</td></tr>
<tr><td>11.00 - 12.30</td><td rowspan="2">Preconference Workshop
10.00 - 16.00</td><td>Oral session 2</td><td rowspan="5">Field trip to Cerro La Bandera
11.30 - 18.00</td><td>Poster session</td><td>Closing address
11.00</td></tr>
<tr><td>13.00 - 14.00</td><td>Box-lunch</td><td>Box-lunch</td><td>Individual lunches</td></tr>
<tr><td>14.00 - 15.30</td><td rowspan="2">Registration at the local school
17.00 - 18.00</td><td>Oral session 3</td><td rowspan="3">Fiels trip to a local peatland
14.00 - 18.00</td><td rowspan="5"></td></tr>
<tr><td>15.30 - 16.00</td><td>Tea & Coffee break</td></tr>
<tr><td>16.00 - 17.00</td><td rowspan="2">Inaugural reception and keynote address
18.00 - 19.30</td><td>Oral session 4</td></tr>
<tr><td>19.00</td><td>Dinner</td><td>Dinner</td><td rowspan="2">Traditional Magellanic barbecue
Award Ceremony
19.00 - 23.00</td></tr>
<tr><td>20.00 - 21.45</td><td>Reception at the Navy Hall
20.00 - 21.30</td><td>Field visit to an aechaelogical site</td><td>IAB Council Meeting
21.00</td></tr>
</table>

PROGRAM

SUNDAY JANUARY 11, 2015

05.30 - 14.30 Navigation with the Chilean Navy to Wulaia Bay - West coast of Navarino Island

10.00 - 16.00 Preconference Workshop: Ecotourism with a Hand lens - Omora Park

17.00 - 18.00 Conference registration - Local School

18.00 - 19.30 Inaugural reception and keynote address - School
pending Presidential schedule

20.00 - 21.30 Reception - Chilean Navy Hall

MONDAY JANUARY 12, 2015

9.00 - 10.30 ***Oral session 1:* Bryophyta flora of (Sub)Antarctic**

OS1. PLENARY TALK: *Convey, P.* Glacial period refugia - how do you mix biology and ice ages in the Antarctic?

OS2. *Buck, W.R., J.J. Engel, M. von Konrat*, L. Briscoe, B. Shaw, J. Larraín & E. Davis.* Bryophytes of the Cape Horn Archipelago: Floristics, phylogeography and implications for biodiversity conservation.

OS3. *Larraín, J.*, B. Carter, B. Shaw, J. Hentschel & M. von Konrat.* Towards a monograph of *Frullania* subgen. *Microfrullania*: the taxonomy of *Frullania magellanica*.

OS4. *Tangney, R.S. & S. Russell*.* Moss flora of the Falkland Islands.

OS5. *Biersma, E.M.*, S. Pisa, P. Convey, & A. Vanderpoorten*. Pre-Pleistocene colonization of Antarctica by bryophytes.

10.30 - 11.00 Tea & Coffee break

11.00 - 12.30 ***Oral session 2.* Bryophyta flora of (Sub)(Ant)Arctic**

OS6. *La Farge, C.*, K.H. Williams, J.H. England, S. Pendelton & G. Miller*. Implication of regrowth of subglacial bryophytes in the Canadian Arctic archipelago.

OS7. *Lewis, L.R.*, R. Rozzi & B. Goffinet.* Resolving bipolar phylogeographic histories of the dung moss *Tetraplodon*: A RAD-seq approach.

OS8. *Convey, P.*, E. Roads & R.E. Longton.* Permafrost preservation and very long term viability in a moss from Antarctica.

OS9. *Stanton, D.E.*, D. Bergstrom & M.C. Ball*. Functional traits and stable isotope signatures of sub-Antarctic bryophytes.

OS10. *Montenegro, L.C* & L.M. Melgarejo.* Photosynthetic efficiency and respiration in *Pleurozium schreberi* during the dry season in the Páramo of Chingaza (3400 masl) – Colombia.

13.00 - 14.00 Box-lunch

14.00 - 15.30 ***Oral session 3:* Bryophyte conservation**

OS11. *Hallingbäck, T.* Using bryophytes in nature conservation – beyond the lists of species.

OS12. *Rozzi, R.* & F. Massardo*. Ecotourism with a hand-lens: moss conservation in the Cape Horn Region.

OS13. *Söderström, L.* & A. Séneca*. Species richness at different geographical scales.

OS14. *Lönnell, N.* Recording species distribution on the internet – Seeing your local findings in a wider context.

OS15. *Pressel, S.*, C. Supple & J.G. Duckett*. Bryophyte diversity and conservation on a remote island: Implementing a Darwin Initiative Biodiversity Action Plan on Ascension Island.

OS16. *Stech, M.*, D. Coombes, T.T. Luong, J. Vollering, T. Zhou & J.D. Kruijer.* DNA barcoding and biodiversity assessment of arctic and temperate *Bryum* species.

15.30 - 16.00 Tea & Coffee Break

16.00 - 17.00 ***Oral session 4:* Evolution of early land plants**

OS17. *Duckett, J.G. & S. Pressel*.* Key land plant innovations in the bryophyte clade: considerations of homology and function.

OS18. *Hasebe, M.* Evolution of water conducting systems in the moss *Physcomitrella patens*.

OS19. *Budke, J.M.*, L. Busta, C.S. Jones, & B. Goffinet*. Beneath the veil of the calyptra: exploring cuticle anatomy during moss sporophyte development in the Funariaceae.

OS20. *Dangwal, M.* & M. Kapoor.* Interactions among the *Polycomb* group complex proteins and their roles in regulating different aspects of development in *Physcomitrella patens.*

19.00 Dinner, Navy Hall

20.00 - 21.45 Visit of local archeological site

TUESDAY JANUARY 13, 2015

9.00 - 10.30 ***Oral session 5:* Bryophytes in the genomic age**

OS21. *Liu, Y., R. Medina & B. Goffinet*.* 350 my of mitochondrial genome stasis in mosses, an early land plant lineage.

OS22. *Lewis, L.R.*, Y. Liu, R. Rozzi & B. Goffinet*. Plastid variation in the young endemic dung moss *Tetraplodon fuegianus*.

OS23. *Krug, M., K. Müller, B. Goffinet, T. Borsch, P. Testroet, S. Noben , V. Knoop & D. Quandt*.* Phylogenetic structure in organellar markers: resolving the backbone phylogeny of mosses.

OS24. *Liu, Y., N. Devos, M. Johnsson, R. Medina, N. Wickett, A.J. Shaw & B. Goffinet*.* Targeted organellar gene enrichment for resolving the macroevolutionary moss tree of life.

OS25. *Sha, W., M.J. Zhang and T.Y. Ma*.* Transcriptomics and proteomics analysis of *Racomitrium canescens* drought tolerance mechanism.

10.30 - 11.00 Coffee break & Box-lunch

11.30 - 18.00 Field trip to Cerro La Bandera

19.00 Dinner, Navy Hall

21.00 IAB Council meeting

WEDNESDAY JANUARY 14, 2015

9.00 - 10.45 ***Oral session 6:* Bryophyte ecology**

OS26. *Hofbauer, W.K.*, M.L. Hollingsworth & P.M. Hollingsworth.* Mosses involved in the primary colonization of modern building surfaces – genetic aspects.

OS27. *Lönnell, N.*, B.G. Jonsson, S. Sundberg & K. Hylander*. Realized dispersal of *Discelium nudum*–experiments with a substrate specialist over one season.

OS28. *Medina, N.G.*, M.A. Bowker, J. Hortal, V. Mazimpaka & F. Lara*. Relative importance of species pools and environmental filters for epiphytic bryophyte richness changes across scales.

OS29. *Pérez, C.*, J.C. Aravena, W. Silva, P. Troncoso, F. Osorio & B. Segura & J. Armesto.* The role of cryptogamic flora during ecosystem development.

OS30. *Sierra, A.M.*, N. Flores & N. Salazar Allen.* Epiphyllous liverworts on the understory shrub, Piper grande Vahl., in the National Park G. D. Omar Torrijos H., El Copé (Panamá). Advance report.

OS31. *Montenegro, L.C.* & L.M. Melgarejo.* Contents of ABA in *Pleurozium schreberi* during the dry season in the Páramo of Chingaza (3400 masl) – Colombia.

OS32. *Itouga, M*. Vertical allocation pattern of elements and chemical shift of the calcifuge-moss population in the wetland ecosystem.

11.00 - 11.30 Tea & Coffee Break

11.30 - 12.30 **Poster session (PS1–11)**

PS1. *Behling, E., L.R. Lewis*, H. Gousse, E. Qian, C. Elphick, J.-F. Lamarre, J. Bêty, J. Liebezeit, R. Rozzi & B. Goffinet.* Migratory birds carry plant diaspores in their feathers.

PS2. *Chmielewski, M.W.* Abundance, species composition, and retention times of bryophyte spores on avian surfaces in a Pacific Northwest USA forest.

PS3. *Higuchi, M.* A revision of the genus *Macrothamniella* (Bryophyta).

PS4. *Medina, N.G.*, B. Estébanez, R. Caparrós, J. Martínez Abaigar & E. Núñez Olivera.* The effects of ultraviolet irradiation on spores of four mosses with different dispersal strategy: germination and ultrastructure.

PS5. *Nomura, T.*, M. Kojima, S. Hasezawa & H. Sakakibara.* Cellular differentiation of the protonema is regulated by copper via auxin signaling in the copper moss, *Scopelophila cataractae.*

PS6. *Phephu, N.* & J. vanRooy.* Centers of moss diversity in southern Africa.

PS7. *Radhakrishnan, G.V.* & G.E.D. Oldroyd.* Signalling in the liverwort – fungal symbiosis – a case study in *Marchantia paleacea.*

PS8. *Roque-Marca, N.* & F.A. Squeo.* Effect of water table depth on the class: Muscopsida in High Andean peatlands in the Atacama Region, Chile.

PS9. *Saldías, C.*, R. Rozzi & F. Massardo.* Experiences with visitors in the "Miniature Forests of Cape Horn."

PS10. *Simpson, M.* Bryophytes add diversity to Alberta's oil sands.

PS11. *Vellak, K.*, T. Tusti & N. Ingerpuu.* Are rare species ecologically more sensitive: laboratory experiment with three fen species.

12.30 - 13.30 Box-lunch

14.00 - 18.00 Field trip to local peatland

19.00 Final dinner (Traditional Magellanic barbecue)
Award ceremony

THURSDAY JANUARY 15, 2015

9.00 - 10.30 ***Oral session 7:* Bryophyte diversity & Bryology - outreach and education**

OS33. *Reeb, C.* How to make a decision for species hypothesis in an integrative taxonomy approach: the example of African *Riccardia.*

OS34. *Lang, A.S.*, J.D. Kruijer, G. Bocksberger & M. Stech.* Species identification and species delimitation approaches within the moss genus *Dicranum*.

OS35. *Wilbraham, J.* & S. Pressel. Macromitrium* (Orthotrichaceae) in sub-Saharan Africa.

OS36. *Zhang, L.* & Q. Zuo.* The rediscovery and the phylogenetic position of *Brachymeniopsis* Broth. (Funariaceae, Bryophyta).

OS37. *Whitelaw, M.* Mad about Mosses - introducing the British public to the bryophytes of London.

OS38. *von Konrat, M.*, A. Smith, B. Carstensen, L. Whyte, T. Campbell, M. Greif, J. Larrain, E. Gaus, M. Bryson, B. Crownover, B. Shaw, J. Scheffel, L. Hasan, C. D'Lavoy, L. Briscoe et al.* Crowd-sourced science: digitized natural history collections extends its branches to education and outreach.

10.30 - 11.00 Tea & Coffee Break

11.30 Closing address

12.30 - 13.30 Individual lunches

ABSTRACTS

NOTES:

BEHLING, E.[1], L.R. LEWIS[1],* H. GOUSSE[1], E. QIAN[1], C. ELPHICK[1], J.-F. LAMARRE[2], J. BÊTY[2], J. LIEBEZEIT[3], R. ROZZI[4] & B. GOFFINET[1].
[1]University of Connecticut, USA; [2]Université du Québec à Rimouski, Canada; [3]Audubon Society of Portland, USA; [4]Univ. North Texas, USA & Uni. Magallanes, Chile.

Migratory birds carry plant diaspores in their feathers

Migratory birds are commonly invoked as vectors for transequatorial dispersal of plants, but supporting evidence is largely circumstantial. Birds disperse plant units internally via ingestion or externally. Internal dispersal plays a significant role in the dispersal of seeds and invertebrates. External dispersal may play an important role in dispersal across extreme bipolar disjunctions and for organisms for which dispersible units (diaspores) are not adapted to animal mediated dispersal. However, it remains unknown if birds carry plant diaspores externally. Here we show that transequatorial migrant birds captured in their arctic breeding range harbour a diversity of plant diaspores in their plumage. Three of the recovered units represent wind-dispersed lineages (mosses and liverworts). Our observations indicate that bird mediated dispersal plays a role in the dispersal of lineages that lack adaptations for animal mediated dispersal. The frequency with which we recovered diaspores suggest that entire migratory populations may be departing their northern breeding grounds laden with potentially viable plant parts and thereby play a significant role in bipolar range expansions.

BIERSMA, E.M.[1, 2],* S. PISA[3], P. CONVEY[1], A. VANDERPOORTEN[4, 5]
[1]British Antarctic Survey, UK; [2]Univ. of Cambridge, UK; [3]Univ. of Murcia, Spain; [4]Univ. of Liège, Belgium; [5]Univ. of the Azores, Portugal.

Pre-Pleistocene colonization of Antarctica by bryophytes

Glaciological reconstructions suggest that thick ice sheets covered most terrestrial areas of Antarctica during the Last Glacial Maximum (LGM; ~22–18ka), as well as during previous glaciations. This has led to the assumption that most modern terrestrial biota must have colonized Antarctica since the LGM. However, recent biogeographic research suggests that much of Antarctica's terrestrial biota has a long-term history in situ, with timescales of persistence ranging through pre-LGM to Gondwana-breakup. Bryophytes seem to stand distinct from these patterns, with their low species endemism levels, distribution patterns and high dispersal abilities being consistent with the suggestion that today's moss biota are recent colonists. Alternatively, the life cycle and ecology of bryophytes suggests that their evolutionary rates may be much slower than those of other taxa, with the low number of phenotypically informative features and phenotypic plasticity making it difficult to distinguish long-term isolation through application of classical taxonomy.
Here, focusing on the species *Bryum argenteum*, we present the first evidence of long-term in situ persistence of mosses in Antarctica. Using the molecular marker ITS combined with worldwide sampling and a molecular clock analysis, we found evidence for at least three separate colonization events of Antarctica by *B. argenteum*, with estimated colonization times ranging from 4-0.5 million years. This strongly supports the survival of *B. argenteum* in Antarctica throughout glacial cycles within the Pleistocene, Pliocene and possibly even the late Miocene, suggesting that mosses may have had a much longer persistence in the Antarctic than previously thought.

BUDKE, J.M.[1],* L. BUSTA[2], C.S. JONES[3], & B. GOFFINET[3]
[1]Plant Biology Dept., Univ. of California – Davis, Davis, CA USA; [2]Chemistry Dept., The Univ. of British Columbia, Vancouver, BC, Canada; [3]Ecology & Evolutionary Biology Dept., Univ. of Connecticut, Storrs, CT USA.

Beneath the veil of the calyptra: exploring cuticle anatomy during moss sporophyte development in the Funariaceae

The moss calyptra is a cap of maternal gametophyte tissue that is necessary for sporangium formation and ultimately sporogenesis. It covers the sporophyte completely during early development, but only the apex during seta elongation. Using transmission electron microscopy, we found that a thick, multi-layered cuticle covers the calyptra in four Funariaceae taxa. In all species, a mature cuticle is present on the calyptra at early stages and persists throughout sporophyte development, while the cuticle of the sporophyte apex remains immature until later developmental stages. Species with taller sporophytes are significantly correlated with both larger calyptra and thicker cuticles. We also explored the chemical composition of the cuticle of Funaria hygrometrica. We found that the calyptra differs from the leafy gametophyte by carrying a heavier wax load that is biosynthesized through two known metabolic pathways, while the leafy gametophyte has fewer wax molecules in its cutic le, which are derived from only one biosynthetic pathway. Sporophytes wilt when their calyptrae are removed, suggesting that the calyptra prevents dehydration of the developing sporophyte apex. To test the hypothesis that wilting is prevented by the cuticle on the calyptra, a manipulation experiment was carried out using F. hygrometrica. Maternal reproductive success and sporophyte fitness, including survival, sporangium production, and spore output were negatively affected by calyptra cuticle removal at lower humidity levels. These findings support the hypothesis that the calyptra cuticle functions in dehydration prevention during moss sporophyte development. As a gametophyte structure, the calyptra is a unique form of maternal care that may have been a critical innovation for the early success of mosses on land.

BUCK, W.R.[1], J. J. ENGEL[2], M. VON KONRAT[2] ,* L. BRISCOE[2], B. SHAW[3], J. LARRAÍN[2] & E. DAVIS[4]
[1]New York Botanical Garden, USA; [2]The Field Museum, USA; [3]Duke Univ., USA; [4]CEQUA, Punta Arenas, Chile.

Bryophytes of the Cape Horn Archipelago: Floristics, phylogeography and implications for biodiversity conservation

Bryophytes are critical components of many terrestrial ecosystems yet they often are understudied, especially in southern Chile. We outline a multi-year project providing the first ever comprehensive treatment of the liverworts, hornworts and mosses of the Cape Horn Archipelago, a physically and biogeographically distinct region of Chile known as a center of biological richness and south temperate endemism for non-vascular plants and diverse animal groups. We have found numerous new species records to the region, including Northern Hemisphere disjuncts and species previously thought to be endemic to other Antarctic/subantarctic regions. New species have already been identified from our collections, as well as many tentative ones requiring additional study. The project is led by two taxonomists, Buck who has worked for over a decade on southern Chilean mosses, and Engel, who has spent his entire career on south temperate and subantarctic liverworts. The combined scientific expertise with political and logistical support provided by numerous individuals, authorities, institutions and organizations, Chilean government and agencies, have contributed to the success of completing an inventory of the Cape Horn Archipelago bryophytes. An intense four-year field effort has led to over 15,000 collections. These are forming the basis of producing a comprehensive account of the diversity, taxonomy and distribution of the region's bryophytes that will have major implications in understanding the phylogeny of these groups and will shed new light on the origins of the south temperate biota.

CHMIELEWSKI, M.W.
Portland State University USA.

Abundance, species composition, and retention times of bryophyte spores on avian surfaces in a Pacific Northwest USA forest

While avian dispersal of angiosperm propagules is well characterized, the potential for bird dispersal of mosses remains almost entirely unexplored. Given the ubiquitous use of mosses by birds as both nesting material and as a place to forage, bird movement provides a potentially powerful vector for moving moss propagules across distances that exceed abiotic and undirected dispersal. To assess the extent to which birds harbor moss propagules on their surfaces, I mist netted forest passerines in a bryophyte-abundant forest in the northwest USA. Birds were swabbed for bryophyte propagules on legs, and rectrices, and a small sample of feathers was taken. Birds were additionally banded and treated with dyed spores. Collected swabs were filtered and spores enumerated via microscopy and plated on growth media. I describe differences in abundance and species composition of spores recovered from bird surfaces as well as potential topical retention times from recapture data. These da ta support that this mode of dispersal may be fairly widespread, with species-specific interactions. Avian dispersal of bryophytes is likely to provide increased connectivity between patches, speed the recolonization of anthropogenically-disturbed forest patches by bryophytes, and may provide a vector for novel introduction onto emerging habitat (such as that created via volcanic activity or ice melt).

CONVEY, P.
British Antarctic Survey, Natural Environment Research Council, High Cross, Cambridge, United Kingdom.

Glacial period refugia - how do you mix biology and ice ages in the Antarctic?

Even today, terrestrial life in Antarctica is surprisingly poorly known in detail. It is clear that most currently ice-free ground in Antarctica would have been covered and scoured by glacial advances at the Last Glacial Maximum or previous maxima. However, as new baseline survey data have become available, in combination with modern molecular biological analysis, it has become clear that long-term persistence and regional isolation is a feature of the Antarctic terrestrial biota whose generality has not previously been appreciated. This biota is dominated by cryptogams, microarthropods and other microinvertebrates, all of which show strong evidence of long-term presence in Antarctica. As well as creating a new paradigm in which to consider the evolution and adaptation of Antarctic terrestrial biota, this opens important new cross-disciplinary linkages in the fields of understanding the geological and glaciological history of the continent itself, and of the climatic and ocea nographic process that can both lead to isolation and support colonisation processes. This new and more complex understanding of Antarctic biogeography also provides important practical challenges for management and conservation in the region, as required under the Antarctic Treaty System.

CONVEY, P.[1],* E. ROADS[2] & R. E. LONGTON[2]
[1]British Antarctic Survey, Natural Environment Research Council, Cambridge, UK; [2]Univ. of Reading, Reading, UK.

Permafrost preservation and very long term viability in a moss from Antarctica

We demonstrate millenial-scale survival and viability deep within an Antarctic moss bank preserved in permafrost. Using a core of the moss Chorisodontium aciphyllum, extracted from an actively growing bank extending into the permafrost on Signy Island, maritime Antarctic, we document regrowth in the laboratory from depths near the surface (0-30 cm), 110 cm, and at the base of the core (121-138 cm). New shoots developing at 0-30 cm and 110 cm originated directly from the stems of existing gametophytes, while those at the base of the core arose from protonema that developed from rhizoids preserved in the core. Core material at 110 cm was radiocarbon dated to 1533-1697 cal years BP. Bank-forming mosses, combining good structural preservation and incorporation into permafrost, have potential for even longer periods of viability than we have demonstrated here, redefining what can potentially be considered as a glacial refuge and providing a novel source for post-glacial habitat recolonisation and genetic diversity.

DANGWAL, M.* & M. KAPOOR
University School of Biotechnology, Guru Gobind Singh Indraprastha University, India.

Interactions among the Polycomb group complex proteins and their roles in regulating different aspects of development in *Physcomitrella patens*

Chromo methyltransferases (CMT) are plant-specific methyltransferases that have been evolutionarily conserved in land plants. Interactome studies using yeast 2 hybrid method reveals that PpCMT specifically interacts with PpTFL2 (*Physcomitrella patens* Terminal flower 2), a homolog of *Arabidopsis* LHP1 (Like-heterochromatin protein) that has PRC1-like (*Polycomb* repressor complex 1) activity. Deletion analysis shows crucial roles of conserved domains in PpCMT and PpTFL2 in mediating hetero dimerization and homodimer formation among these proteins. PpCMT knockout drastically reduces genome wide DNA methylation levels and affects apical cell growth and suppresses leafy gametophyte initiation in *Physcomitrella*. Disruption of endogenous PpTFL2 also affects growth and differentiation in protonemata. PpTFL2 interact with other components of the PRC1 complex such as RING domain containing proteins and others that are conserved in polycomb complexes in angiosperms. This is the first report that suggests crosstalk between DNA methylation and PcG proteins in early land plants.

DUCKETT, J.G. & S. PRESSEL*
The Natural History Museum, London, UK.

Key land plant innovations in the bryophyte clade: considerations of homology and function

Bryophytes, as the most basal lineages of embryophytes, represent a unique window into the conquest of land by plants from fresh water origins, some 490 MYA. Our research addresses major questions pertaining to homology and function of some of the key innovations that drove plant terrestrialization: stomata, intercellular spaces and fungal associations, in the bryophyte clade.
Our data on the physiology, anatomy and development of bryophyte stomata and those of the subtending intercellular spaces strongly suggest very different origins and function from that of tracheophyte stomata, though both share many of the same genes. All our structural and physiological data favor an ancestral role for bryophyte stomata in sporophyte dehiscence leading to spore dispersal rather than gaseous exchange.
Our studies of fungal associations in bryophytes are also providing novel insights into their functional significance and raise exciting new hypotheses on the origin and evolution of this key land plant attribute. Consequent to our recent discovery that early divergent clades of liverworts and hornworts form associations not only with Glomeromycota fungi but also with members of an earlier fungal lineage, the Mucoromycotina, our research now focuses on the distribution, anatomy and physiology of these hitherto unknown symbioses. Our latest molecular, functional and ultrastructural data are showing that associations with Mucoromycotina fungi are widespread in bryophytes and range from obligate and highly host specific to facultative and with a broad host range. Bryophyte-Mucoromycotina associations represent true mutualistic partnerships, on a par with fungal symbioses in higher plants, however their responses to simulated ancient atmospheric CO2 concentrations are strikingly different from those of bryophyte- and tracheophyte-Glomeromycota associations. We will discuss our latest findings in the light of current phylogenetic hypotheses and their implications for understanding the origin and evolution of this key attribute of land plants, including critical comparisons with the fossil record.

HALLINGBÄCK, T.
Swedish University of Agricultural Sciences, Uppsala, Sweden.

Using Bryophytes in Nature Conservation – beyond the lists of species

Bryophytes are useful tool in nature conservation. Some cost-effective methods suitable for bryophytes in different landscapes and regions are presented. Two approaches. One is the habitat approach; the second is the species approach. They can successfully be combined. Use overview maps, satellite images, aerial photos, spotting structures like mountains, rock out crops, gorges, canyons, rivers and continue with smaller elements like old or dead trees and big boulders. This step is important because some habitats are richer in bryophytes than others. Mountains hold a significant proportion of the diversity of bryophytes. Regions with high precipitation are richer in bryophytes and the mountain cloud zone has higher diversity than lowland. Land with a diverse bedrock, containing both acidic and base rich rocks and soil types make by complementary principle a very species rich flora. Also places with a long ecological continuity have a wider range of taxa. Certain ecological structures are richer in bryophytes than others, like old and dead trees, shaded rocks along streams etc. The practice of using only habitats can be fatal, because some habitats can be empty in species. Using a selection of genera, species, can be a successful. The selection of potential indicators, in combination with habitat structures can at the first step be scientifically analyzed and tested. Selecting species with a slow life strategy is better than using all species. The perennials are more vulnerable to human-caused environmental changes. A Species-oriented approach in nature conservation is positive for several reasons. Finally, a mixed palette of methods depending on economy, geographical region, supply of educated personnel the methods should not only be cost-effective and scientifically sound but also pick up those habitats, localities where bryophyte in need of conservation still occur – the Bryophyte Hotspots

HASEBE, M.
National Institute for Basic Biology, Okazaki, Japan.

Evolution of water conducting systems in the moss *Physcomitrella patens*

Mosses have internal and external water conducting systems. The former is carried by hydroids and the latter by cellular surface materials. Hydroids have been hypothesized to be non-homologous to xylem vessels in vascular plants. We analyzed function of *Physcomitrella* VND genes of the NAC transcription factor gene family, whose *Arabidopsis* orthologs regulate secondary cell wall formation including cell death and cell wall thickening. *Physcomitrella* VNDs are expressed in leaf veins. Loss of function mutants of *Physcomitrella* VND showed the defect in water conduction and their over-expression caused cell death. These indicate that hydroids and xylems are regulated by the same gene regulatory networks, suggesting the homologous relationship between hydroids and xylem vessels.
Mosses have been believed to fertilize with exogenous water supply including rain. We unexpectedly found that *Physcomitrella* gametophores autonomously submerged in liquid and fertilize likely with external water conducting systems. I will show that some genes regulate the autonomous water supply and discuss on their molecular mechanisms and evolution.

HIGUCHI, M.
National Museum of Nature and Science, Tsukuba, Japan.

A revision of the genus *Macrothamniella* (Bryophyta)

Macrothemniella was revised based on the detailed morphological investigation. The genus is considered to be synonymous with *Ectropothecium* (Hypnaceae). The genus Macrothamniella was established by Max Fleischer in his work entitled "Die Musci der Flora von Buitenzorg" in 1923 based on Stereodon pilosulus Mitt. known from the southern Himalayas and was placed in the family Hylocomiaceae. Subsequently two species, *M. novoguinensis* and *M. robbinsii* were described by Edwin B. Bartram from New Guinea in 1961 and 1962 respectively. Thus, totally three species have been attributed to the genus and have never been revised, although some authors discussed the taxonomic position of the genus. My examination of the type specimen of *Stereodon pilosulus* Mitt. indicates that this species is identical with *Ectropothecium* species. The taxonomic position of *Isopterygium* subleptotapes Cardot & P. de la Varde is also discussed.

HOFBAUER, W.K.[1],* M.L. HOLLINGSWORTH[2] & P.M. HOLLINGSWORTH[2]
[1]Fraunhofer-Institute for Building Physics, Germany; [2]The Royal Botanic Garden Edinburgh, UK.

Mosses involved in the primary colonization of modern building surfaces – genetic aspects

Schistidium spp. are prominent colonizers amongst primary biological growth on modern building surfaces. The taxonomy of this critical genus has advanced considerably in recent years (Blom 1996). However, the growth of *Schistidium* on buildings is slow and development often incomplete. The presence of morphological characters for species identification is therefore often limited and as a consequence these building colonizers are often assigned to *Schistidium apocarpum* s.l.
In recent years DNA barcoding has been extensively used in studies of species complexes, to aid species assignments for morphologically cryptic species and the identification of new species (e.g. Bell et al. 2012). The application of DNA barcoding to obtain a genetic ID of 'reference' material is a powerful tool for species identification in environmental samples.
This presentation will report on the findings of a DNA barcoding project on European *Schistidium* involved in the colonization of modern buildings. A reference library of DNA barcodes and a review of morphological characters were made on herbarium collections of Schistidium previously classified by morphological characters. A study of both morphological characters and DNA barcodes was then made on colonizing material from modern buildings, with an emphasis on *Schistidium* spp. This study gives a first insight into the taxonomy of *Schistidium* species found growing on building surfaces and an assessment of the utility of DNA barcoding for the identification of cryptic, character poor species. Blom H.H. 1996. Bryophytorum Bibliotheca 49. Bell D. et al. 2012. Mol. Ecol. Resour. 12: 36–47.

ITOUGA, M.
RIKEN Center for Sustainable Resource Science, Yokohama, Kanagawa, Japan.

Vertical allocation pattern of elements and chemical shift of the calcifuge-moss population in the wetland ecosystem

Mosses play an important role of the hydrologic cycle and the element cycle in the wetland ecosystem (e.g., water-absorption, water-holding capacity, diffusion of water, water purification). Recently organic matter chemistry such as peat chemistry has been well used to monitor the physicochemical response to climate changes, and to measure the impact of climate feedbacks (i.e., increasing temperature, carbon mobilization from permafrost thaw etc.). Considering local manner on how to allocate the element resource and what happen in the organic cycle such as biosynthesis and decomposition is necessary to maintain sustainable wetland ecosystem, although climate change is public concern. To address this unique manner on the element cycle in the wetland ecosystem, we examined element distribution pattern and chemical shift in the vertical system composed of Polytrichum commune Hedw., one of typical calcifuge-mosses, and the substratum by Inductively coupled plasma mass spectrometr y (ICP-MS) and Fourier transform infrared (FTIR) spectroscopy. Essential elements such as potassium (K) in the terminal layer was statistically higher than that in the basal layer. Layer distinctive chemical shifts were observed at 4,000 - 550 cm-1 in IR spectrum. These results imply that sustainable growth of moss population is maintained by dynamic element recycling system and/or loss system with some processes of gradual chemical shifts.

KRUG, M.[1], K. MÜLLER[2], B. GOFFINET[3], T. BORSCH[4], P. TESTROET[1], S. NOBEN[1], V. KNOOP[5] & D. QUANDT[1],*
[1]Univ. of Bonn, Germany; [2]Univ. of Muenster, [3]Univ. of Connecticut; [4]Free Univ. Berlin; 5 Univ. of Bonn.

Phylogenetic structure in organellar markers: resolving the backbone phylogeny of mosses

A decade ago, Borsch et al. (2003) showed that non-coding plastid DNA sequences can be confidently used to infer evolutionary relationships at far deep levels than previously assumed. In comparison with multi-gene approaches, the results even suggested that fast-evolving, non-coding regions are more effective in reconstructing phylogenies at high taxonomic levels. Subsequently this idea was tested by Mueller et al. (2006) who showed that regions evolving close to neutrality are indeed more effective than slowly evolving genes. Later, Barniske et al. (2012) provided more insight into the capability of noncoding regions to resolve phylogenetic backbones: spacer and intron regions clearly outperformed coding regions except for matK which ranked highest.
Two questions remain: 1) does the neutrality assumption hold true for other evolutionary old lineages as well? 2) is this phenomenon also present in mitochondrial data? So far, all studies have been solely based on plastid data. To address these points, the divergence of the major moss lineages was chosen as further test case, as mosses represent another evolutionary old clade and various non-coding mitochondrial markers are accessible for all lineages.
The phylogenetic reconstructions of the concatenated data set revealed a fully resolved tree with overall high support that offers a new hypothesis concerning the evolution of the mosses. In contrast to earlier reconstructions the Gigaspermales retain an early branching position among the Bryopsida, branching off just after Diphyscium. Topology test rejected published alternative topologies. In addition, our analyses show that i) high functional constraints generally lead to low phylogenetic structure, ii) evolutionary constraints of organellar non-coding regions of both compartments are similar, and iii) plastid markers seem to be more rewarding than mitochondrial markers in general. References: Barniske et al. 2012. J. Syst. Evol. 50: 85-108. Borsch et al. 2013. J. Evol. Biol. 16: 558–576. Müller et al. 2006. Mol. Phyl. Evol. 41: 96–117.

LA FARGE, C.[1],* K.H. WILLIAMS[1], J.H. ENGLAND[1], S. PENDELTON[2] & G. MILLER[2]
[1]Univ. of Alberta, Edmonton, Canada; [2]Univ. of Colorado, USA.

Implication of regrowth of subglacial bryophytes in the Canadian Arctic archipelago

Rapid retreat of glaciers throughout the Canadian Arctic Archipelago is exposing pristine exhumed vegetation beneath cold-based ice. For the past half century this vegetation has been consistently reported as dead. Successful re-growth of Little Ice Age (1550-1850 AD) bryophytes emerging from the Teardrop Glacier, Sverdrup Pass, Ellesmere Island (79° N) collected in 2009 has overturned this assumption. Observed regeneration of in situ field populations and lab culture assays confirmed their capacity to regrow. Species richness of these High Arctic emergent subglacial populations is exceptional (> 62 species, 44% of the extant bryophyte flora of Sverdrup Pass). Glacial ecosystems have been well known to provide critical habitats for diverse microbiota (i.e., fungi, algae, cyanobacteria, bacteria and viruses) in high latitudes. Regeneration of 400 year old, ice-entombed bryophytes was the first demonstration of land plant revival on the pristine, glacial foreland. This has fundamentally expanded the concept of biological refugia to include subglacial environments for land plants that was previously restricted to survival above and beyond glacial margins. Given this novel understanding of subglacial ecosystems, fieldwork has been extended southward to plateau ice caps on Baffin Island, Nunavut (67° N), where rapid ice retreat is exposing older emergent populations (300 to > 40,000 y BP). The totipotent (all cells with stem cell equivalency), poikilohydric (desiccation tolerance), and cryophyllic nature of arctic bryophytes facilitate their unique adaptation to extreme polar environments. Cryopreserved populations recently released from ice entombment will form the basis of the data discussed here. A general evolutionary perspective of the Arctic bryophyte flora will extend from the Little Ice Age to the late Tertiary (2-5 Ma). The biological significance of bryophytes in high latitude ecosystems will be discussed.

LANG, A.S.[1,2],* J.D. KRUIJER[1,2], G. BOCKSBERGER[3] & M. STECH[1,2]
[1]Naturalis Biodiversity Center, The Netherlands; [2]Univ. Leiden, The Netherlands; [3]Max Planck Institute for Evolutionary Anthropology, Germany.

Species identification and species delimitation approaches within the moss genus *Dicranum*

Identification of bryophyte species and in particular polar species is often difficult because morphological characters of the gametophyte often deviate in extreme environmental conditions. This is especially true for the species-rich and taxonomically complex genera *Dicranum*. Molecular methods, such as barcoding have shown to be useful for the identification of Arctic bryophyte species but the optimal combination of markers, especially for delimiting closely related species, is still under discussion. Lately, many different species delimitation methods have been developed, the generalized mixed yule coalescent (GMYC) approach being the most popular. However, only few studies on land plants have been published so far and GMYC analyses of bryophytes are largely missing. In this presentation, I will discuss the species circumscription and species identification of Arctic *Dicranum* using six potential barcode markers (rps4-trnT UGU, trnL UAA-trnF GAA, trnH GUG-psbA, rps19-rpl2, rpoB, and nrITS1-5.8S-ITS2). Furthermore, I will present GMYC results obtained using phylogenetic analyses of 28 European *Dicranum* species and compare their delineation capacities with species boundaries inferred from the phylogenetic reconstruction and with the morphological species concept.

LARRAÍN, J.[1],* B. CARTER[2], B. SHAW[2], J. HENTSCHEL[3] & M .VON KONRAT[1]
[1]Field Museum, Chicago, IL, USA; [2]Duke University, Durham, NC, USA; [3]Herbarium Haussknecht, Jena, Germany.

Towards a monograph of *Frullania* subgen. Microfrullania: the taxonomy of *Frullania magellanica*

The subgenus *Microfrullania* is the most common group in terms of abundance and frequency within the hyperdiverse genus *Frullania* in southern South America. Within this group, the most common taxon is what traditionally has been reported as Frullania magellanica F. Weber & Nees, distributed along the southern Andes, from central Chile to Cape Horn, and extending to the Falkland Islands and Tristan da Cunha in the South Atlantic Ocean. This taxon is easily recognized because of its small size, pinnate branching, massive styli and autoicous sexual condition. However, there has been controversy in the recognition of specimens matching these traits as belonging to one or two species, being the other name available Frullania fertilis De Not. different from proper *F. magellanica* in the shape of leaves, underleaves, styli and perianths. Intensive molecular sampling of several populations belonging to this species complex gathered from central Chile to Cape Horn, have proven that there are at least three different genetic "strains", confirming the already observed differences reported between F. magellanica and F. fertilis, and even adding a third taxon to the discussion which would eventually correspond to an undescribed species. Morphological characters traditionally considered diagnostic to differentiate these species are here discussed, and new traits are presented that would help in the recognition of each of these clades recognized on molecular grounds. The results obtained from these taxa are compared with recent studies made in the *Frullania rostrata* (Hook. f. & Taylor) Gottsche, Lindenb. & Nees species complex from New Zealand, where one single traditional species is currently recognized as five different taxa, some of them phylogenetically distantly related.

LEWIS, L.R.[1],* Y. LIU[1], R. ROZZI[2] & B. GOFFINET[1]
[1]Univ. Connecticut, Storrs, USA; [2]Univ. of North Texas, Denton, USA.

Plastid variation in the young endemic dung moss *Tetraplodon fuegianus*

Populations of the Southernmost South American endemic *Tetraplodon fuegianus* compose a monophyletic lineage that diverged from high-latitude Northern Hemisphere populations during the late Miocene to Pliocene, (mean 8.63 Ma, 95% HPD 3.07–10.11 Ma), and diversified in the late Miocene to late Pleistocene, (mean 5.2 Ma, 95% HPD 1.4 - 7.0 Ma). The ancestor to *T. fuegianus* arrived via a single direct long-distance dispersal event, possible mediated by a migratory bird. Using a next generation shot-gun sequencing approach on whole genome extracts from nine populations we assembled the entire chloroplast (i.e., ± 123.665 kb) and mitochondrial (i.e., ± 104.740 kb) genomes and the entire nuclear ribosomal repeats (i.e., ± 10.462 kb). We will describe the patterns of genetic variation, both within and between populations, accumulated in these sequences among the nine *T. fuegianus* populations over the course of 8.63 Ma of isolation from their Holarctic relatives.

LEWIS, L.R.[1],* R. ROZZI[2] & B. GOFFINET[1]
[1]Univ. Connecticut, Storrs, USA; [2]Univ. of North Texas, Denton, USA.

Resolving bipolar phylogeographic histories the dung moss *Tetraplodon*: A RAD-seq approach

Bipolar disjunctions are recurrent across land plant lineages, and have been predominantly explained by long distance dispersal (LDD) across the tropics. Despite the fact that mosses display bipolar disjunctions at or below the species level frequently relative to vascular plants, few studies have explored this extreme disjunction in mosses. We have previously shown that the southern South American endemic *Tetraplodon fuegianus* belonged to a clade of predominantly Holarctic populations of *T. mnioides*, but its exact affinities and hence origin were ambiguous. We are now employing a restriction site associated DNA sequencing (RAD-seq) approach to resolve the phylogeographic history of the bipolar dung moss complex of *T. mnioides* with a focus on understanding the origin of the Southernmost South American endemic *T. fuegianus* and the timing and vector of its dispersal across the Equator.

LIU, Y.[1], N. DEVOS[2], M. JOHNSSON[3], R. MEDINA[1], N. WICKETT[3], A.J. SHAW[2] & B. GOFFINET[1],*
[1]Univ. Connecticut, USA; [2]Duke Univ., North Carolina, USA; [1]Chicago Botanical Garden, Chicago, USA.

Targeted organellar gene enrichment for resolving the macroevolutionary moss tree of life

The relationships among orders of mosses across the entire moss tree of life cannot be resolved based on variation in morphological traits and remain largely ambiguous even based on inferences from discrete loci. In particular the relationship of *Takakia*, *Tetraphis*, *Timmia* are incongruent among various studies. Here we seek to reconstruct the ordinal phylogeny of mosses based on an extensive sampling of all organellar protein coding genes for representatives of all major or critical orders of mosses. Our data sampling strategy consist in multiplexing to 96 libraries representing 96 taxa and selecting genes from this combined genomic library using a liquid phase enrichment phase prior to sequencing on an Illumina platform. We will present the results of our first sequencing runs, assessing the efficiency of the enrichment, and the promise of the data to resolve critical nodes in the backbone tree of mosses.

LIU, Y., R. MEDINA & B. GOFFINET*
Univ. Connecticut, USA.

350 my of mitochondrial genome stasis in mosses, an early land plant lineage

Among land plants, angiosperms have the structurally most labile mitochondrial (mt) genomes. In contrast, the so-called early land plants (e.g., mosses) seem to have completely static mt chromosomes. We assembled the complete mt genomes from 12 mosses spanning the moss tree of life, to assess 1) the phylogenetic depth of the conserved mt gene content and order and 2) the correlation between scattered sequence repeats and gene order lability in land plants. The mt genome of most mosses is approximately 100 kb in size, and thereby the smallest among land plants. Based on divergence time estimates, moss mt genome structure has remained virtually frozen for 350My, with only two independent gene losses and a single gene relocation detected across the macroevolutionary tree. This is the longest period of mt genome stasis demonstrated to date in a plant lineage. The complete lack of intergenic repeat sequences, considered to be essential for intragenomic recombinations, likely accounts for the evolutionary stability of moss mt genomes.

LÖNNELL, N.[1, 2],* B.G. JONSSON[3], S. SUNDBERG[2, 4] & K. HYLANDER[1]
[1]Department of Ecology, Environment and Plant Sciences, Stockholm University, Sweden; [2]Swedish Species Information Centre, Swedish University of Agricultural Sciences, Uppsala, Sweden; [3]Department of Natural Sciences, Mid Sweden University, Sundsvall, Sweden Swedish Species Information Centre, Swedish University of Agricultural Sciences, P.O. Box 7007, SE-750 07 Uppsala, Sweden; [4]Department of Plant Ecology, Evolutionary Biology Centre (EBC), Uppsala University, Norbyvägen 18 D, SE-752 36 Uppsala, Sweden.

Realized dispersal of *Discelium nudum*– experiments with a substrate specialist over one season

Most direct studies of bryophyte dispersal on a short temporal scale only cover a couple of meters. By using an experimental design, studying the realized dispersal, we extend this range by almost two orders of magnitude. We recorded the establishment of the fast-growing, acrocarpous moss *Discelium nudum* on an introduced suitable substrate (acidic clay). In one study with 2000 pots placed around a translocated, sporulating mother colony, dispersal over a distance of up to 600 m was recorded. At distances between 10 and 50 m colonization dropped sharply, but beyond 50 m the mean colonization rates leveled out. In a second study the establishment rate on an introduced substrate was measured at 14 sites with different connectivity (measured as the amount of acidic clay suitable substrate in the surroundings) within a plot of 200 x 200 km in a region in northern Sweden, where the species has a substantial population. There was a significant correlation between the colonization rate and the connectivity in a buffer of 20 km radius. The relationship became weaker for the 10 km buffer, and there was no significant relationship between colonization rate and connectivity at a smaller scale (1 and 5 km, respectively). The result implicates that a large population of a species with small diaspores (25 µm) in an open landscape may result in spore deposition over extensive areas. This indicates that regional connectivity is more important than local connectivity to this kind of species.

LÖNNELL, N.
Swedish Species Information Centre, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Recording species distribution on the internet – Seeing your local findings in a wider context

A wide array of distribution data and records of bryophytes are currently becoming available on the internet: global initiatives, national databases and local recording schemes. In addition to constituting a valuable source of information for everyone interested in bryophytes and their distribution, the compilation of bryophyte data from different sources into one interface also opens up possibilities for new analyses. Different approaches to coping with various aspects of such a system will be discussed. Two Swedish examples presented here are the Species Gateway and the Analysis Portal. The former is also known as the Swedish Species Observation System, an Internet-based, freely accessible reporting system for species observations, used by the public, governmental agencies and county administrations. The latter was developed within the Swedish LifeWatch to make all major national biodiversity databases in Sweden interoperable, and thereby accessible through standardized web services. To include coordinates and indicate the level of accuracy increases the usefulness of the data. A crucial point is to create a system for handling and documenting the certainty of the identification. A dynamic system which is continuously updated it will be more used. It tends to encourage field bryologists to fill in the gaps and visit the white spots. No contribution is too small or insignificant, and everyone can contribute after their own capability and knowledge. Moreover, the possibility to report your own records and see them together with data from other people gives a satisfaction that may also boost the recording effort. The challenge lies in optimizing and making the most of scarce resources, and in enabling everyone to contribute.

MEDINA, N.G.[1],* M.A. BOWKER[1,2], J. HORTAL[3], V. MAZIMPAKA[1] & F. LARA[1].
[1]Universidad Autónoma de Madrid, Spain; [2]Northern Arizona Univ. USA; [3]Museo Nacional de Ciencias Naturales, Spain.

Relative importance of species pools and environmental filters for epiphytic bryophyte richness changes across scales

Investigating the processes that give rise to small scale richness has been a central question of ecological research. Until recently researches have focused either on small-scale environmental filters and biotic interactions or on meso-scale environmental filters and regional species pools. However, current knowledge suggests that small-scale richness depends on both groups of factors. Therefore research should focus on accounting for the nested set of factors that influence richness across scales.
Our main goal is to unravel the relative importance of environmental filters and species pools on species richness of epiphytic bryophytes at different scales. To do so, we studied the epiphytic bryophytes growing on tree trunks of *Quercus ilex*-dominated forests of the northern and central inland Iberian Peninsula. Using structural equation models (SEM) we related environmental factors, species richness and abundance at three different scales: locality, stand and sample.
Structural models explained considerable variation in richness (from 30 to 62%) at the three scales. At the locality scale, the environmental filters acting at meso- and micro-scales have the strongest influence on richness while at the stand-scale locality richness was the most important factor. At the sample-scale the most relevant variables were sample richness and bryophyte cover. Our results indicate that both environmental conditions and regional species pools are important for epiphytic bryophyte richness. Moreover, we report a shift in the relative importance of these effects: locality richness is constrained mainly by environmental filters, while at the smallest scale richness is constrained mainly by the species pool.

MEDINA, N.G.[1],* B. ESTÉBANEZ[1], R. CAPARRÓS[1], J. MARTÍNEZ ABAIGAR[2] & E. NÚÑEZ OLIVERA[2]
[1]Univ. Autónoma de Madrid, Spain; [2]Univ. de La Rioja, Spain.

The effects of ultraviolet irradiation on spores of four mosses with different dispersal strategy: germination and ultrastructure

Most mosses disperse their spores in dry conditions. The opposite strategy, hygrochasy, is understandably common in humid environments. However, there are some hygrochastic species also in Mediterranean environments. The significance of this strategy in dry climates is still unclear, but it might be related with a greater sensitivity of the spore to stress during transportation.
Here we explore the sensitivity to ultraviolet exposition in four species of *Orthotrichum*, two hygrochastic (*O. acuminatum* and *O. ibericum*) and two xerochastic (*O. rupestre* and *O. striatum*). Spores were sown in petri dishes and exposed to different irradiation periods. A sample per experiment was processed for ultrastructural observation shortly after irradiation. The germination rate of the rest (3 samples per experiment) was tested after 3 weeks in culture.
The two hygrochastic representatives are confirmed to be more sensitive: in both species all spores die after 6 hours of exposition, whereas, for the same irradiation period, some proportion of spores survives in the two xerochastic species. Our ultrastructural observations allow establishing a cellular damage sequence: moderate damage is marked mainly by some extent of cytoplasmic retraction and vacuolization, plastid deformation and looser thylakoid packing, and alterations in the lipid storage; severe damage involves irregularities in the spore wall stratification, extensive cytoplasmic retraction and vacuolization, swelling and degeneration of plastids, and alterations in the nucleus.
Our results support a relationship between hygrochastic dispersal and sensitivity to ultraviolet radiation in these Mediterranean species. Whether hygrochasy is advantageous for species with sensitive spores, or whether ultraviolet resistance may become less important in spores where their transportation distance, in wet conditions, is reduced, remains to be elucidated.

MONTENEGRO, L.C.* & MELGAREJO, L.M.
Department of Biology, National University of Colombia, Colombia.

Contents of ABA in *Pleurozium schreberi* during the dry season in the Páramo of Chingaza (3400 masl) – Colombia

This study evaluated the variation of the contents of ABA in relation to relative water content in *Pleurozium schreberi*, when faced with low water content, in the Páramo of Chingaza at 3400 m asl (Colombia) and under simulated conditions of water deficit in the laboratory. Extractions of ABA consisted of 0.02 g of lyophilized plant material taken from each sample and macerated in liquid nitrogen, added to a solution of methanol, butyl hydroxy (0.4 mM) toluene, and citric acid (2 mM). Extraction samples were centrifuged at 6000 rpm for 30 min at 4°C, retaining the supernatant. ABA quantifications were achieved using a preelaborated kit (Phytodetek ABA, Agdia Test Inc). The absorbance of the samples was read at 405 nm using a microplate reader (IMarkTM BioRad). In the case of ABA levels for the field measurements, high contents were maintained during the dry season, showing average values in between 0.05 and 0.1 µg of ABA per g^{-1}. However, ABA content exhibited a peak once *P. schereberi* reduced its relative water content below 50%. At the beginning and middle point of the dry season, ABA reached values of 0.25 and 0.17 µg of ABA per g^{-1} respectively. ABA content was also influenced by low relative humidity and high radiation, reaching peak values during mid dry season around 17:00 (1.3µg de ABA per g^{-1}) and at the end of the dry season around 21:00 (1.2 µg of ABA per g^{-1}).Finally, an increase of ABA content in *P. schereberi* was observed at the end of the dry season, right at the start of the rehydration period, reaching values around 1.5 µg of ABA per g^{-1}. For the measurements conducted in the lab, lower ABA values were measured in comparison to levels detected on the field measurements. Average values were around 0.02 µg of ABA per g^{-1}. Nevertheless, the same response to dehydration was show by lab measurements, reaching peak values around 0.05 µg of ABA per g^{-1}.

MONTENEGRO, L.C* & MELGAREJO, L.M.
Department of Biology, National University of Colombia.

Photosynthetic efficiency and respiration in *Pleurozium schreberi* during the dry season in the Páramo of Chingaza (3400 masl) – Colombia

This study evaluated the variation of photosynthetic efficiency and respiration in *Pleurozium schreberi* in relation to relative water content when faced with low water content in the Páramo of Chingaza (3400 m asl, Colombia) and under simulated conditions of water deficit in the laboratory. Field measurements were made every 2 hours for a 24 hours cycle. A continuous excitation chlorophyll fluorometer (Handy PEA, Hansatech, UK) was used at 3000 µmol photons m-2 s-1 for 0.5 s, on moss apical portions pre-adapted to dark (i.e. 30 min). Under laboratory conditions, Fv/Fm, Fo, Fm, ϕPSII and ETR was determined. *P. schreberi* is a dehydration tolerant plant, which is proven to survive loss of relative water content greater than 90% for periods greater than two weeks, exhibiting a reactivation of photosynthetic activity immediately after a period dehydration. When the dehydration period is short (i.e. less than 24 hours) both in the field and under controlled conditions, the protection system of the photosynthetic machinery allows to reach normal values on subsequent rehydration hours, but if the dehydration period is extended (as usually observed at the end of the dry season in the paramos), the period of time allotted to rehydration will also include the reparation of photosystems In all the measure variables related to photosynthetic efficiency, it took *P. scherebери* several hours to reach normal values after rehydration. P. schreberi presents a large increase in respiration rate at the moment it starts rehydration, associated with repair processes, during the hours following return to normal. *P. schreberi*, under conditions of extreme dehydration, stops all photosynthetic process and decrease its respiration rate to near zero levels, entering a state of dormancy while recovering its water content.

NOMURA, T.[1],* M. KOJIMA[1], S. HASEZAWA[2] & H. SAKAKIBARA[1]
[1]RIKEN Center for Sustainable Resource Science; [2]Univ. Tokyo, Japan.

Cellular differentiation of the protonema is regulated by copper via auxin signaling in the copper moss, *Scopelophila cataractae*

Typical copper moss, *Scopelophila cataractae* (Mitt.) Broth., is distributed in copper-rich environments worldwide. In Japan, *S. cataractae* colonies are often found under the copper roofs of Buddhist temples and around copper mines, but how this moss species only luxuriate in regions with high copper remains unknown. In this study, we investigated the effect of copper on gemma germination and protonemal development in *S. cataractae*. At first, we confirmed that copper (up to 800 µM CuSO4) did not affect gemma germination. On the other hand, in the protonemal stage, a low concentration of copper promoted protonemal gemma formation, which is the main strategy *S. cataractae* use to expand their habitat to new locations. Copper-rich conditions promoted auxin accumulation and induced the differentiation from chloronema to caulonema cells, whereas it repressed protonemal gemma formation. In spite of low copper conditions, auxin treatment caused similar effects as those induced under high-copper conditions. Furthermore, copper-induced caulonema differentiation was repressed in the treatment of the auxin biosynthesis inhibitor L-kynurenine or the auxin antagonist PEO-IAA. These results suggest that *S. cataractae* can flourish in copper-rich environments via auxin-regulated cell differentiation. This species might have acquired this mechanism to benefit from its advantageous high copper-tolerance ability during the evolutionary process.

PÉREZ, C.[1],* J.C. ARAVENA[2], W. SILVA[1], P. TRONCOSO[3], F. OSORIO[4], B. SEGURA[1] & J. ARMESTO[1,3]
[1]Institute of Ecology and Biodiversity, Chile; [2]Univ. de Magallanes, Chile, [3]Univ. Católica de Chile.

The role of cryptogamic flora during ecosystem development

Almost half of nitrogen input via biological nitrogen fixation (BNF) in the planet is provided by cryptogamic flora. Moreover, they are the first plants that colonized denuded substrate after catastrophic disturbances incorporating new N and carbon initiating ecosystem development and recovery. However, they may also play a key role in late stages of succession when N become a limiting element. The mail goal of this study was to estimate the rates of biological nitrogen fixation of cryptogamic flora composed by mosses, liver-horn worts and lichens along primary succession in Antarctic and sub Antarctic ecosystems. We also explored which are the main chemical elements that limit BNF during ecosystem development. We estimated BNF by the acetylene reduction assay in laboratory and field incubations of the cryptogamic vegetation in two sub Antarctic glacial forelands: Santa Inés Island and Cordillera de Darwin chronosequences and one Antarctic chronosequences in Ardley Island, King George Island. Results show that BNF performed by cryptogamic flora can incorporate significant amounts of N along ecosystem development; however, BNF can be strongly inhibited by the addition of N as guano in Antarctic ecosystems and positively affected by the addition of Mo, P and C in the sub Antarctic ecosystems, especially during late stages of succession. Our main conclusion is that the recovery of Antarctic and sub Antarctic ecosystems depends on the performance of key species that conform the cryptogamic flora.

PHEPHU, N.* & J. VANROOY
National Herbarium, South African National Biodiversity Institute (SANBI), South Africa.

Centers of moss diversity in southern Africa

The Flora of southern Africa (FSA) area, comprising the countries of South Africa, Namibia, Botswana, Lesotho and Swaziland, contains about 520 species of mosses. The numbers of moss species per ½ degree grid square, obtained from SANBI's PRECIS database, were plotted on a map of the region. It shows that mosses are not uniformly distributed throughout the area but are concentrated along and below the Great Escarpment of southern Africa. Areas with more than 100 species per ½ degree grid square are described as centers, and those with more than 50 species as subcenters of diversity. Moss diversity is greatest in the Cape Fold Mountains of the south-western Cape, and the Drakensberg mountains of KwaZulu-Natal, Mpumalanga and Limpopo Provinces. The moss centers overlap with several known centers of vascular plant diversity. Moss diversity in southern Africa is strongly correlated with habitat heterogeneity and mean annual rainfall.

PRESSEL, S.[1],* C. SUPPLE[2] & J.G. DUCKETT[1]
[1]The Natural History Museum, London, UK; [2]Conservation Office, Ascension Island.

Bryophyte diversity and conservation on a remote island: Implementing a Darwin Initiative Biodiversity Action Plan on Ascension Island

Ascension Island is a young (ca. 1 million years), small (97km2), and extremely isolated, tropical volcanic island in the South Atlantic. Most of its 85 bryophytes are found on moist slopes and ravines between 700m and the summit of the highest peak (859m) that form part of Green Mountain National Park. Bryophyte diversity declines dramatically below 450m with the lower limit marked out by just 6 species (*Frullania ericoides*, *Lejeunea laetevirens*, *Microlejeunea africana*, *Bryum arachnoideum*, *Trichostomum brachydontium*, *Weissia brachycarpa*). Any changes in temperature and rainfall are expected to produce major shifts in bryophyte distribution particularly their lower limit, presently at around 300m. Thus we have initiated long-term environmental monitoring, management and conservation of the bryophytes of Ascension Island in addition to producing the first flora.
Prior to our expeditions in 2012 and 2013, few bryologists had visited the Island, thus earlier collections were extremely limited with several supposed endemic species only known from type specimens, some even dating back to before JD Hooker's visit in 1843. After extensive collecting we now know that the bryophyte flora comprises 4 hornworts, 24 liverworts and over 55 mosses. These include a handful of endemics, a mixture of South American and African taxa, around 25 in common with Europe but only 20 from the 110 species recorded from St Helena. Introduced bryophytes are rare on Ascension with *Ceratodon purpureus* and *Tortula muralis* the most notable absentees.
Hooker initiated wholesale tree importations into Ascension and today the summit region of Green Mountain boasts the only man made cloud forest in the world where many formerly terrestrial bryophytes have now migrated as epiphytes and epiphylls onto the introduced trees. Year round sampling has revealed that, compared with their mainland counterparts, far fewer species on Ascension produce sporophytes, most remarkably *Marchantia pappeana*.

RADHAKRISHNAN, G.V.* & G.E.D. OLDROYD
John Innes Centre, Norwich Research Park, Norwich, UK.

Signalling in the liverwort – fungal symbiosis – a case study in *Marchantia paleacea*

Bryophytes, the earliest known extant land plants, are also one of the many plant species that are able to host Arbuscular Mycorrhizal (AM) fungi. Occurrence of AM symbiosis in bryophytes is extensive in members of the Anthocerotophyta (hornworts) and Marchantiophyta (liverworts) but is absent in all studied members of the Bryopsida (mosses).
Thus, *Physcomitrella patens*, a member of the bryopsida cannot be used as a model for studying AM symbiosis in basal land plants. The sequencing of the *Marchantia polymorpha* genome and the recently developed genetic tools in this plant has facilitated the use of this liverwort to study various plant functions. But as this liverwort strain does not form mycorrhizal symbiosis, we selected a close relative, *Marchantia paleacea*, for studying the genetics involved in the bryophyte-AM symbiosis.
We investigated the gene space of *M. polymorpha* and *M. palecea* for orthologs of known symbiosis signalling components from higher plants. Although some symbiosis signalling components from different bryophytes have been cloned and used to complement the respective *Medicago truncatula* mutants, an extensive survey of all common symbiosis signalling components has not been carried out in a bryophyte.
Through sequence similarity searches and phylogenetics, we found that for most genes involved in the symbiosis signalling pathway clear orthologs exist both in *M. polymorpha* and *M. paleacea*. A few genes did not have any direct orthologs in *M. polymorpha* but did so in *M. paleacea*. The loss of these genes could explain why the model liverwort *M. polymorpha* does not form a symbiosis with arbuscular mycorrhizal fungi, while *M. paleacea* is able to establish this symbiosis. Although AM symbiosis occurs.

REEB, C.
Muséum National d'Histoire Naturelle, Paris, France.

How to make a decision for species hypothesis in an integrative taxonomy approach : the example of African *Riccardia*

The genus *Riccardia* (Aneuraceae) is represented by simple thalloïd pinnate to pluripinnate liverworts. Their highly plastic and irregular morphology leads to great difficulties for their description and to numerous misidentified or unidentified specimens in herbaria. An integrative taxonomical approach has been conducted on the genus in Africa, based on various approaches, using morphological and molecular characters. A morphometric analysis is performed, after the establishment of a model of the thallus shape, the formalization of shape description. A set of five hundred thallus representing eight species have been measured using the software “Branchometer” and various analysis are performed in order to find which features discriminate thallus forms, and if a taxonomical discrimination can be retrieved. Species hypothesis are proposed, based on morphological and morphometric analysis. Molecular species delimitations are proposed using different approaches: distances delimitation, haplotypes networks, molecular diagnostic characters and monophyly acquisition. They will not be detailed, but the criteria chosen for the final decisions for species delimitation are discussed in a General Lineage Species concept. How can we decide which criteria are the best ones? Which workflow for making decision can be proposed in order than species hypothesis are not arbitrary taken? Finally, 11 species of *Riccardia* are confirmed for the moment in Africa, including six new species. One new genus, closed to Lobatiriccardia is probably present in Africa.

ROQUE-MARCA, N.[1],* & F.A. SQUEO[1, 2]
[1]La Serena Univ., Dept. of Biology, La Serena, Chile; [2]Center for Advanced Studies in Arid Zones (CEAZA), Institute of Ecology and Biodiversity (IEB), Chile.

Effect of water table depth on the class: Muscopsida in High Andean peatlands in the Atacama Region, Chile

The main species that make the peatlands correspond to Juncaceae and Cyperaceae. However, in these environments the presence of moss contributes to the formation of peat. The aim of this study was to evaluate the effect of water table depth in class: Muscopsida. For which, five random samples were collected annually (from 2006 to 2014) for two peatlands (Pascua and Tres Quebradas) located at 3,750 m.a.s.l. Additionally, to determine the depth of the water table piezometers was installed and suspended with steel wire one Leveloggers. Two events where found (2008 and 2011) where the depth of the water table it was decreased to 0.45 and 0.62 m for Pascua and Tres Quebradas respectively. During these two years the biomass of moss recovered, with increasing biomass in the following year. In the Pascua peatland for 2009 was 58 g m-2 and 2012 (20 g m-2). Similarly, Tres Quebradas in 2009 (25 g m-2) and 11 g m-2 for the year 2012. However, the primary productivity of moss has negative trend. The results clearly suggest that mosses are able to recover after years of drought in their natural habitat.

ROZZI, R.[1,2,3],* & F. MASSARDO[1,2]
[1]Univ. de Magallanes, Chile; [2]Inst. Ecology & Biodiversity, Chile; [3]Univ. of North Texas, US.

Ecotourism with a hand-lens: moss conservation in the Cape Horn region

A vast diversity of living beings and human values are invisible for the worldview that governs global society today. As an example, global standard biodiversity assessments based on vascular plants had considered floristic diversity of southwestern South America to be poor. However, long-term botanical fieldwork in the region disclosed its floristic otherness: non-vascular plants had a greater diversity than vascular plant species. Moreover, the sub-Antarctic Magellanic ecoregion hosts >5% of the world's species of non-vascular plants. This stimulated the research team at Omora Park to "change the lenses to assess biodiversity richness" and focus on non-vascular plants for defining conservation priorities in high latitude ecoregions creating the UNESCO Cape Horn Biosphere Reserve in 2005. This protection based on the diversity of mosses led to a change in the language referring to mosses, and to an awareness of interspecific co-inhabitation. The field activity of ecotourism with a hand-lens (EHL) helps citizens and decision makers discover the beauty, diversity and ecological importance of a flora regularly unnoticed. From the south of the world, EHL summons ethical, aesthetical, and ecological values that broaden the narrow economic lens that prevails in the relationship of global society with nature.

SHA, W., M.J. ZHANG & T.Y. MA*
Qiqihar University, Qiqihar, China.

Transcriptomics and proteomics analysis of *Racomitrium canescens* drought tolerance mechanism

Transcriptomic analysis showed 83 552 non-redundant unigenes were yielded. 54 359 unigenes were annotated by BLASTx and BLASTn against six public databases. The differently expressed genes between GH and CK were analyzed based on the RNA-Seq data. There were 41 763 differently expressed genes (p-value<0.001), including 33 559 were up-regulated and 8 204 down-regulated. Among them, 19 635 unigenes were assigned to 123 KEGG pathways. Pathway enrichment analysis revealed that most significant differences were seen in ribosome, metabolic pathways, RNA polymerase, citrate (TCA cycle), purine metabolism and others.
Proteomic analysis showed that a total of 7 229 peptides were detected, which were assembled into identified 2 814 proteins in GH and CK. All proteins with a COG classification and were divided into 24 categories. Proteins with expression difference ratio reached above 1.2 times, and the p-value of statistical test was less than 0.05 were considered as differently expressed protein (DEP), finally 228 DEPs were obtained (144 up- and 84 down-regulated). In this study, DEPs are belonging to 146 signaling pathways under KEGG analysis, 5 signaling pathways were changed significantly (p<0.05), including phenylalanine metabolism, ribosome, photosynthesis, phenylpropanoid biosynthesis and linoleic acid metabolism.
This study provides insight into the effective transcriptome and proteome data of *R. canescens* in response to drought under different conditions and establishes a platform for future researches for bryophytes.

SALDÍAS, C.[1],* R. ROZZI[1, 2, 3], F. MASSARDO[1, 3]
[1]University of Magellan; [2]University of North Texas; [3]Institute of Ecology and Biodiversity, Chile.

Experiences with visitors in the "Miniature Forests of Cape Horn"

The Omora Ethnobotanical Parl (OEP) is a space dedicated to scientific and philosophical research, education and biocultural conservation located in the Cape Horn Biosphere Reserve, Chilean Antarctic Province, Chile. In 2002, researchers associated with this park Cape Horn discovered that Cape Horn region represents a "hotspot" of bryophyte diversity. Since 2004 Chilean and foreign visitors, students and resident population of Puerto Williams, capital of the Antarctic Province, arrive the OEP in different seasons to practice the innovative activity called "Eco-Tourism with a Hand-Lens" in the "miniature forests of Cape Horn" to appreciate this biodiversity. This scientist tourism is performed using a hand-lens to observe the biodiversity, beauty, colors, textures, and the ethical, economic, and biocultural values of this flora that grows in different types of habitats and substrates in the sub-Antarctic Magellanic ecoregion. Visitors are surprised to get a magnifying glass and for many of them turns out to be a new instrument. Questions of children and adults are: What are they? Why are they so small?, Do they provoke damage to the tree?, Are they necessary for the forest?, What they eat? This exercise not only opens up new dimensions in the biophysical level, but triggers attitudes: greater curiosity and care for other living and non-living beings that are also small (lichens, insects, spiders, dwarf plants, flowers and edible fruit, holes in the trunks, mushrooms, stones). The physical and emotional exercise of observing and touching carefully a cushion of moss is key to induce visitors to understand the intrinsic value of the small, including mosses as part of a dynamic ecosystem that exists in a time scale step completely different from ours as human beings space. The challenge for forest conservation thumbnail is then encourage and recursively generate this kind of educational experiences both in protected areas and in other rural and urban habitats to appreciate the flora that had hitherto been frequently omitted from education, conservation and ecotourism.

SIERRA, A.M.[1,2],* N. FLORES[1] & N. SALAZAR ALLEN[3]
[1]Univ. de Panamá (UP); [2]Corredor Biológico Mesoamericano del Atlántico Panameño (CBMAPII); [3]Smithsonian Tropical Research Institute (STRI).

Epiphyllous liverworts on the understory shrub, Piper grande Vahl., in the National Park G. D. Omar Torrijos H., El Copé (Panamá). Advance report

In humid tropical forests bryophytes are the dominant group in epiphyllous communities, especially liverworts of the family Lejeuneaceae. Several authors have demostrated that microclimatic conditions, particularly relative humidity, as well as leaf texture and chemistry, and availability of dispersal propagules have great influence on the diversity, distribution and cover of epiphyllous bryophytes. In this study we sample epiphyllous bryophytes on one phorophyte species (Piper grande Vahl) an understory shrub along the Guabal River, in National Park G. D. Omar Torrijos H., El Copé (Panamá). To compare the composition of epiphyllous communities in young and old leaves in the same branch, two to four branches with 5-7 leaves each were collected from 16 individuals, 5 and 11 individuals, in two contiguous sites respectively. The branches had young apical leaves and old leaves. Species distribution on the leaves was recorded in terms of presence or absence of species. To date, 31 species of liverworts (30 Lejeuneaceae, 1 Metzgeriaceae) have been recorded. The younger (uppermost) leaves (No. 1) have the lowest number of species (4-6 spp.) while the oldest (lowermost) leaves (No. 2-5) have the higher number (7-18 spp.). Species of *Odontolejeunea* and *Cyclolejeunea* were recorded from all leaves studied to date (17 of 200). Species of *Drepanolejeunea* were found in 86,6% of the leaves, and species of *Cololejeunea* and *Diplasiolejeunea* in 73,3 %. Species of these 5 genera were the primary colonists of the youngest leaves. More than 70 % of the leaves sampled shared only five of the 31 species, *Cyclolejeunea* (2 spp.), *Odontolejeunea* (1 spp.), *Drepanolejeunea* (1 spp.), and *Cololejeunea* (1 spp.). These give an insight into the heterogeneity, in species composition, of epiphyllous communities in cloud forest.

SIMPSON, M.
Matrix Solutions Inc., Calgary, Canada.

Bryophytes add diversity to Alberta's oil sands

To obtain approval to extract bitumen in the oil sands region of Alberta, Canada, oil producers are required to provide an Environmental Impact Assessment. This assessment must include an evaluation of the potential social and ecological effects of building industrial extraction and processing facilities. A wide range of biotic indicators are assessed in EIAs, including vegetation. Bryophytes are accounted for in vegetation surveys designed to provide landscape characterization and species inventory data. These data are used for assessing affects during project operations and for informing subsequent reclamation activities. The focus of attention in the public and regulatory domains with respect to environmental assessments in Alberta tends to be on charismatic megafauna (such as moose and caribou) and on fish. However, bryophytes are an equally important consideration in EIAs because of the ecological and social contributions they make to boreal ecosystems and the biological and human communities that live in them. Bryophytes contribute a large proportion to vegetation diversity: mosses and liverworts comprise around 20% of all species recorded in vegetation surveys and around a third of all species when considered together with lichens. Furthermore, mosses and liverworts can account for over 50% of the rare plant species recorded in rare plant surveys. Aside from their ecological value, bryophytes also have spiritual and practical significance for First Nations groups where they occur within traditional lands. Given the increased emphasis on biodiversity and aboriginal rights in regulatory initiatives, it is reassuring that bryologists are used by oil companies and their consultants and essential that regulators and stakeholders value bryophytes as much as the conspicuous species that draw public attention.

SÖDERSTRÖM, L.[1],* & A. SÉNECA[1, 2]
[1]Norwegian University of Science and Technology, Norway, [2]Porto University, Portugal.

Species richness at different geographical scales

Species richness is normally a function of the size of the area considered and the size of the species pool in the region. The species pool is influenced by habitat diversity at different scales, and how suitable the habitats are for the taxon group mapped. Species richness of liverworts will be mapped from a global scale to local scales, using both well explored and less well known areas, to analyze the impact of habitat diversity and habitat quality on liverwort diversity at different scales.

STANTON, D.E.[1, 2],* D. BERGSTROM[3] & M.C. BALL[2]
[1]Univ. Minnesota-Twin Cities; [2]Australian National University; [3]Australian Antarctic Division.

Functional traits and stable isotope signatures of sub-Antarctic bryophytes

Vascular plant ecology has developed a strong focus on functional traits in recent years, building large global databases in an attempt to identify general trends and trade-offs in plant morphology and physiology. Some aspects of this approach may be beneficial in bryology to help link between anatomy, morphology and physiology. We examine anatomical (leaf and shoot anatomy), morphological (shoot dimensions and architecture) and functional (carbon and nitrogen content, stable isotope ratios) of 19 commonly occurring species of bryophyte from a sub-Antarctic island. Greater size, and in particular leaf area, was strongly correlated with stem structural complexity, suggesting increased specialization of water transport. Water transport specialization was also reflected in stable isotopes of dry matter: the relative water content of shoots was strongly correlated with the stable isotopic composition of the shoot dry matter in species with internal water conducting structures but unrelated in those lacking conducting strands, where it was more closely related to overall clump size. Delta-15N values varied between co-occurring species, suggesting potential differences in nitrogen sources (such as associated N-fixation) and showed less influence of animal sources than expected. These results add to a small but growing literature

STECH, M.[1],* D. COOMBES[2], T.T. LUONG[3], J. VOLLERING[1], T. ZHOU[1] & J.D. KRUIJER[1]
[1]Naturalis Biodiversity Center, Leiden, The Netherlands; [2]Univ. of Applied Sciences In Holland, Haarlem, The Netherlands; [3]Dep. of Ecology - Evolutionary Biology, Univ. of Sciences, Ho Chi Minh City, Vietnam.

DNA barcoding and biodiversity assessment of arctic and temperate *Bryum* species

With about 440 species, *Bryum* is one of the most species-rich and taxonomically most complicated moss genera. Morphological diversity within *Bryum* is very high and the identification of unknown *Bryum* plants is still notoriously difficult and often remains unsuccessful or unsatisfactory. In the Arctic, deviating morphologies due to the harsh conditions and the often poorly developed plants further complicate species identification. This situation clearly hampers the accuracy of biodiversity assessments and ecological studies. To address species circumscriptions of arctic and temperate *Bryum* species at the molecular level, we applied a DNA barcoding approach based on plastid trnT-trnL-trnF and nrITS sequences. Preliminary results showed that DNA barcodes facilitate the identification of *Bryum* species and revealed frequent misidentifications based on morphological characters in several species or species complexes. We furthermore employed molecular species identification and analyses of intraspecific diversity in ecological studies on changes in the vegetation composition in Svalbard under herbivore grazing pressure, and we studied species and haplotype diversity of *Bryum* across the Greenland Sea.

TANGNEY, R.S. & S. RUSSELL*
National Museum of Wales, UK.

Moss flora of the Falkland Islands

The Falkland Islands are an archipelago of approximately 700 islands located about 450 kilometers east of southern South America, at 510 42’ south latitude. The climate is maritime-subantarctic, dominated by the southern Atlantic Ocean. The moss flora of the islands is not well known. Despite a relatively long history of visitors who have made collections of mosses, substantial collections are rare, and there continue to be new records for the islands. In addition, many taxa are insufficiently understood. There are nearly 20 endemic taxa described from the Falklands, representing 13 percent of the moss flora, compared with four species (3.1 %) of the more closely studied hepatic and hornwort flora. Many of the endemic mosses are varieties of more widespread species, and the status of most of them has not been scrutinized. There are strong affinities with the adjacent southern South American landmass, and a full understanding of the Falklands flora will be dependent on fuller knowledge of the flora of Patagonia. This talk discusses the history of collecting and the main features of flora, and outlines a current project aimed at increasing knowledge of the bryophytes and lichens of the Falkland Islands.

VELLAK, K.* T. TUSTI & N. INGERPUU
Uni. of Tartu, Tartu 51005, Estonia.

Are rare species ecologically more sensitive: laboratory experiment with three fen species

Over-exploitation of mires has turned some communities rather rare and habitats for many species, especially for fen bryophytes, have been degraded. Species with specific ecological demands and restricted distribution are most vulnerable. In Europe 30 bryophytes species are included in the Habitat Directive Annex II - a list of species with need of special protection. Several of them inhabit only wetland communities, among them our target species *Hamatocaulis vernicosus*, which grows in rich fens in Europe. The aim of our study was to clarify whether fen species with restricted distribution are more sensitive to the changes in ecological conditions comparing with common species. We conducted an experiment in growth chamber. Three fen species, one rare (*H. vernicosus*) and two common (*Calliergonella cuspidata* and *Scorpidium cossonii*), were grown in conditions imitating natural and drained fen communities: at higher and lower water level, lower and higher temperature, higher and lower radiation. Species were grown in one-species culture and in mixtures of three species. Our results showed that the increment of biomass was significantly higher for all species in one-species cultures, but shoot elongation was significantly higher in mixtures only for *C. cuspidata*. In one-species cultures the environmental variables did not affect the biomass increment of common species, but the biomass increment of the rarer *H. vernicosus* was significantly suppressed by lower radiation, lower water level and higher temperature. We conclude that although fen species have rather similar demands for ecological conditions, common species are more tolerant to the changes and m ay get advantage in changed habitat conditions, and therefore inhibit the growth of rarer species, which are more sensitive to the changes.

VON KONRAT, M.[1],* A. SMITH[2], B. CARSTENSEN[2], L. WHYTE[2], T. CAMPBELL[3], M. GREIF[4], J. LARRAIN[1], E. GAUS[1], M. BRYSON[5], B. CROWNOVER[1], B. SHAW[6], J. SCHEFFEL[1], L. HASAN[1], C. D'LAVOY[3], L. BRISCOE[1] ET AL.
[1]The Field Museum, USA; [2]Adler Planetarium, Zooniverse, USA; [3]Northeastern Illinois Univ., USA; [4]Wilbur Wright College, USA; [5]Roosevelt Univ., USA; [6]Duke Univ., USA.

Crowd-sourced science: digitized natural history collections extends its branches to education and outreach

Alarmingly, the world's biodiversity is diminishing rapidly and undergoing an extinction crisis. Biological collections of museums and academic institutions, documenting the fossilized and living members of the world's ecosystems and their changes over time, are uniquely poised to inform the stewardship of life on Earth. Scientists and educators of The Field Museum (Chicago) are partnering with leaders in online Citizen Science, Zooniverse (see www.zooniverse.org) Adler Planetarium), and have a coordinated network including students and professionals at universities and partnering high schools and middle schools to accelerate the pace of scientific discovery. The underlying theme is to connect biological research and collections with education and outreach while working towards addressing the critical urgency of the loss of taxonomic expertise and the rapid decline of biodiversity. The project has the specific goal of engaging a broader audience; especially students and citizen scientists to partner with our efforts in recording critical data sets from digitally rendered images focusing on the mega-diverse early land plant lineage, Frullania. A web-based tool has been developed (see http://microplants.fieldmuseum.org) which could be broadly applied to other organisms to aid in collecting data that would be otherwise impossible to generate without large-scale volunteers. To date, over 5000 participants have generated over 55,000 data points that are being utilized by researchers. The online tool, currently in four languages, provides participation in authentic science research, which is an important component in moving youth toward engaging in in scientific thinking.

WHITELAW, M.
St. Albans, UK.

Mad about Mosses - Introducing the British public to the bryophytes of London

The South London Botanical Institute (SLBI) was founded in 1910 with the aim of providing an environment where those interested in the study of plants, professional or amateur, could develop their knowledge. In the past 114 years these aims have not changed and today the institute is home to a wide range of activities, from lectures to art classes, catering to both adults and children.

In 2013 the SLBI received funding from the Esmée Fairbairn Foundation to create London's first Moss Trail in the garden of the institute and to run a series of events to promote the trail and introduce the general public to the fascinating world of urban mosses.

The SLBI "Mad about Mosses" month took place in February/March 2014. Activities included introductory identification classes, a "Bryoblitz", an urban ramble, a microscope session to find "min-beasts" living in the mosses as well as a lecture series and craft event. Further events planned for the summer of 2014 include craft days and an all day event, which will include involvement from a science theatre project group and a folk band.

The "Moss Trail", to be completed in the summer of 2014, features 12 bryophytes found within the garden. A guide to the trial is being produced in the form of a leaflet. Along with this an identification app is in development; initially featuring just the bryophytes in the garden but inclusion of up to 50 common bryophytes is planned.

Attendance at the events was good, particularly for the "Bryoblitz" and urban ramble, and feedback was extremely positive. This presentation will look at how people responded to learning about bryophytes and which approaches were most successful, with the aim of sharing insights into positive approaches to bryophyte education.

WILBRAHAM, J.* & S. PRESSEL
Natural History Museum (BM), London, UK.

Macromitrium (Orthotrichaceae) in sub-Saharan Africa

With c. 140 taxa in twelve genera, the Orthotrichaceae is the fifth largest moss family in Africa and can form a conspicuous element of tropical montane forests. This project comprises a taxonomic revision of the Orthotrichaceae in Sub-Saharan Africa and the Indian Ocean Islands, with particular focus on the pantropical genera *Macromitrium* (c. 40 African taxa) and *Schlotheimia* (c. 50 African taxa). We have taken an integrative taxonomic approach by combining data from herbarium research with novel morphological characters based on SEM and preliminary data from a molecular analysis. We will discuss recent progress and future challenges in resolving the taxonomy of *Macromitrium* and thus providing a more accurate portrayal of the species diversity across this region.

ZHANG, L.* & Q. ZUO
Fairylake Botanical Garden, China.

The rediscovery and the phylogenetic position of _Brachymeniopsis_ Broth. (Funariaceae, Bryophyta)

Brachymeniopsis Broth. consists of only one species, *B. gymnostoma*, and is a peculiar member of Funariaceae whose calyptra is mitrate which differs from the cucullate ones of the other members of this family. This genus was established by Brotherus in 1929 based a specimen collected by Handel-Mazzetti from Lidjiang (or Likiang, now Lijiang), NE Yunnan, China in 1916. No other population has been located and documented, and hence the species was considered extinct.
The senior author collected it again near the border between Xizang (Tibet) and Bhutan in the summer 2012. The habitat is shrubland over 4000 m elevation. By comparison with the isotype (US!), we found it is a variable species morphologically. The original description in Symbolae Sinicae (1929) and those occurred in the Flora Bryophytorum Muscorum (vol. 3) and Moss Flora of China (vol. 3) needs to amend. Variations of costae are of the most prominent which they are generally precurrent in leaves of vegetative shoots, but excurrent in fertile ones.
A maximum parsimony analysis was carried out using a combined data set of chloroplast rps4, trnL-F and atpB-rbcL regions including 40 samples, representing nine genera in Funariaceae and three outgroup families. *Brachymeniopsis* was resolved as a distinct lineage in the crown of the subfamily Funarioideae (the clade III sensu Liu et al. 2012) comprising *Aphanorrhegma*, *Bryobeckettia*, *Physcomitrella*, *Physcomitrium*, and partial *Entosthodon*. References: Brotherus. 1929. Bryophyta. In Engler's Natürlichen Pflanzenfamilien. Liu et al. 2012. Mol. Phyl. Evol. 62: 130–145

PRESENTERS INFORMATION

Biersma, Elise
British Antarctic Survey
High Cross, Madingley Road,
Cambridgeshire Cambridge
CB3 0ET
United Kingdom
elibi@bas.ac.uk

Budke, Jessica
Plant Biology, University of California - Davis
One Shields Ave.
Davis, CA 95616
United States
jessica.m.budke@gmail.com

Chmielewski, Matthew
1719 SW 10th Avenue
SRTC Room 246
Portland, Oregon 97201
United States
chmiel@pdx.edu

Convey, Peter
British Antarctic Survey
High Cross, Madingley Road
Cambridge, Cambridgeshire CB3 0ET
United Kingdom
pcon@bas.ac.uk

Dangwal, Meenakshi
University School of Biotechnology
Guru Gobind Singh Indraprastha University
Sector 16C, Dwarka
New Delhi-110078
India
meenakshi.dangwal@gmail.com

Goffinet Bernard
75 North Eagleville road
Dept. of Ecology and Evolutionary Biology
University of Connecticut
Storrs, CT, 06269-3043
USA
bernard.goffinet@uconn.edu

Hallingbäck, Tomas
Swedish University of Agricultural Sciences, SLU
P O Box 7007
750 07, Uppsala SE 75007
Sweden
tomas.hallingback@slu.se

Hasebe Mitsuyasu
National Institute for Basic Biology and SOKENDAI
38 Nishigonaka, Myodaiji-cho
Okazaki, AICHI 444-8585
Japan
mhasebe@nibb.ac.jp

Higuchi, Masanobu
Department of Botany
National Museum of Nature and Science
Amakubo 4-1-1
Tsukuba, Ibaraki 305-0005
Japan
higuchi@kahaku.go.jp

Hofbauer, Wolfgang
Fraunhofer-Institut für Bauphysik IBP
Standort Holzkirchen

Fraunhoferstr. 10,
83626 Valley
Germany

Itouga, Misao
RIKEN Center for Sustainable Resource Science
1-7-22 Suehiro-cho
Tsurumi-ku, Yokohama, Kanagawa 230-0045
Japan
Misao.itouga@riken.jp

La Farge, Catherine
Department of Biological Sciences
Edmonton, Alberta T6G 2E9
Canada
clafarge@ualberta.ca

Lang, Annick
Nieuwenhuisenweg 19
Postbus 9517
Leiden, Zuid-Holland 2300 RA
Netherlands
annick.lang55@gmail.com

Larrain, Juan
1400 S Lake Shore Drive
Department of Botany, the Field Museum
Chicago, Illinois 60605
United States
jlarrain@fieldmuseum.org

Lewis, Lily
75 North Eagleville road
Dept. of Ecology and Evolutionary Biology
University of Connecticut
Storrs, CT, 06269-3043
USA
Lilyrlewis@gmail.com

Lonnell, Niklas
Swedish Species Information Centre
Swedish University of Agricultural Sciences
P.O. Box 7007
Uppsala, Sweden SE-750 07
Sweden
niklas.lonnell@slu.se

Mediina, Nagore Garcia
C/darwin 2, Edif. Biología. Cantoblanco Universidad
Madrid, Madrid 28049
Spain
ngmedina@gmail.com

Montenegro, Luis
Universidad Nacional de Colombia
Departamento de Biología, Carrera 30 No. 45-03
Carrera 30 No. 45-03
Bogotá, D.C. 11001
Colombia
lcmontenegror@unal.edu.co

Nomura, Toshihisa
Tsurumi, Suehiro 1-7-22
Research building E-714
Yokohama, Kanagawa 230-0045
Japan
toshihisa.nomura@riken.jp

Nonkululo, Phepu
National Herbarium, South African National Biodiversity Institute (SANBI)
2 Cussonia Avenue
Brummeria
Pretoria, Gauteng 0001
South Africa
n.phephu@sanbi.org.za

Pérez, Cecilia
Instituto de Ecología y Biodiversidad
Las Palmeras 3425
Ñuñoa,
Santiago
cperez@bio.puc.cl

Pressel, Silvia
Life Sciences Department
Plants Division
The Natural History Museum
Cromwell Road
London SW7 5BD
United Kingdom
s.pressel@nhm.ac.uk

Quandt, Dietmar
Meckenheimer Allee 170Meckenheimer Allee 170
Nees Institute for Plant Biodiversity
Bonn, NRW 53115
Germany
quandt@uni-bonn.de

Radhakrishnan , Guru
John Innes Centre
Norwich Research Park
Norwich, Norfolk NR4 7UH
United Kingdom
guru.radhakrishnan@jic.ac.uk

Reeb, Catherine
Museum National d'Histoire Naturelle
57 rue Cuvier, case 39
75005 Paris
France
reeb@mnhn.fr

Natalio Roque Marca
Universidad de La Serena
Programa de Magister en Ciencias Biológícas
Mención Ecología de Zonas Áridas
Laboratorio de Ecofisiología Vegetal
Benavente 980, Casilla 554
La Serena – Chile
natalio.roquem@gmail.com

Rozzi, Riccardo
Institute of Ecology and Biodiversity
& Universidad de Magallanes
Puerto Williams, Antarctic Province
Chile
and Department of Philosophy
University of North Texas
Denton TX 76201, USA

Russell, Shaun
Director, Wales Environment Resource Hub
Bangor University
Gwynedd LL54 6RS
UK
shaun_russell@btinternet.com

Saldías, Camila
Centro Universitario Puerto Williams
Universidad de Magallanes
Teniente Muñoz 166, Puerto Williams
Provincia Antártica Chilena, Chile
camila.saldias@umag.cl

Sha, Wei
College of Life Science, Agriculture and Forestry
Qiqihar University
No.42, Wenhua Street, Jianhua District
Qiqihar, Heilongjiang 161006
China
shw1129@263.net

Sierra, Adriel
Universidad de Panamá
Vía Simón Bolívar (Transístmica)
Panama, Panama 507
Panama
adsierra26@gmail.com

Simpson, Michael
Matrix Solutions Inc
Suite 200, 150 – 13 Ave. SW
Calgary, Alberta T2R 0V2
Canada
msimpson@matrix-solutions.com

Söderström, Lars
Norwegian University of Science and Technology
Department of Biology
Trondheim, - N-7491
Norway
soder@ntnu.no
Stanton, Daniel
100 Ecology Building
1987 Upper Buford Circle
Saint Paul, Minnesota 55108
United States
stan0477@umn.edu

Stech, Michael
Naturalis Biodiversity Center
P.O. Box 9517
Leiden, Zuid-Holland 2300 RA
The Netherlands
michael.stech@naturalis.nl

von Konrat, Matt
1400 S Lake Shore Drive
Science & Education, The Field Museum
Chicago, IL 60605
United States
mkonrat@fieldmuseum.org

Whitelaw, Marie
18 Eastbury Court
Lemsford Road
St Albans, Hertfordshire AL1 3PS
United Kingdom
mariwhitelaw@yahoo.co.uk

Wilbraham, Joanna
Natural History Museum
Cromwell Road, London SW7 5BD
United Kingdom
j.wilbraham@nhm.ac.uk

Zhang, Li
Shenzhen Key Laboratory of Southern Subtropical Plant Diversity
Fairylake Botanical Garden
160 Xianhu Rd.
Liantang, Luohu District
Shenzhen 518004, Guangdong,
China
zhangyanyun@mail.kib.ac.cn

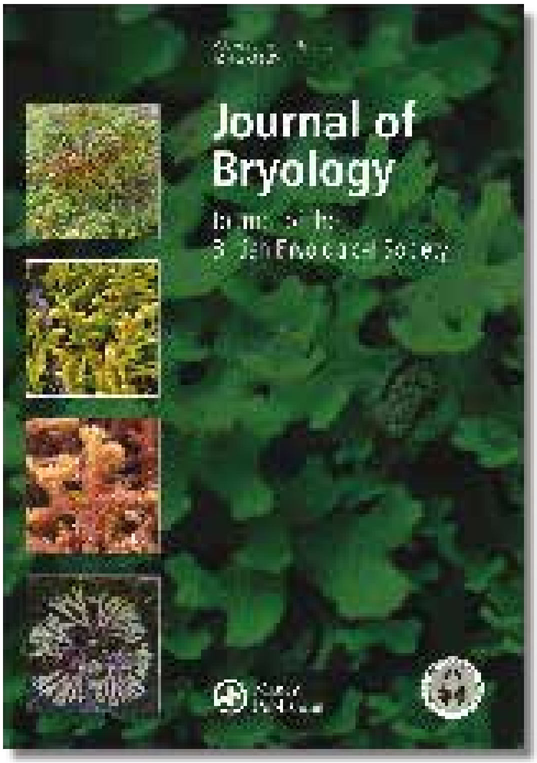
AUTHOR INDEX

OS: Oral Session, page of the abstract
PS: Poster Session, page of the abstract

NOTES:

Journal of Bryology

Journal of the British Bryological Society



Journal of Bryology exists to promote the scientific study of bryophytes (mosses, peat-mosses, liverworts and hornworts) and to foster understanding of the wider aspects of bryology.

www.maneyonline.com/jbr

Delegates receive 25% off!

Individual print & online: £114 / US$219
Individual online-only: £106 / US$205

All subscriptions include online access to the archive from Volume 1, 1947.

Email: **subscriptions@maneypublishing.com**
Discount code: **IAB2015**

Sample articles:

- Diversity and vertical distribution of epiphytic liverworts in lowland rain forest and lowland cloud forest of French Guiana, *Gehrig-Downie et al.*
- Stomatal differentiation and abnormal stomata in hornworts, *Pressel et al.*
- Bryophyte photosynthesis in sunflecks: greater relative induction rate than in tracheophytes, *Kubásek et al.*
- Subgenome analysis of two Southern Hemisphere allotriploid species in Sphagnum (Sphagnaceae), *Karlin*

Maney Publishing
Research • Knowledge • Innovation

USEFUL INFORMATION AND MAPS

GENERAL INFORMATION

Contacts
Cristina Orchard: Mobile phone 9.535.0216; caorchar@gmail.com
Francisca Massardo: Mobile phone 8.886.7593; massardorozzi@yahoo.com
Pamela Oyarzo: Mobile phone 8.367.0809; pamela.oyarzo@umag.cl
Universidad de Magallanes offices: Punta Arenas (61) 2207.112, Puerto Williams (61) 2621305, (61) 2621715

Santiago
Airport: Arturo Merino Benítez, Aeropuerto Internacional (SCL)
Weather/Temperature: Mediterranean. January has in average 15°C min y 30°C max.

Punta Arenas
Airport: Carlos Ibáñez del Campo (PUQ), at 20 km from the town of Punta Arenas.
Weather/Temperature: The weather is dry, with temperatures averaging 8°C min and 15°C max. Wind speed can reach 130 km/hour.

Puerto Williams
Puerto Williams is a Chilean city located in the northern coast of Navarino Island (54°56'00"S 67°37'00"W), in the Magellanic and Chilean Antarctic Region. Puerto Williams is the capital city of the Cape Horn County and of the Chilean Antarctic Province. It is located 3,552 km south of Santiago and 547,5 km south of Punta Arenas city (the capital city of the region).
Weather/Temperature: On average the expected minimum is 6 ° C and maximum 15 ° C for January, with a fairly dry climate.

Safety
Punta Arenas and Puerto Williams are widely known as safe cities for visitors. Nevertheless, we recommend taking the usual safety measures, avoiding contact with strangers and keeping your valuables out of sight of strangers. Similarly avoid walking alone at night in unfamiliar areas away form your hotel or hostal.

Water
Drinking is completely safe for consumption, but sealed water containers will be available during the conference at the school.

Internet
Punta Arenas: Most hotels and hostels offer internet service through Business Center. Also one may check email accounts in any of the of cyber cafes in the downtown.
Puerto Williams: the internet signal is weak and intermittent. Some hostels have internet.

Transportation
Punta Arenas: the "radiotaxi" is a useful way to go to the airport, like Radiotaxi Patagonia (61-2-229330), Radiotaxi Cofrima (61-2214144) y Ona (61-2281544) or ask in your hotel. For transportation within the city, you can stop a taxi in the street.
Puerto Williams: The conference will provide transportation for the field trips and from the airport or dock to accomodations at your arrival.

Money exchange
The national currency are the Chilean "pesos". On average the exchange rate with the $US is 1 dollar = 600 Chilean pesos.
Punta Arenas: For money exchange in Punta Arenas you have to go to "Casas de Cambio" at for example: Lautaro Navarro 1001, Lautaro Navarro 1099, Roca 915.
Puerto Williams: you may exchange money at the "Banco de Chile". See the map.

Banks and ATM
Banks in Chile are open from 9.00 to 14.00. ATM access is open 24 h a day.

Restaurants
Punta Arenas: we recommend Sotito's Bar (O'Higgins 1130), Sabores (Mejicana 702), La Marmita (Plaza Sampaio 678), La Luna (O'Higgins 1017).
Puerto Williams: See the city map, p.37).

Post Mail offices
Punta Arenas: Bories 911.
Puerto Williams: Center (see the city map, p. 37).

Hospitals:
Punta Arenas: Hospital Regional de Punta Arenas (Av. Los Flamencos 0136) and Clinica Magallanes (Av. Bulnes 01448).
Puerto Williams: Hospital Naval de Puerto Williams (61-2621098)

Emergency phones: From any phone
Ambulance (SAMU): 131
Fire Station: 132
Police: 133

It is suggested to bring:
Waterproof parka or windbreaker
Trekking shoes
Thick socks
Wool hat, gloves and scarf
Fleece vest. It is advisable to always wear something light or short sleeve under warm clothing.
Small lantern
Any hygiene or health care needs
Camera
Rechargeable batteries
Adapter for 220 V (Type C plug)
Sunscreen
Water bottle

IAB CONFERENCE 2015

PUERTO WILLIAMS MAP

Puerto Williams (54°56’S, 67°37’W) is a Chilean city, located on the northern coats of Navarino Island, facing the Beagle Channel. It is the capital of the Chilean Antarctic Province, one of four provinces located in the Magellan and Chilean Antarctica Region, and administers the communes of Chilean Antarctic Territory and Cabo de Hornos. It has a population of 2,200, including both naval personnel and civilians. Puerto Williams is geographically the world's southernmost city.

The settlement was founded in 1953, and was first named Puerto Luisa. The town was later named for John Williams Wilson, a British man who founded Fuerte Bulnes, the first settlement in the Strait of Magellan since 1587. It has served primarily as a naval base for Chile. The Chilean Navy runs the Guardiamarina Zañartu Airport and hospital, as well as nearby meteorological stations. Since the late 20th century, the number of navy personnel have decreased in Puerto Williams and the civilian population has increased. In that period, tourism and support of scientific research have contributed to an increase in economic activity. The port attracts tourists going to Cape Horn or Antarctica; its tourism industry developed around the concept of "the world's most southern city".

Since 2002 the Universidad of Magallanes has a university centre in Puerto Williams. This is a public university and the activities developed in Puerto Williams are associated with the Sub-Antarctic Biocultural Conservation Program that develop the Omora Ethnobotanical Park. This Program is coordinated in Chile by the Universidad de Magallanes, the Institute of Ecology and Biodiversity and the Omora Foundation, and in the United States by the University of North Texas.

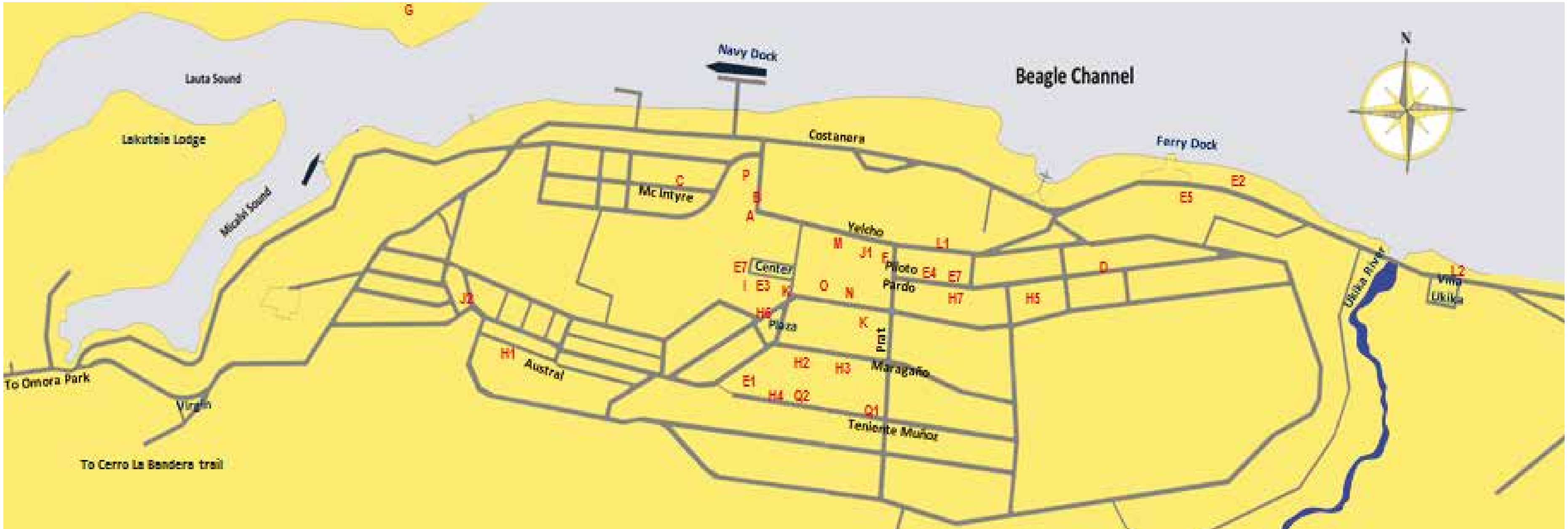


Figure 1. map of Puerto Williams city, Cape Horn County, Chilean Antarctic Province.

A: ATM (cajero automatico)
B: Bank.
C: Hospital
D: Police Station
E: Restaurants: E1=Resto del Sur, E2=Cafe Puerto Luisa, E3=Dientes de Navarino, E4=El Alamabique Restobar, E5=Onashaga Pub Restaurant, E7=La Pica del Castor.
F: Fire Station
G: airport
H: Hostels. H1=Hostal Akainij, H2=Hostal Cabo de Hornos, H3= Coiron, H4=Hostal Miramar, H5=Hostal Yagán, H6=Hostal Beagle, H7=Hostal Pusaki., H8=Lajuwa. (Villa Ukika)
I: Post Mail office
J: Internet: J1 Biblioteca Pública Pierre Chilli , J2 Museo Martín Gusinde.
K: Handcrafts and souvenirs: K1=Fio-Fio Piti, K2=Turismo Shila.
L: Yahgan handcrafts, Julia (L1), Kipa-Akar (L2)
M: Local school: Liceo Donald McIntyre
N: Municipality Office
O: Government Office
P: Navy Hall
Q: Q1=Universidad de Magallanes Office, Q2=Omora Field Station.
R: J2 Museo Martín Gusinde.

OMORA PARK

The Omora Ethnobotanical Park is a public-private protected wilderness area that was created in 2000 to conduct long-term interdisciplinary ecological research, environmental education, and biocultural conservation. A pivotal element of our biocultural conservation initiative was the identification of the Green-backed Firecrown (*Sephanoides sephaniodes*), or Omora in the Yahgan language, as a flagship species. The focus on the hummingbird was appealing to the diverse stakeholders who live in Puerto Williams. Directing the attention toward this unique bird helped the Omora initiative to integrate biological and cultural diversity, as well as ecological, anthropological, social, cultural, aesthetic, economic, and ethical dimensions into its international sub-Antarctic Biocultural Conservation Program (Rozzi et al. 2008c). The main functions of Omora Park are:

a) Protection of the Róbalo River watershed that provides drinkable water for the citizens of Puerto Williams, the world's southernmost city and capital of the Antarctic Province of Chile.

b) Conservation of the Magellanic sub-Antarctic biodiversity at a Priority Site for Biodiversity Conservation identified by the Chilean National Commission for the Environment (CONAMA) in 2002.

c) Interdisciplinary Research, Education, and Conservation at the southernmost site of the LTSER-Chile network, which also functions as a "natural laboratory" for the Cape Horn Biosphere Reserve and the Sub-Antarctic Biocultural Conservation Program (www.chile.unt.edu).

In terms of land tenure, the Chilean Ministry of National Land granted the park jointly to a state institution, the University of Magallanes, and to a private non-profit organization, Omora Foundation, as a renewable 25-yr free concession of 1,069 ha (54º56'-54º59'S, 67º38'-67º42'W). The altitudinal profile extends from the coast rising through peat bogs, forests and shrubs (0 to 400 m approximately) to the high Andean zones that include cushion plant formations and abundant lichens and mosses (400-900 m approximately) (Figure 2-4).

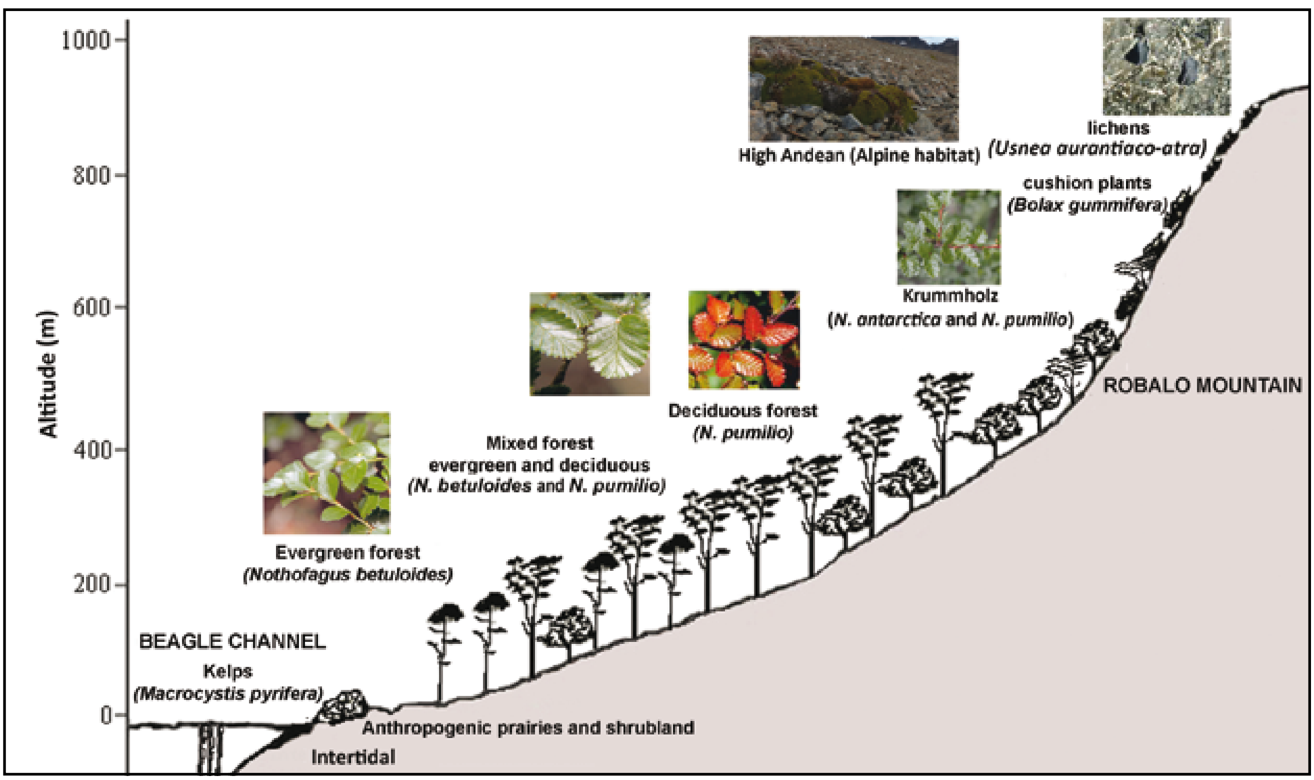


Figure 2. Altitudinal profile of the Omora Ethnobotanical Park. From Rozzi & Jimenez 2014.

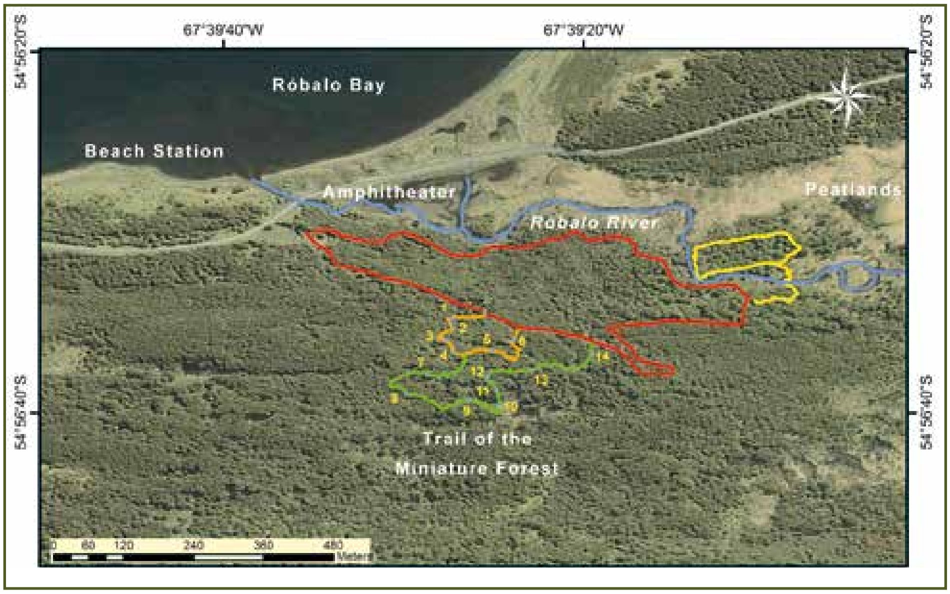


Figure 3. The Omora Ethnobotanical Park includes several interpretive trails. The stations of the Trail of the Miniature Forests of Cape Horn that you will visit in your Ecotourism with a Hand Lens experience are indicated on the satellite image. The first part of the trail, including stations 1 through 6, is marked in orange. The second portion of the trail, including stations 7 -14 is marked in green. Also the Amphitheater of the Large and Small Landscapes and the stations of the third section (Beach and Peatland) are indicated. The High Andean station, which is not shown, can be reached following the *Sendero de Chile* (Chile Trail) that ascends to the summit of La Bandera hill. From Rozzi, R., L. Lewis, F. Massardo, Y. Medina, K. Moses, M. Méndez, L. Sancho, P. Vezzani, S. Russell & B. Goffinet. 2012. *Ecotourism with a Hand-Lens at Omora Park*. It includes the documentary *The Invisible Journey* by Jaime Sepúlveda, and photography by Adam Wilson. Ediciones Universidad de Magallanes, Punta Arenas, Chile. (190 pp.) ISBN 978-956-9160-00-4.

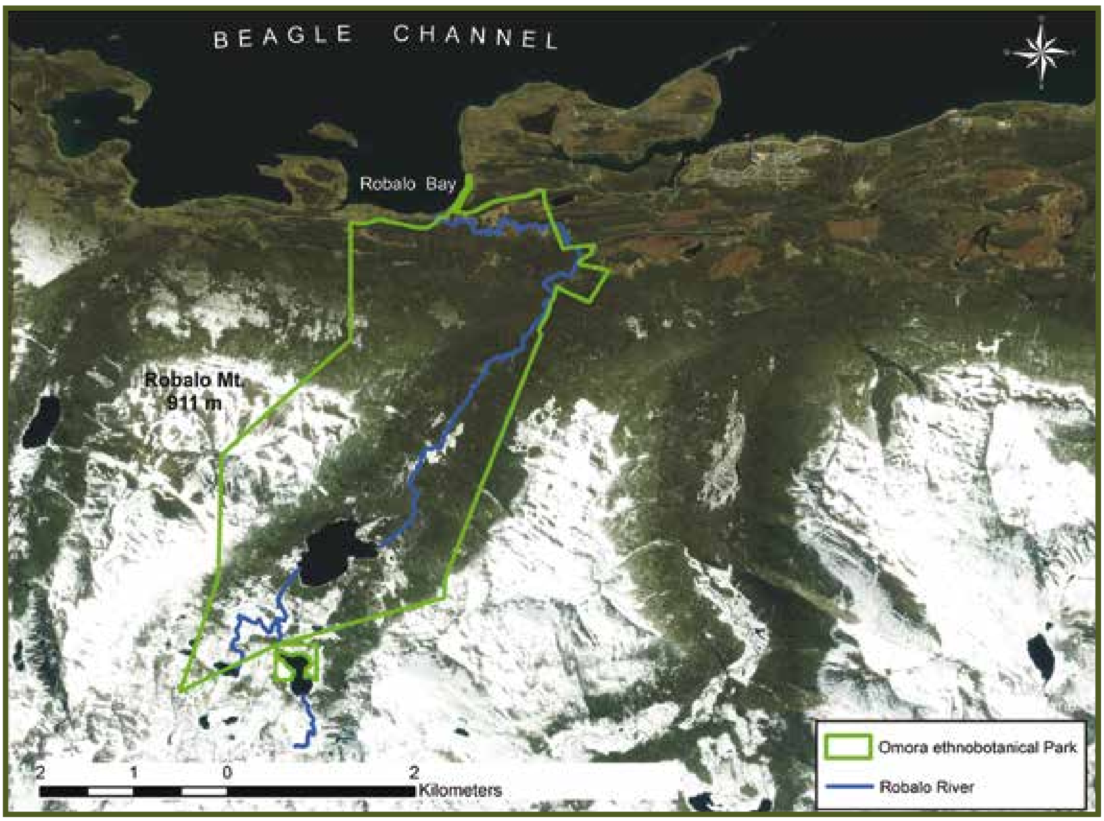


Figure 4. Omora Park area at Robalo Bay, 3 km W of Puerto Williams city in the northern coat of Navarino Island. From Rozzi, R., & J. E. Jiménez. 2014. *Magellanic Subantarctic Ornithology: First Decade of Forest Bird Studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve*. UNT Press - Ediciones Universidad de Magallanes, Denton TX, USA - Punta Arenas, Chile.

THE CAPE HORN BIOSPHERE RESERVE

The Cape Horn Biosphere Reserve is a landmark for global biodiversity conservation (Figure 5). Today, southwestern South America still preserves an extensive area of evergreen forests that covers most of the Magellanic sub-Antarctic ecoregion (Rozzi et al. 2012). In this ecoregion that spans a myriad of islands, Cape Horn emerges as the southernmost forested point in the world. Metaphorically we have called it "the Southern summit of the Americas."

Just as Mount Everest is the world's highest summit, Cape Horn is the highest latitude forested point in the Southern Hemisphere. Because of their extreme altitude or latitude, respectively, both peaks are subject to extreme climatic conditions, which acquire special relevance as we confront global climate change. Furthermore, in contrast to the broad longitudinal extension of temperate and boreal forests in the Northern Hemisphere, the temperate and sub-Antarctic forests of South America extend along a strip of land that is latitudinally very long (33-56ºS), but longitudinally very narrow (71-73ºW). This inter-hemispheric contrast creates unique possibilities for comparative studies on the life histories, ecology, and impacts of global environmental change on the birds, and biodiversity in general for at least five unique attributes of Cape Horn.

At the landscape scale, Cape Horn offers a remarkable diversity of habitats with a rich biodiversity that derives its uniqueness to a great extent from the variety of its biogeographical relationships (Moore 1983). The biota of Cape Horn has affinities with five contrasting biogeographic regions.

1. Gondwana. Today, the genus *Nothofagus* is only found in the Southern Hemisphere, in Australasia (eastern and southeastern Australia, New Zealand, New Guinea, and New Caledonia) and southern South America (Chile, Argentina). Fossil trees are also preserved in Antarctica (Veblen et al. 1996). In most islands of the Cape Horn Biosphere Reserve, dense old-growth forests dominated by species of *Nothofagus* grow on the slopes protected from the wind. The presence of this genus provides a living example of the Gondwanic connections that southern South America had with Antarctica, New Zealand, and Australia, until the late Cretaceous 75 million years B.P.

2. Neotropical. *Drimys* is a Neotropical genus whose species are distributed throughout South and Central America reaching southern Mexico (Arroyo et al. 1996). The southernmost representative of this genus, the Winter's Bark or Canelo (*D. winteri*), grow in the broadleaf evergreen forests of Cape Horn near the coast. In coastal forests, the Winter's Bark is a dominant tree that is characterized by its large leaves. It also produces fleshy fruits, which are consumed by the Austral Thrush (*Turdus falcklandii*) and the White-crested Elaenia (*Elaenia albiceps*), which feeds on them before its migration each autumn from Cape Horn to the Amazonian forests. In the coastal broadleaf evergreen forests it is also possible to observe parrots and hummingbirds that reflect the biogeographical connections that the forests of Cape Horn have with the Neotropical forests of South and Central America.

3. Andean. Above the tree line, in Omora Park it is possible to observe birds of the genera *Attagis* (seedsnipes) and *Meladonera* (finches) that are distributed northward along the high Andes. The cushion plants of the genus *Azorella* that grow above the treeline as well as near the coast at Omora Park and other places in the Cape Horn Biosphere Reserve. These plants grow about 4000 m altitude in the high Andes of Bolivia, Peru, and northern Chile and Argentina (Armesto et al. 1980). Both the bird and cushion plants are examples of the connections that the biota of Cape Horn has with the biota of the high-Andean Puna.

4. Antarctica. On the rocks of the coast in the Cape Horn Biosphere Reserve, the bright orange lichens *Caloplaca hookeri* and *C. sublobata* (Goffinet et al. 2012), and the penguins *Eudyptes chrysolophus* (Macaroni Penguin) and *Pygoscelis antarctica* (Chinstrap Penguin), are an example of the close connections between the terrestrial and marine biota of the Magellanic sub-Antarctic ecoregion and the Antarctica.

5. Bipolar. The abundance of low shrubs of Red Crowberry or Diddle-dee (*Empetrum rubrum*) is an example of long dispersal between the sub-Antarctic and subarctic regions, which generates a "bipolar distribution." The genus *Empetrum* has only two species: *E. nigrum* restricted to Alaska and other subarctic zones, and *E. rubrum* restricted to Cape Horn and other sub-Antarctic zones (Donoghue 2011, Popp et al. 2011).

Figure 5. The Cape Horn Biosphere Reserve was created in 2005.

Two other factors that contribute to the great heterogeneity of habitats in the Cape Horn Biosphere Reserve (CHBR) are the complex physical geography and the strong west-east gradient of rainfall (Rozzi et al. 2006a,b,c). In the western and southern areas of the CHBR toward the Pacific Ocean are innumerable islands with peninsulas, bays, steep mountains, narrow valleys, and fjords. In the northern area of the CHBR, the most dominant characteristic of the physical geography is the Andean Cordillera system that bends eastwards along the southwestern extension of Tierra del Fuego giving origin to the Darwin Cordillera, also known as the Fuegian Andes. This cordillera creates an abrupt alteration in the topography that generates abrupt changes in climate over short distances. The highest peaks of the Darwin Cordillera are found to the west on Mt. Sarmiento (2404 m) and in the Darwin Cordillera (Mt. Luis de Saboya 2469 m, Mt. Darwin 2438 m) (Figure 15). The altitude of the mountains diminishes eastwards and southwards. On Navarino Island the highest peaks are the "Dientes de Navarino" (1195 m) where the Róbalo River is born. At Omora Park, the highest altitude is the summit of Róbalo Mountain (920 m). In the Cape Horn Archipelago, only Wollaston Island has peaks above 500 m.

The high altitude of the Darwin Cordillera combined with the prevailing winds carrying high moisture from the Pacific Ocean, creates a remarkable rainfall gradient from the west to the east. When the westerlies arrive on the western coast and the Darwin Cordillera their moisture condenses and precipitates as rain on the lowlands and as snow on the mountains. It is not possible to give a detailed and reliable map of the distribution of the precipitation, but the main features have been well synthesized by Tuhkanen et al. (1990). In less than 300 km the annual rainfall decreases approximately an order of magnitude, from over 3000 mm in the west to less than 500 mm in Puerto Williams and Omora Park. The combination of biological, orographic, climatic, and other factors gives origin to a terrestrial ecosystem mosaic that includes a complex of (I) forests, (II) scrublands, (III) moorlands and wetlands, and (IV) high-Andean habitats. Among the forests, four main types are present at Omora Park and in other areas of the Cape Horn Biosphere Reserve. the sub-Antarctic and subarctic regions, which generates a "bipolar distribution."

Extracted from From Rozzi, R., & J. E. Jiménez. 2014. *Magellanic Subantarctic Ornithology: First Decade of Forest Bird Studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve*. UNT Press - Ediciones Universidad de Magallanes, Denton TX, USA - Punta Arenas, Chile.

FIELD TRIP AREAS IN NAVARINO ISLAND

The IAB Conference 2005 include the visit four different areas in the northern and western coasts of Navarino Island, in addition to Omora Park (Figures 6 and 7).

1. Bahia Wulaia (Wulaia Bay).

2. Caleta Paula (Paula Cove). A very interesting archaeological site located in the Northern coast

3. Cerro La Bandera (La Bandera Hill).

4. Turbera (peatland).

Figure 6. Navarino Island from Google Earth.

Figure 7. *Front page.* Sites included in the visits of IAB Conference 2005. Image from Google Earth.


N
TIERRA DEL FUEGO
Archaeological site:
Caleta Paula
Wulaia Bay
CANAL BEAGLE
Cerro La Bandera
ISLA PICTON
Peatland
ISLA LENNOX
ISLA NUEVA

MOSSES COLLECTED AT WULAIA BAY, NAVARINO ISLAND, CHILEAN ANTARCTIC PROVINCE, CHILE

Contributed by William Buck (New York Botanical Garden)

Achrophyllum magellanicum (Besch.) Matteri
Acrocladium auriculatum (Mont.) Mitt.
Bartramia ithyphylloides Schimp. ex Müll. Hal.
Bartramia mossmaniana Müll.Hal.
Blindia magellanica Schimp.
Brachythecium albicans (Hedw.) Schimp.
Brachythecium austrosalebrosum (Müll.Hal.) Paris
Brachythecium paradoxum (Hook. f. & Wilson) A. Jaeger
Brachythecium subpilosum (Hook. f. & Wilson) A. Jaeger
Brachythecium subplicatum (Hampe) A. Jaeger
Breutelia integrifolia (Taylor) A. Jaeger
Bryum caespiticium Hedw.
Bryum gayanum Mont.
Campylopus introflexus (Hedw.) Brid.
Catagonium nitens (Brid.) Cardot
Ceratodon purpureus (Hedw.) Brid.
Cladomniopsis crenato-obtusa M. Fleisch.
Dicranoloma robustum (Hook. f. & Wilson) Paris
Distichium capillaceum (Hedw.) Bruch & Schimp.
Eurhynchium fuegianum Cardot
Grimmia pulvinata (Hedw.) Sm.
Grimmia trichophylla Grev.
Hennediella antarctica (Ångstr.) Ochyra & Matteri
Hennediella densifolia (Hook. f. & Wilson) R. H. Zander
Hygroamblystegium chilense (Hedw.) Reimers
Hymenodontopsis mnioides (Hook.) N. E. Bell, Ang. Newton & Quandt
Hypopterygium didictyon Müll.Hal.
Leptotheca gaudichaudii Schwägr.
Lepyrodon lagurus (Hook.) Mitt.
Muelleriella crassifolia (Hook. f. & Wilson) Dusén
Notoligotrichum minimum (Cardot) G. L. Sm.
Orthotrichum brotheri Dusén ex Lewinsky
Philonotis scabrifolia (Hook. f. & Wilson) Braithw.
Philonotis vagans (Hook. f. & Wilson) Mitt.
Pohlia lonchochaete (Dusén) Broth.
Polytrichum piliferum Hedw.
Rigodium brachypodium (Müll. Hal.) Paris
Rigodium pseudothuidium Dusén
Syntrichia anderssonii (Ångstr.) R. H. Zander
Syntrichia geheebiaeopsis (Müll.Hal.) R. H. Zander
Syntrichia magellanica (Mont.) R. H. Zander
Syntrichia saxicola (Cardot) R. H. Zander
Tayloria dubyi Broth.
Tayloria magellanica (Brid.) Mitt.
Tortella knightii (Mitt.) Broth.
Vittia pachyloma (Mont.) Ochyra
Willia austroleucophaea (Besch.) Broth.
Zygodon hookeri var. leptobolax (Müll.Hal.) Calabrese