Abstracts for IAL 6- ABLS Joint Meeting (2008)

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Isolation and characterization of non-phototrophic bacterial symbionts of Icelandic lichens

Lichens are symbiotic organisms comprise an ascomycete mycobiont, an algal or cyanobacterial photobiont, and typically a host of other bacterial symbionts that in most cases have remained uncharacterized. In the current project, which focuses on the identification and preliminary characterization of these bacterial symbionts, the species composition of the resident associate microbiota of eleven species of lichen was investigated using both 16S rDNA sequencing of isolated bacteria growing in pure culture and Denaturing Gradient Gel Electrophoresis (DGGE) of the 16S-23S internal transcribed spacer (ITS) region amplified from DNA isolated directly from lichen samples. Gram-positive bacteria appear to be the most prevalent, especially actinomycetes, although bacilli were also observed. Gamma-proteobacteria and species from the Bacteroides/Chlorobi group were also observed. Among identified genera are *Rhodococcus, Micrococcus, Microbacterium, Bacillus, Chryseobacterium, Pseudomonas, Sporosarcina, Agreia, Methylobacterium* and *Stenotrophomonas*. Further characterization of selected strains indicated that most strains ar psychrophilic or borderline psychrophilic, and halotolerant to halophilic. Some strains are slightly alkaliphilic. (Poster: Symbiosis, Wednesday in Triton)

ALPERT, PETER

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***Vita interrupta:* life that tolerates desiccation**

Poikilohydry, the inability to stay moist in a dry place, requires the ability to tolerate being dry. Because metabolism depends on water, tolerance of desiccation means being able to stop metabolism during drying, survive in an inanimate state, and restart metabolism upon rewetting. Although all vertebrates and crop plants die if they dry, a majority of lichens and bryophytes, a minority of ferns and flowering plants, many microbes, and animals in five phyla tolerate desiccation. They do so largely by virtue of biochemical mechanisms, including sugars that replace water and form glasses, proteins that further stabilize macromolecules and membranes, and antioxidants that counter damage by reactive oxygen species. Understanding these mechanisms has already contributed to medicine and might one day help prevent famines due to drought. (*Symposium*: Biochemistry and Physiology of Poikilohydry)

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Geographic structure of fungi and algae in a widespread lichen of western North America

The sorediate lichenized fungus *Letharia vulpina* 'lupina' is geographically widespread in Western North America, and it is found from British Columbia to Southern California and Oregon to South Dakota.DNA sequences of five fungal and two algal loci demonstrate asymmetry in the two partners' respective geographic structures. The fungus has low structure throughout its range whereas the alga shows strong structure, especially in Southern California. This study system provides a window on 1) the geographic patterns of fungal-algal partnership combinations and 2) the geographic scale of gene flow in each partner. (*Symposium*: Together and Separate The Lives of Lichen Symbionts)

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Evolutionary trends in *Xanthoparmelia* clade

Molecular data showed that *Xanthoparmelia* species form the biggest monophyletic group in Parmeliaceae. Recent molecular analysis reveal that monophyletic lineages did not match the circumscriptions of genera previously described on morphological and chemical data. Our current project attempts to relate the main phylogenetic lineages found within the *Xanthoparmelia* clade to the morphological, chemical and biogeographical traits. Preliminary results show: (i) characters used to define *Karoowia* are not synapomorphic and this genus should be included within *Xanthoparmelia*. (ii) several monophyletic clades within *Xanthoparmelia* show unique combinations of characters, e.g. the species of the *X. hypoleia* group, distinguished by M. Hale as a morphological entity, form a monophyletic group; the species lacking usnic acid and atranorin in the cortex and containing orcinol derived metabolites in the medulla make up another remarkable monophyletic group. (iii) The paraphyletic topology found in several clades suggests that divergent speciation processes are occurring in some groups. A combination of molecular, morphological, chemical and biogeographical characters are needed to propose a well supported systematic treatment of the *Xanthoparmelia* clade, and to understand the biological basis of *Xanthoparmelia* diversification. (*Symposium*: Parmeliaceae: Development of a new Systematics)

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Phylogenetic position of the genus *Harpidium* Körber

The genus *Harpidium* includes two species: *H. nashii*, known from Southwest North America, and the type species *H. rutilans*, known so far only from Europe. *Harpidium*, together with the closely related genus *Euopsis* Nyl., were placed in the Lichinaceae by Henssen et al. (1987), based on a characteristic rostrate asci and ascoma ontogeny. We collected specimens of *H.* cf. *rutilans* and *H. rutilans* from South Africa and Spain, respectively, from which we obtained sequences of nuSSU, nuLSU and mtSSU. Bayesian analysis showed that the genus is placed out of the monophyletic Lichinomycetidae group. This result suggests that *Harpidium* together with *Euopsis* may constitute an undescribed independent lineage of lichenized fungi. (Poster: Taxonomy & Systematics, Wednesday in Nautilus)

***ARMALEO, DANIELE[1], JONESON, SUZANNE[1], MCDONALD, TAMI[1], WRAY, GREG[1], DIETRICH, FRED[2], MIADLIKOWSKA, JOLANTA[1],** and **LUTZONI, FRANCOIS[1]**

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Decoding symbiosis: sequencing the two genomes of the lichen *Cladonia grayi*

We are sequencing the genomes of the isolated mycobiont and photobiont (the green alga *Asterochloris*) from the lichen *Cladonia grayi*. The overall goal of this and of other emerging lichen genome projects is to understand the genetic and genomic adaptations that underlie the symbiotic interactions and the coevolution of lichen fungi and their photobionts. The first phase involves the 5x coverage of each genome using 454 technology. The initial results will be discussed. (*Symposium*: *Xanthoria* and *Physcomitrella* Genomics: Potentials for New Research)

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Endolichenic fungi: diversity, distributions, and evolutionary origins

Endolichenic fungi – fungi that occur within asymptomatic lichen thalli, analogous to endophytic fungi within healthy tissues of plants – have been recovered from phylogenetically diverse saxicolous, corticolous, and muscicolous lichens in communities ranging from Arctic tundra to tropical rainforests. These ubiquitous symbionts preferentially associate with photobionts and are ecologically and phylogenetically distinct from both mycobionts and lichenicolous fungi. Drawing from five years of studies conducted in a diverse array of biomes, and focusing only on fungi recovered from the interior of surface-sterilized lichens, we will highlight the apparent hyperdiversity of these little-known fungi; their geographic heterogeneity; the degree to which their distributions are shaped by mycobiont taxonomy, photobiont taxonomy, and lichen substrate; their genotypic congruence with plant endophytes, especially with regard to bryophyte-associated fungi; their evolutionary distinctiveness with regard to saprotrophs; and the ways in which they inform, through multi-locus phylogenies, our view of major evolutionary trends across the Ascomycota. (*Symposium*: Endolichenic Fungi and Bacteria: Implications for Symbioses)

ASCASO, CARMEN[1], *DE LOS RIOS, ASUNCION[1], DAVILA, ALFONSO F.[2], GRUBE, MARTIN[3] , CAMARA, BEATRIZ[1], VALEA, SERGIO[1] and **WIERZCHOS, JACEK[4]**

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Lichen colonization of gypsum crusts from the hyperarid zone of the Atacama Desert

The Atacama Desert ranks as the driest place on our planet with long-term mean annual rainfall as low as a few millimeters in its driest zone. Gypsum and anhydrite crusts are widely distributed throughout the entire hyper-arid region; possible sources include *in situ* weathering at the soil site, local sources such as aerosols from the adjacent Pacific Ocean or salt-encrusted playas (salars), and extra-local atmospheric dust. Here we report endolithic and epilithic lichen colonization within gypsum and anhydrite crusts in the North-Central Atacama Desert. Other microorganisms, including non-lichenized fungi and algae and heterotrophic bacteria, have also been observed nearby. The spatial relationships between the different components of the community, as well as the colonization strategies of the lichens, have been characterized by scanning electron microscopy in backscattered electron mode. We have also monitored microclimatic conditions in order to characterize this extreme environment. Over a period of 8 months, relative humidity values never reached water condensation levels (Mean= 50.6%; Max = 83%; Min =15%), suggesting that dew is the only source of liquid water for these communities. (Poster: Ecology, Thursday in Nautilus)

***ASPLUND, JOHAN and GAUSLAA, YNGVAR**

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Mollusc Grazing Limits Growth and Early Development of the Old Forest Lichen *Lobaria pulmonaria* in Broadleaved Deciduous Forests

This study aims: (1) to quantify mollusc grazing on juvenile and mature thalli of the foliose epiphytic lichen *Lobaria pulmonaria*, and (2) to test the hypothesis inferring a herbivore defensive role of lichen depsidones in forests with indigenous populations of lichen-feeding molluscs. Lichens were transplanted in shaded and less shaded positions in each of two calcareous broadleaved deciduous forests. Preventing the access of molluscs significantly reduced the loss of juvenile *L. pulmonaria*. Molluscs also severely grazed mature thalli in the lichen-poor forest, especially thalli placed under the more shading canopies. Furthermore, reducing the natural concentration of depsidones by pre-rinsing with acetone increased subsequent grazing significantly, showing that lichen depsidones function as herbivore defence in natural habitats. Our results suggest that mollusc grazing may play important roles in shaping the epiphytic vegetation in calcareous deciduous forests, and that recently established juvenile *L. pulmonaria* thalli seem to be particularly vulnerable. (*Symposium*: Functional Ecology)

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Studies on lichenicolous *Dacampiaceae* (*Ascomycota*) from the Iberian Peninsula

Lichenicolous *Dacampiaceae* Körb studies in the Spanish lichen flora project indicate that 27 species included in five genera have been reported growing on lichens in the Iberian Peninsula. The genera and species considered are *Clypeococcum* (4), *Dacampia* (3), *Polycoccum* (13), *Pyrenidium* (1) and *Weddellomyces* (6). The main objective of these studies was to refer to the Iberian species features and to assist in the identification of all these *Dacampiaceae* taxa. Iberian specimens and type material, if required for controversial cases, from the ASCO, BCN, IMI, LEB, MA, MAF, MARSS, S, SANT, UPS, VAL herbaria have been studied. Descriptions, comments regarding taxonomic features, relationships with other taxa, host specificity, the distribution in Spain and abroad of all the species and identification keys for the aforementioned genera and species are provided. Data on *Weddellomyces* have been obtained in collaboration with Dr. P. Navarro-Rossines. Support from the Spanish CGL2007-66734-C03-01/BOS is acknowledged. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

AUGUSTO, SOFIA, MÁGUAS, CRISTINA and ***BRANQUINHO, CRISTINA**

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The effect of thallus morphology, size and age on the performance of lichens as biomonitors of toxic organic compounds

Dioxins and furans (PCDD/Fs) and polycyclic aromatic hydrocarbons (PAHs) are organic compounds which are persistent, bioaccumulative and toxic to human health. Recently lichens have been shown potential for monitoring PCDD/F and PAH atmospheric deposition. This development is very important since spatial and temporal information on atmospheric PCDD/F and PAH deposition is rather scarce. The aim of this study is to compare the performance of different lichen species to monitor PCDD/F and PAH atmospheric deposition. For that, lichens of different species (*Xanthoria parietina, Parmotrema hypoleucinum, Parmelia caperata, Parmelia reticulata, Ramalina canariensis, Ramalina fastigiata* and *Cladina* sp.) were collected in different rural, industrial and urban areas and analysed for PCDD/Fs and PAHs. The levels and profiles of PCDD/Fs and PAHs were compared between species and with other common environmental monitors such as pine needles and soil samples. The effect of thallus morphology, size and age are also used to discuss the differences observed. (Poster: Environmental Monitoring, Friday in Merrill Hall)

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The Carbon Balance of Tropical Bryophytes and Lichens: Carbon Exchange and Carbon Pools along an Altitudinal Gradient from Lowland to Cloud Forest in Panamá

The biomass and diversity of bryophytes and lichens in the tropics show a strong altitudinal gradient, with highest values in montane cloud forests and low values in lowland forests. A popular hypothesis to explain the low biomass of these life forms in lowland forests is that their net carbon gain is very low here due to high night temperatures, causing strong respiration, combined with high day temperatures, causing dehydration, thereby restricting the time available for photosynthesis. If carbon gain is indeed especially limiting in the lowlands, we expect to find very little stored carbon in lowland bryophytes and lichens compared to those at higher altitudes. We have started to test this hypothesis by determining the total non-structural carbon (TNC) pool in bryophytes ad lichens from different altitudes in Panamá. We will here present our preliminary TNC data, as well as the first carbon exchange data for tropical lowland bryophytes, showing temperature responses and the potential of temperature acclimatization. (*Symposium*: Biochemistry and Physiology of Poikilohydry)

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The major clades and phylogenetic position of the Ostropales

Various groups of lichenized Ostropomycetideae have been extensively studied in recent years using molecular phylogenetic methods. In the presented study we include data of the previously neglected families of Odontotremataceae and Stictidaceae (Ostropales s.str.). Both families comprise mainly saprobes, but also lichens, lichenicolous fungi, and plant parasites. We analysed three independent genetic regions (mtSSU and nuLSU rDNA, RPB2) of members of the Stictidaceae and Odontotremataceae together with representatives of the allied families Coenogoniaceae, Gomphillaceae, Graphidaceae, Gyalectaceae, Phlyctidaceae, Porinaceae, Solorinellaceae, Stictidaceae, and Thelotremataceae, with different analytical methods. The aim of the study is to test whether Stictidaceae and Odontotremataceae as currently understood are monophyletic entities and how they are related to mainly lichenized lineages. We will utilize a thorough analysis of morphological and anatomical traits together with the phylogenetic hypotheses presented to revise the systematic concepts within the Ostropomycetideae, with particular focus on Ostropales s. str. The evolution of characters and lifestyles in the group will be discussed. (*Symposium*: Roots, trunks, branches and leaves: Systematics and Phylogenetics)

***BARCENAS PEÑA, ALEJANDRINA[1], HERRERA CAMPOS, MARÍA ANGELES[1]** and **LÜCKING, ROBERT[2]**

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Altitudinal foliicolous lichen species composition in the tropical rain forests of Veracruz, Mexico

The colonization of vascular plant leave surface by foliicolous lichens is a peculiar phenomenon that occurs mainly in the tropical rain forests, whose most northern limit in America is located at Sierra de Los Tuxtlas, Mexico. In this sierra, San Martin Tuxtla and Santa Marta volcanoes are located, study area where foliicolous lichen species composition was analyzed every 100 m of altitude at the east and west sides of both volcanoes. It was observed that the highest values of diversity are found in lower elevations. Likewise some characteristic species of each altitude were identified like *Actinoplaca strigulacea* and *Arthonia cyanea* to 1200 and to 1600 m of altitude respectively, and *Gyalectidium filicinum* and *Logilvia gilva* at the top of the mountains. (Poster: Biogeography and Floristics, Monday in Nautilus)

BARRENO, EVA[1], *HERRERA-CAMPOS, MARIA[2], GARCÍA-BREIJO, FRANCISCO[1,3], GASULLA, FRANCISCO[1] and **REIG-ARMIÑANA, JOSÉ[1]**

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Non photosynthetic bacteria associated to cortical structures on *Ramalina* and *Usnea* thalli from Mexico

Bacterial aggregates physically associated to the cortex of *Ramalina farinacea* thalli from Spain were previously studied. These non-phosynthetic bacteria regularly colonize this taxon, and may have interesting implications for the metabolism and evolution of fruticose lichens. We decided to test if these unexpected associations were a more general condition among lichens. Samples of *Usnea* and *Ramalina* from Sierra de Juárez (México) were studied using 16S ribosomal sequences and ultrathin sections observed by OM, TEM, SEM, LTSEM. Poorly known consortia of bacteria were detected in both genera. They are adhered to the outer cortical surface and clearly interact with several mycobiont hyphae. Curiously, one species showed them into the cortical plectenchyma without reaching the photobiont layer. Lichen thalli are quite complex and these bacteria may be indispensable for its functioning. Moreover, lichen symbiogenesis might help to explain how evolutionary innovations have emerged from multidimensional individualities. (Poster: Symbiosis, Wednesday in Triton)

***BATES, S.T., NASH III, T.H. and GARCIA-PICHEL, F.**

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Investigation of fungal populations and diversity associated with biological soil crusts in the Western United States using culture-independent methods

Biological soil crusts (BSCs) are communities of microorganisms within certain ecosystems that have the potential to contribute significantly to nutrient cycling, act to stabilize the upper soil strata through the production of extracellular polysaccharides (EPS) and ramifying filament-like cells, and exert influence on the hydrologic cycle. BSCs dominated by eukaryotic lichenized fungi have been recognized for the significant contributions that they make in terms of soil stability and nutrient input in arid/semi-arid systems; however, free-living fungal components of crusts are rarely investigated. In this study, we use molecular methodologies to examine fungal communities (primarily free-living) associated with BSCs in arid-lands of the Western United States. PCR-DGGE fingerprinting and sequencing are employed to measure fungal community diversity and composition, and fungi-specific qPCR is used to measure fungal population densities as compared to those of bacteria. The methods presented in this study provide a rapid means to assess BSC community diversity and structure; as such, these molecular-based techniques address some previously cited limitations of culture-dependent research and can be readily employed in advancing the study of BSC associated fungi. (*Symposium*: The World under Your Feet: Biological Soil Crusts)

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Characterization of the microbial community associated with *Xanthoria parietina*

As slow-growing organisms lichens provide long-living ecological niches under rather extreme conditions, and thus possibly harbour additional microorganisms with interesting adaptations. Our knowledge about lichen-associated microorganisms, apart from the symbiotic microbial components, is still scarce. However, in recent times evidence for lichen associated bacteria is increasing (e.g. Cardinale et al. 2006, FEMS ME, 57:484). In this study, we focus on the widespread lichen species *Xanthoria parietina*, collected from three different localities in Southern Germany for elucidation of whether species-specific associations

between prokaryotes and lichens may exist within this particular lichen species. We have initiated a full-inventory approach to characterize the bacterial community in these samples, encompassing: i) SEM-analysis of *Xanthoria parietina* for visualization of surface-associated bacteria; ii) characterization of aerobic, culturable surface-associated bacteria; iii) molecular identification of the whole community, including both surface associated and internal prokaryotes, and iv) microscopical studies based on FISH and gene probes. (*Symposium*: Endolichenic Fungi & Bacteria: Implications for Symbioses)

***BELINCHÓN, ROCÍO., MARTÍNEZ, ISABEL., OTÁLORA, MÓNICA A.G., ARAGÓN, GREGORIO, DIMAS, JESÚS** and **ESCUDERO, ADRIÁN**

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Distribution pattern of *Lobaria pulmonaria* in fragmented Mediterranean forests

We tested the relative importance of landscape structure, local conditions and tree characteristics on the spatial distribution of the red-listed epiphytic lichen *Lobaria pulmonaria* in central Spain. Presence and abundance of the species was recorded for a total of 2039 trees in 31 patches of *Fagus sylvatica* and *Quercus pyrenaica* forests. The results show that patch area and connectivity have no influence on spatial distribution of *L. pulmonaria*, suggesting that stand structure and tree features play an important role in local dynamic. The most important predictor in explaining the occupancy of *L. pulmonaria* was tree diameter. At patch level, cover and presence of *L. pulmonaria* were positively correlated to the number of trees and distance to the river. Moreover, the results were influenced by the tree species considered, being the behavior of *Lobaria pulmonaria* different between beech and oak forests. (Poster: Ecology, Thursday in Triton)

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Novelties on the type material of some South American *Bulbothrix* Hale species (**Parmeliaceae**, **Ascomycetes**)

The ongoing taxonomic revision of the genus *Bulbothrix* Hale is leading to many discoveries. Anatomical and morphological features were analyzed according the practice of the São Paulo's Lichen Taxonomy Group. Here are related novelties referring to some South American species. Comparing the holotypes and other specimens of *B. oliveirae* Fletcher (NY!) and *B. leprieurii* Aubel (U!), we discovered that except by the type, all material in the protologue of *B. oliveirae* actually belong to *B. leprieurii*, since that specimen is the only one with true pustulae and not with typical soralia. Specimens of *B. ventricosa*, including the lectotype (TUR-V!), were discovered to produce laminal bulbs identical to those of marginal cilia, a rare and not reported characteristic on the genus; in addition, their lower cortices have a wide variability of coloration, an uncommon feature. The concept of *B. suffixa* (BM!) also should be changed, since the lectotype does not have laminal lacinules, but adventitious marginal ones instead. The lectotype of *Parmelia pseudocoronata* Gyelnik (G!), a synonym of *B. fungicola* (Lynge) Hale (S!), better represents that concept, since it has laminal lacinules covering the surface. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

***BERG, ANNA[1], ÖSTLUND, LARS[1], MOEN, JON[2]** and **OLOFSSON, JOHAN[2]**

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A century of logging and forestry in a reindeer herding area in northern Sweden

Lichens often dominate the ground flora in boreal ecosystems. Naturally these ecosystems were shaped by reoccurring fires, but forestry activities are now the most influential disturbance factor. Lichens are important winter food for the semi domesticated reindeer herded by the native Sami people. We studied the effects of forestry on the forest structure in a reindeer herding area in northern Sweden by using detailed historical sources, like forest inventories. In general forestry has had negative effects on lichen abundance, mainly by decreasing the proportion of old forests and by increasing the productivity and density in modern forest stands. Modern forestry has often been discussed as a threat to rare and sensitive arboreal lichens. We have shown that the amount of ground growing lichen available for grazing have been halved during the last century, and conclude that modern forestry has had considerable negative effects also on ground growing lichens. (*Symposium*: Lichens in Polar Ecosystems)

*BOONPRAGOB, KANSRI and PANGPET, MONGKOL

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Survival and growth of different vegetative propagules of lichens after transplantation at Khao Yai National Park, Thailand

Effects of microclimate on survival and growth after transplantation of lichen by using different vegetative propagules were tested. Thallus fragments and isidia of *Parmotrema tinctorum*, together with soredia of *P. praesorediosum* were collected from secondary forest (SF) at Khao Yai National Park, Thailand. Five hundred and sixty thallus fragments and 1,120 samples of isidia and soredia were attached along tree trunks in tropical rain forest (TRF), dry evergreen forest (DEF), lower mountain rain forest (LMF), as well as SF. After 45 months, the thallus fragments in LMF, with lower temperature and higher relative humidity, had the highest rates of survival (47%) and growth (0.36 mm. /month). Both isidia and soredia developed into recognizable lobes of 3-5 mm. only in SF, where the temperature was higher and relative humidity was lower. The results suggested that successful transplantation of lichens in various forests need different vegetative propagules. (Poster: Ecology, Thursday in Nautilus)

***BOONPRAGOB, KANSRI** and **PANGPET, MONGKOL**

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Preliminary study on possible distribution of tropical lichens under climate change

Changes in lichen distribution in the tropic caused by global warming were investigated by transplantation of lichens among ecosystems at Khao Yai National Park, Thailand. Thallus fragments of lichens which grow in tropical rain forest (TRF) (*Pseudocyphellaria argyracea*, *Relicina abstrusa* and *Relicina subconnivens*) and secondary forest (SF) (*Parmotrema rubromarginatum* and *Dirinaria picta*) were transplanted to lower mountain rain forest (LMF). Whilst those from LMF (*Hypotrachyna kingii*, *Heterodermia lepidota*, *Hypotrachyna osseoalba* and *Parmelinella chozoubae*) were transplanted to TRF, SF and dry evergreen forest (DEF). Thallus fragments were attached on barks at mid-trunks and canopies. Thirty one months after transplantation the survival percentages of lichens in LMF, TRF, SF and DEF were 46, 20, 8 and 5, respectively. This suggested that lichens from warmer sites could acclimate in 2-3^{o}C cooler habitats, whilst those from the cool sites hardly thrive in warmer habitats and may be threaten to extinct under global warming. (Poster: Ecology, Thursday in Nautilus)

***BUARUANG, KAWINNAT[1], RANGSIRUJI, ACHARIYA[2], PARNMEN, SITTIPORN[2], MONGKOLSUK, PIBOON[1]** and **BOONPRAGOB, KANSRI[1]**

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Analysis of morphological and chemical data of lichens in the family Parmeliaceae in Thailand

Phylogenetic relationships within the family Parmeliaceae were reconstructed based on analysis of a combined morphological and chemical data. Data matrix included 56 species of 13 genera. In the analysis 50 characters were employed. The analysis was carried out using neighbor-joining method. Results obtained revealed 5 clades with clear relationships of the lichens based on vegetative propagules. The character responsible for the grouping of 3 genera in Clade I is dichotomous rhizine. Clade II includes 4 genera which possess cilia and soredia. Clade III consists of 4 genera having important characters of cilia and isidia. Clade IV also contains 4 genera which produce a distinct substance known as usnic acid. Clade V includes only 1 genus which is grouped based on narrow erhizine. Although both morphological and chemical characters proved useful in resolving phylogeny the results were not strongly supported by a bootstrap test and hence should be interpreted with caution. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

BUNGARTZ, FRANK

Charles Darwin Research Station, Isla Santa Cruz, Galapagos; Postal Address: Charles Darwin Foundation, Av. 6 de Diciembre N 36-109 y Pasaje California, Post Box 17-01-3891, Quito, Ecuador

The Galapagos Lichen Flora – towards a total species inventory

The Galápagos Archipelago is a small volcanic island group of oceanic origin, located on the equator ca. 1000 km off the coast of mainland Ecuador. Within the Pacific Dry Zone this tropical archipelago can be characterized by an unusually arid climate.

Nevertheless, on islands reaching altitudes of more than 800 m the arid lowland vegetation gives way to cloud forest of the humid highlands. As a consequence, the archipelago supports a highly diverse lichen flora despite its strong isolation. No recent inventory has been undertaken since Weber's first checklists in the 1980s. Updates so far resulted only in nomenclatural changes and few additional identifications. In 2006 the Charles Darwin Research Station initiated a new comprehensive inventory; to date more than 9,000 specimens have been collected on 14 different islands. For several species groups new accounts have been published. Thus, in the Roccellaceae, more than half of the species were previously unknown. In the Collemataceae the majority of species was also unknown. In the genus *Ramalina* four new species have been published and numerous species are new records to Galapagos. The majority of species in the Graphidaceae was previously unknown; this is also the case in Lecanoraceae, Physciaceae, Opegraphaceae, and Arthoniaceae. Identification of this material is in progress and it is estimated that the islands support between 500-600 species. This means that least an additional 300 species have to be added to Weber's original list. The majority of new records to Galapagos are also additions to the flora of Ecuador, and several are new to South America. (*Symposium*: Tropical Lichens and Bryophytes)

***BUNGARTZ, FRANK** and **NUGRA-SALAZAR, FREDY IVÁN**

Charles Darwin Research Station, Isla Santa Cruz, Galapagos; Postal Address: Charles Darwin Foundation, Av. 6 de Diciembre N 36-109 y Pasaje California, Post Box 17-01-3891, Quito, Ecuador

"Invasive" or "in phases" – how is the Galapagos lichen flora changing?

The Galapagos archipelago is renowned for its unique biodiversity with high rates of endemism, species that evolved in isolation from continental South America. This isolation is today no longer intact. Tourism attracts more than 150,000 visitors annually. Introduced plant species are twice as numerous as native ones. Many newcomers are aggressive invaders, altering native vegetation dynamics; a major cause for extinction of native species. Little is known if similar processes can be observed in lichens. The historic record, which species could be considered native, is scant. Rates of endemism are generally much lower than in vascular plants, probably caused by more effective long-distance dispersal of lichen propagules. Finally, intentional introduction of lichens is highly improbable. Thus it could be argued that anthropogenic introduction of lichens will be extremely rare. Substrate affinity could present some indirect support for this hypothesis: We examined epiphytic lichens on both endemic/native and introduced/invasive trees to understand if epiphytes show particular preferences for either substrate. Preliminary studies are still inconclusive. Multivariate analysis of lichen communities on two native and two introduced trees revealed the following groups: (1) epiphytes with strong affinities to introduced, rough-barked *Cinchona pubescens*, (2) a suite of species typical for native, rough-barked *Scalesia pedunculata*, and (3) a third group with preference for smoothed-barked trees irrespectively of the status of their substrate, i.e., the same lichens were found associated with both native *Psidium galapagaeium* and introduced *Psidium guava*. This suggest that epiphytes show strong preferences for particular trees and affinities are possibly better explained by factors like bark structure and pH than introduced vs. native status of their substrate. With new introduced tree species becoming available for colonization, lichens with particular substrate preferences may follow, but not necessarily invade and alter existing communities. (Poster: Ecology, Thursday in Nautilus)

***CÁCERES, MARCELA** and **OLIVEIRA, JULIANA**

Universidade Federal de Pernambuco, Centro de Ciências Biológicas, Departamento de Micologia, Av. Prof. Nelson Chaves, s/n, Cidade Universitária, 50670-420, Recife, PE, Brasil.

Corticolous microlichens from the Caatinga, the unique Brazilian semiarid vegetation

An introduction to the corticolous crustose lichenized fungi from the Caatinga biome is presented, with a total of 90 species, represented mostly by the Lecanoromycetidae (Lecanorales:Lecanoraceae; Teloschistales: Physciaceae) and Pertusariales (Pertusariaceae), the predominant subclasses, orders and families found in this vegetation. The Caatinga domain occupies an area of 734.478 km^2 (7% of the Brazilian territory), representing a unique and exclusively Brazilian biome located at the country's Northeast Region, not found in any other part of the globe. The name Caatinga, in the language of the Brazilian native inhabitants, means "white forest", referring to the general appearance of the dry and almost desert- like vegetation of this biome, with the pale stems of the trees and herbs, shedding leaves once a year during the dry season. Only recently detailed inventories have been published about the lichenized mycota from a few Caatinga localities, now including the Catimbau National Park (800–1000 m altitude), presented here. (Poster: Biogeography and Floristics, Monday in Nautilus)

***CAMPBELL, JOCELYN[1], BRADFIELD, GARY E.[2], PRESCOTT, CINDY E.[2]** and **FREDEEN, ARTHUR L.[3].**

[1]Faculty of Forestry, University of British Columbia, Vancouver, BC. V6T 1Z4
[2]Department of Botany, University of British Columbia, Vancouver, BC. V6T 1Z4

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Poplar Trees as Facilitators of Epiphytic Cyanolichen Communities

Most epiphytic cyanolichens are adapted to a relatively narrow range of ecological conditions and depend on old-growth forests and humid climates to flourish. However, there are distributional patterns within individual old-forest stands that are apparently not explicable in terms of stand age or moisture. We demonstrate here that epiphytic cyanolichen communities are more diverse and abundant on saplings occurring beneath poplar trees than beneath birch, interior hybrid spruce, subalpine fir or Douglas-fir. These poplar-cyanolichen associations were consistently observed at 9 sites spread across a relative precipitation gradient from very wet to moist sub-boreal spruce forests in central British Columbia. A non-metric multidimensional scaling (NMS) ordination revealed a clear separation between lichens occurring under poplar as opposed to all other tree species. None of the measured environmental variables appeared to be well correlated indicating that patterns are cannot be explained by factors such as light availability, relative humidity or soil pH. (*Symposium*: Community Structure and Dynamics)

***CANEZ, LUCIANA** and **MARCELLI, MARCELO PINTO**

Instituto de Botânica, Seção de Micologia e Liquenologia, Avenida Miguel Estéfano, 3687, Água Funda, São Paulo/SP, 04301-902, Brazil

***Punctelia borreri* (Sm.) Krog (Parmeliaceae) and its synonyms**

Lichen [P.] borreri was described in 1807 based on English material is characterized by producing soredia, medulla C+, and black lower surface. Several similar species from different parts of the world were described and synonymized to it, which became cosmopolitan. However, the types of *P. borreri* and its synonyms are different in soredia kind and developing. The holotype of *P. borreri* (BM!) has round to orbicular soralia with corticated caduceus granules. *Parmelia aleuriza* Vain. *ex* Lynge (TUR!) from South Africa and *P. rudecta* f. *albida* Zahlb. (W!) from Hawaii have both marginal and laminal soralia commonly forming isidioid structures. *P. borrerioides* Nyl. (H!) from Bolivia has confluent marginal capitate soralia. *P. insignata* Stizenb. (ZT!) from Africa has soralia forming almost true isidia, soredia and corticated granules. *P. subaequans* Nyl. (H!) from Africa has rare soralia that sometimes seem to be originated from opening of the margin. Possibly *P. borreri* has a more restricted distribution and some of its synonyms are good species. (Supported by FAPESP, 04/12192-2). (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

CANNONE, NICOLETTA[1], FAVERO-LONGO, SERGIO ENRICO[2], GUGLIELMIN, MAURO[3], and ***PIERVITTORI, ROSANNA[2]**

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[2]University of Torino, Department of Plant Biology and Centre of Excellence for Plant and Microbial Biosensing, Viale Mattioli 25, Torino 10125, Italy; [3]University of Insubria, Department of Structural and Functional Biology, Via Dunant 3, Varese 21100, Italy

Lichen colonization of weathering landforms in continental Antarctica

Tafoni and weathering pits are common weathering landforms of continental Antarctica. On Mount Keinath (74°34'S/163°57'E), we examined lichens on the inner and the outer roofs of a tafone and inside an overlying weathering pit. Colonization is concentrated on the outer roof of the tafone, where *Lecidea cancriformis* shows casmoendolithic growth down to 9 mm. Confocal laser scanning microscopy shows that its algal layer is scattered at about 1.5 mm in depth and particularly localized below quartz grains. Where the photobiont is absent, the thalli show a brownish upper layer, probably melanin according to Raman spectroscopy. A surface reddish weathering rind, due to a hematite deposit, characterizes the outer roof and extends in depth as far as the hyphal penetration component (stained by PAS), being prominent where thallus contacts biotite crystals. The inner roof and the bottom of the weathering pit do not show neither lichen colonization nor reddish weathering rind. (Poster: Ecology, Thursday in Nautilus)

***CARDINALE, MASSIMILIANO[1], VIEIRA DE CASTRO JUNIOR, JOÃO[1], MÜLLER, HENRY[1], BERG, GABRIELE[1]** and **GRUBE, MARTIN[2]**

[1]Graz University of Technology, Department of Environmental Biotechnology, Petersgasse 12, A-8010 Graz, Austria; **[2]** Karl-Franzens University Graz, Institute for Plant Sciences, Holteigasse 6, A-8010 Graz, Austria.

***In situ* analysis of lichen-associated bacterial communities**

We analyzed bacterial communities associated with lichen species *in situ* by general DNA staining and hybridization coupled with confocal laser scanning microscopy (CLSM). With fluorescent probes targeting major bacterial groups we demonstrate high abundance of bacteria (up to 10^8 cell $gram^{-1}$ lichen thallus) in all analyzed lichens and the dominance of *Alphaproteobacteria*. The different lichen structures are colonized to different extents and patterns of colonization are clearly variable among species. About 200 pure bacterial cultures were isolated, identified and metabolically characterized. About 15% of the isolates are able to grow in absence of essential nutrients, and to produce some biotechnologically interesting enzymes. There is no correspondence between the taxonomic structure of the cultivable community and the total *in situ*-analyzed community. Our data indicate that the majority of the bacterial population in lichens belongs to species not yet cultivated. We suppose that these bacteria require the symbiotic structure of lichens for growth. (*Symposium*: Endolichenic Fungi & Bacteria: Implications for Symbioses)

CARL-RUPRECHT, ULRIKE[1], LUMBSCH, H. THORSTEN[2], BRUNAUER, GEORG[1], HAGER, ARMIN[1], HOCHSCHARTNER, GERALD[3], GREEN, T. G. ALLAN[4], and **TÜRK, ROMAN[1]**

[1]Department of Organismic Biology, University of Salzburg, Hellbrunnerstr. 34, 5020 Salzburg, Austria; [2]Department of Botany, The Field Museum, 1400 S, Lake Shore Drive, Chicago, IL 60605, USA; [3]University of St Andrews, School of Biology, Harold Mitchell Building, St Andrews, KY16 9TH, UK; [4]Biological Sciences, Waikato University, Hamilton, New Zealand

Diversity of crustose lichens in continental Antarctica: Morphological and molecular studies on the genus *Lecidea* (Lecideaceae, Ascomycota) from Ross Sea region

Saxicolous lecideoid lichens are rich in species, but only a few are known to occur in continental Antarctica. Because of the high variability in thallus morphology, such species have often been falsely classified based on the variations. In the current study we recorded the diversity of lichen species along a north to south transect at ecologically different locations in continental Antarctica. More than 200 specimens were collected and classified to 17 species using microscopic, chemical and molecular (ITS-region) methods. Included in this total were species from *Lecidea, Lecidella* and other *Lecanoraceae*. Specimens of the genus *Lecidea* (105 specimens) were found in all regions except Mt. Kyffin. Phylogenetic analyses assigned these to four major groups, compared with closely related species worldwide. Some of the molecular clades are supported by morphological and chemical characters, while others cannot be distinguished morphologically and may represent cryptic species. The diversity of *Lecidea* species in continental Antarctica is shown to be higher than previously thought.. (*Symposium*: Roots, trunks, branches and leaves: Systematics and Phylogenetics)

CATALÁ, MYRIAM[1], GARCÍA-BREIJO, F.[2-3], GASULLA, FRANCISCO[2], GUÉRA, ALFREDO[2-4], PRADA, ANA[1], REIG-ARMIÑANA, JOSÉ[2] and ***BARRENO, EVA[2]**

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Nitric oxide protection against oxidative stress during rehydration of *Ramalina farinacea* (L.) Ach.

Air pollution impacts have dramatically decreased lichen diversity. The real causes underlying this sensitivity are poorly known, hindering the prevention of biodiversity decay. Nitric oxide (NO) is a bioactive gas involved in stress signalling and free radical (ROS) defence, being also actor in the complex atmospheric pollution chemistry. NO production in lichens has been recently demonstrated during rehydration. Our aim was to analyze the role of NO as antioxidant defence in lichens. In *Ramalina farinacea*, we have visualised NO and ROS with fluorophores *in vivo*, quantified NO endproducts and lipid peroxidation during rehydration, finding a significant role of NO in oxidative stress regulation. Photosynthesis studies point to a role for NO in the stabilization of photosystem II. We conclude that NO has a pivotal role in antioxidant defence. The high reactivity of this gas could constitute the background of the sensitivity of lichens to air pollutants. (*Symposium*: Air Pollution)

CHABANENKO, SVETLANA

Sakhalin Botanical Garden Far Eastern Branch Russian Academy of Science, Gorky st., 25, Yuzhno-Sakhalinsk 693023, Russia.

Lichens of oak forests of the Russian Far East

Lichens of oak forests are presented by 339 species. The basis of oak forests of the south of the Far East is made by 2 families: Parmeliaceae (15 genera, 50 species) and Physciaceae (8 genera, 54 species). Physciaceae it is characteristic for xeromorphic

type of the oak forests located on southern and southwest slopes and also for the oak forests of the rarefied type generated *Quercus dentata*. Parmeliaceae are characteristic for mesophytic oak forests where as accompanying breeds are *Tilia, Fraxinus, Acer* and conifers trees. The great phytocenotic activity here are shown with species of a genera *Parmelia*. From 15 genera of family Parmeliaceae by the greatest number of species are presented genera *Cetrelia* and *Parmelia*. In structure of oak forests are noted also such nemoral genera as *Anzia, Myelochroa, Parmotrema, Rimelia, Hypotrachyna*. Here too there are such rare species as *Parmelia pseudolaevior, Cetreliopsis asahinae, Nephromopsis ornata, Usnea rubicunda* and others. (Poster: Biogeography and Floristics, Monday in Triton)

***CLERC, PHILIPPE** and **TRUONG, CAMILLE**

Conservatoire et Jardin botaniques de la Ville de Genève, case postale 60, CH-1292 Chambésy, Switzerland

The non-sorediate and non-isidiate *Parmelina* species in Switzerland - *P. atricha* (Nyl.) P. Clerc reinstated in the European lichen flora

The separation of the corticolous species *Parmelina quercina* (Willd.) Hale and *P. carporrhizans* (Tayl.) Poelt & Vezda is discussed. The presence of rhizines on the underside of the apothecia has been found to be a weak diagnostic character. Presence of maculae on the upper cortex and morphology of rhizines on the lower side of the thallus have been found to be of utmost importance in segregating those two taxa. *Parmelina quercina* has a non-maculated upper cortex and short rhizines, whereas *P. carporrhizans* has a maculated upper cortex and longer rhizines. *Parmelina atricha* (Nyl.) P. Clerc, a saxicolous species described from the Pyrenees, has been separated from the corticolous *P. quercina*. *Parmelina atricha* is exclusively saxicolous, lacks maculae and has lobules and long rhizines. A key for the European species of the genus *Parmelina* is presented. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

***CLERC, PHILIPPE** and **TRUONG, CAMILLE**

Conservatoire et Jardin botaniques de la Ville de Genève, case postale 60, CH-1292 Chambésy, Switzerland

Digital flora of the Swiss lichens : Interactive keys on a web-based access system

A checklist of the lichenized fungi of Switzerland was recently published (2004) but a lichen flora is still lacking for this country. In this project we propose to realize and manage a digital flora on a web-based access system, with interactive keys built in the Delta/Intkey environment. An electronic database of information about the ca. 1800 taxa of swiss lichens will be created and be accessible via the internet. The database will be used to provide full descriptions of species, regional synonyms, taxonomic notes, variability, information on related species, ecology, biogeography, distribution in Switzerland (distribution maps), conservation statuts in Switzerland and neighbouring countries, literature and access to images of swiss lichens. A pilot key has been realized with the genus *Parmelia* s. l., including 55 species or aggregates, each coded for 59 characters. This flora is planned to be used as a teaching source at all educational levels. (Poster: Biogeography and Floristics, Monday in Triton)

CORNEJO CAROLINA and **SCHEIDEGGER CHRISTOPH**

Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland

Out of East Asia: Regional genetic diversity differentiation of the epiphytic lichen *Lobaria retigera*

The distribution of *Lobaria retigera* ranges from Australia and Africa to Eastern Asia, and northward to Sakhalin and British Columbia. This taxon was long regarded as «species-pair» together with *L. kurokawae*, which is identical except that the latter never produces isidia. Based on morphological, chemical and phylogenetic analyses, this study shows that both forms are conspecific. In addition, evolutionary analysis of the character state «presence» or «absence» of isidia reveals different frequencies of apothecia; from isidiate morphs that rarely form apothecia to apotheciate morphs that produce no vegetative propagules. Split decomposition analysis of ITS nrRNA indicates (1) that the major genetic variability is found in Eastern Asia supporting the hypothesis of an East Asian origin of this taxon, and (2) that out of this region, several lineages have developed into regionally defined, genetically differentiated units, e.g. Sakhalin, British Columbia and Madagascar. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall))

COXSON, DARWYN* and **COYLE, MICHELLE**

University of Northern British Columbia, Ecosystem Science and Management Program, Prince George, B.C., V2N 4Z9. Canada

Niche partitioning in Alectoriod lichens: The role of physiological response patterns

An underlying assumption in many studies on lichen physiological response patterns is that patterns of net carbon assimilation reflect prior adaptation of photosynthetic and respiratory mechanisms to prevailing environmental conditions. Validation of this assumption, however, requires a differentiation between fundamental and realized niche space. We have made this assessment for Alectoriod lichens in subalpine forests in north-central British Columbia, using an empirical model of predicted net assimilation response, where laboratory derived photosynthetic and respiratory response patterns were integrated against canopy microclimate gradients measured over a two-year period. This modeling suggests that the realized niche in Alectoriod lichens can be quite different from that of their fundamental niche. We would hypothesis that periodic disturbance events largely determine the realized niche in these Alectoriod lichen communities from subalpine forests. Disturbance events such as windstorms or heavy snowpack occur stochastically through time and can have differential intensity at different heights within the canopy. Thus realized niche space is rarely stable. During periods between major disturbance events canopy lichen communities gradually occupy their full fundamental niche space. Storm events, however, abruptly reshape available niche space within the canopy, as reflecting in the vertical distribution and abundance of lichen communities. (*Symposium*: Functional Ecology)

CRUZ DE CARVALHO, R.[1]; MARQUES DA SILVA, J.[1], and ***BRANQUINHO, C.[2]**

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Desiccation caused respiratory burst upon rehydration in *Fontinalis antipyretica*

Although aquatic, the bryophyte *Fontinalis antipyretica* may be periodically affected by desiccation events namely during the dry season in Mediterranean areas. In order to study the effect of desiccation on this aquatic moss, some samples were dehydrated to different relative water contents and rehydrated by immersion on water. Conductivity measurements indicated membrane damage which increased with water deficit. Oxygen exchange measurements showed during rehydration a strong respiratory burst fully inhibited by the mitochondrial respiration inhibitor KCN. This burst showed to have a good correlation with conductivity. Gross photosynthesis decreased linearly with relative water content and also showed a good negative correlation with conductivity. Our data suggest different effects on photosynthesis and respiration due to membrane disruption resulting from desiccation. Some explanatory hypotheses are proposed and discussed. (Poster)

***DAL GRANDE, FRANCESCO[1], CORNEJO, CAROLINA[1], BECK, ANDREAS[2], WIDMER, IVO[1]** and **SCHEIDEGGER, CHRISTOPH[1]**

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Photobiont selectivity and diversity in *Lobaria pulmonaria* (L.) Hoffm

The foliose tripartite lichen *Lobaria pulmonaria* is an important model species for biological conservation studies of epiphytic lichens because of its wide geographical distribution and its value as a bioindicator. Despite the amount of available biological information for the mycobiont, the genetic diversity and evolutionary role of its green algal partner is still very much *terra incognita*. The aims of the present work are: i) to assess the degree of selectivity of *L. pulmonaria* towards its phycobiont; ii) to shed more light on the phylogeographic framework of this algal species. Phylogenetic analyses on multi-locus sequence data (18S, rbcL, ITS, actin intron type I) from a worldwide collection of thalli reveal *L. pulmonaria* to be highly selective for its phycobiont. In contrast, the specificity of the symbiosis is rather low, with several species of the genera *Lobaria* and *Sticta* specialized on the same alga. Furthermore, our data show a well-supported phylogeographic structure and lead to the hypothesis of an East Asian hotspot of this algal taxon. (*Symposium*: Selectivity in the Lichen Symbiosis)

***DE LOS RÍOS, ASUNCION [1], WIERZCHOS, JACEK[2], SANCHO, LEOPOLDO G.[3], GRUBE, MARTIN[4]** and **ASCASO, CARMEN[1]**

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Lithobiontic microbial ecosystems in continental Antarctica

The lithic substrate is being increasingly viewed as an important part of the biosphere, especially in areas of extreme climate such as continental Antarctica, where lithobiontic communities (those colonizing rocks) are the predominant terrestrial forms of life. To analyse these microbial ecosystems and address the complex processes that take place within them, their components need to be first identified. Once the biological components of the ecosystem are known, we can then go on to explore their functional relationships and interactions with the rock substrate that shelters them. To properly characterize these different features, we used a combination of molecular and microscopy tools. Strategies common to all the microbial components of ecosystems from different areas of continental Antarctica include the formation of endolithic biofilms and biogeophysical and biogeochemical interactions with the rock substrate. The predominant biological components identified were chasmoendolithic and cryptoendolithic lichen thalli, along with free-living endolithic cyanobacteria. (*Symposium*: Lichens in Polar Ecosystems)

DEL CAMPO, EVA M[1], CASANO, LEONARDO, M[1], GASULLA, F[2] and ***BARRENO, EVA[2]**

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Nature and distribution of HEGs in the chloroplast genome of Trebouxoids

Homing endonucleases (HEs), which catalyze the lateral transfer of intervening sequences to a new target gene, are located in introns, inteins and free standing ORFs. Information about HEs within lichen-forming phycobionts is scarce. Consequently we started studying the nature and distribution of HEGs in the chloroplast genome of some Trebouxoids. Sequencing of the 23S rDNA gene from five *Trebouxia* species revealed the existence of ten group I introns. Fifty percent of these introns encode putative LAGLIDADG HEs. Some of these HEs have homologies with distantly related organisms including prokaryotes, fungi mitochondria and green algae chloroplasts. Unexpectedly, portions of two of these HE proteins show similarities with land plant nucleus-encoded hypothetical proteins, which have both a pentatricopeptide (PPR) repeated motif and a LAGLIDADG-like motif. We propose symbiogenetic lichen thalli as a scenario for HE-mediated horizontal transfer of genetic material among phylogenetically distant organisms and a possible source of PPR proteins. (*Symposium*: Selectivity in the Lichen Symbiosis)

DEL CAMPO, EVA M.[1], GIMENO, JACINTA[2], CASANO, LEONARDO M[1], GASULLA, FRANCISCO[2], GARCÍA-BREIJO, FRANCISCO[2-3], REIG-ARMIÑANA, JOSÉ[2] and ***BARRENO, EVA[2]**

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Spanish populations of *Ramalina farinacea* share three different *Trebouxia* photobionts

Nowadays, little is known about the population structure of lichen photobionts. Thereby, we analyzed the nature and distribution of phycobionts in different Spanish populations of *Ramalina farinacea*. We isolated and identified three different *Trebouxia* photobionts on the basis of anatomical and chloroplast LSU rDNA sequence studies. Interestingly, most of the thalli contained the three photobionts. To search for possible genetic variability among these photobionts, we also compared ITS nuclear rDNA sequences. Surprisingly, only one ITS sequence was found in each thallus, even in those exhibiting multiple photobionts. Therefore, ITS sequence analyses are probably only indicative of the predominant photobiont while others go unnoticed. In this line, one photobiont seems predominant in the Canary Islands populations while the other two ones predominate in peninsular ones. Additionally, here we propose a possible DNA barcode based on the plastid LSU rDNA which may provide rapid identification of co-existing photobionts within the same thallus. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

***DEL-PRADO, RUTH[1], LUMBSCH, H. THORSTEN[2], DIVAKAR, PRADEEP K.[1], BLANCO, OSCAR[1], MOLINA, CARMEN[3], AMO DE PAZ, GUILLERMO[1],** and **CRESPO, ANA[1]**

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Genetic diversity within and among species and genera in Parmeliaceae

The intra- and interspecific distances, and the intra- and intergeneric distances of ITS rDNA sequences were studied in different monophyletic clades of parmelioid lichens (Parmeliaceae). Seven major monophyletic groups within parmelioid lichens group were found in previous studies. Here we compare the distances within these clades, since previously notable different branch

lengths between these clades were found. We calculated distances from maximum-likelihood phylogenetic trees using the HKY+Gamma substitution model. To accommodate for differences that may exist between specimens form widely distant areas, a minimum of 10 sequences from different localities was included in the study. The study addresses the issue of homogeneity or inequality of genetic variability within and among major clades in parmelioid lichens. The results contribute additional information about the current concept of genus and species in parmelioid lichens (a highly controversial matter), but also to identify cases of excessive lumping or splitting in taxa arrangement. (*Symposium*: Between Individuals and Species: The Genetics of Populations)

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Air quality biomonitoring with lichens-Tongass National Forest, Alaska Region

To assess status and trends in air quality in Tongass National Forest, bio-monitoring sites were established in 1987-2005. Provisional thresholds for S, N, Al, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, Si, Sr, Ti, V and Zn were determined for the epiphytic macrolichens *Alectoria sarmentosa*, *Hypogymnia enteromorpha*, *Lobaria oregana* and *Platismatia glauca*. No significant relationships between element concentrations in lichens and other physiographic characteristics were observed. Elemental concentrations were above threshold in the vicinity of mining and urban areas in S, N, Cd, Cr, Cu, Fe, Ni, P, Pb, and Zn. Some lichens near marine beaches may be enhanced in S and N due to the use of adjacent bays as popular marine vessel anchorages. Enhanced element concentrations provide evidence of the assimilation of localized anthropogenic airborne pollutants by the environment in this temperate rainforest ecosystem. (Poster: Environmental Monitoring, Friday in Merrill Hall)

***DIVAKAR, PRADEEP K.[1], CRESPO, ANA[1], KAUFF, FRANK[2], DEL PRADO, RUTH[1], PEREZ-ORTEGA, SERGIO[1], AMO DE PAZ, GUILLERMO[1], FERENCOVA, ZUZANA[1], BLANCO, OSCAR[1], ARGUELLO, ARTURO[1], MILLANES, ANA[3], MOLINA, M. CARMEN[3], NORMORE, M.P.[4], WEDIN, MATS[5], APTROOT, ANDRE[6], BUNGARTZ, FRANK[7], CALVELO, SUSANA[8], CANDAN, MEHMET[9], COLE, MARIETTE[10], ELIX, JONH A.[11], ERTZ, DAMIEN[12], GOFFINET, BERNARD[13], KNIGHT, ALLISON[14], LENDEMER, JAMES[15], LINDBLOM, LOUISE[16], LUECKING, ROBERT[17], LUTZONI, FRANCOIS[18], MATTSSON, JAN-ERIC[19], MESSUTI, M. INÉS[20], PERLMUTTER, GARY[21], RICO, VICTOR J.[1], SPRIBILLE, TOBY[22], STEFFEN, U. PAULS[23], SWEAT, K.[24], THELL, ARNE[25], THOR, GÖRAN[26], URBANAVICHUS, GENADII[27],** and **LUMBSCH, H.THORSTEN[17]**

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New systematics and generic circumscription of parmelioid lichens inferred from multigene analysis provided by PARSYS-08

The generic concept in Parmeliaceae has been widely discussed and different opinions have been expressed in the literature resulting in widely differing generic classifications. Within the last decade, molecular data have been gathered in numerous studies and revealed that while some of the morphologically based genera were monophyletic, others were not. Parmelioid lichens include a large number of species with a worldwide distribution and the sheer number of species makes it advisable that different research groups join forces in the study of the phylogeny of these lichens. The goals of PARSYS project are to perform an analysis of all available DNA sequence data (from Genbank and newly submitted from several research groups) to address a long-standing issue of lichen taxonomy. Based on a multi-gene phylogeny, a new revised generic concept of parmelioid lichens will be proposed. Genetic markers included in the study comprise nuclear ribosomal regions, such as nuSSU, ITS and nuLSU rDNA, mitochondral SSU rDNA, and RPB1. Single-gene and combined data sets were analyzed using maximum parsimony, maximum likelihood, and Bayesian methods. (*Symposium*: Parmeliaceae: Development of a New Systematics)

DOMASCHKE, STEPHANIE[1], MARTÍNEZ, MARÍA PAZ[2], GARCIA, MIGUEL ÁNGEL[2] and **PRINTZEN, CHRISTIAN[1]**

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Genetic variability in photobiont populations of the bipolar lichen *Cetraria aculeata*

The fruticose lichen *Cetraria aculeata* is widely distributed in both hemispheres and displays a huge ecological amplitude. It occurs from alpine and arctic environments to dry grasslands in temperate and mediterranean regions. Based on DNA-sequences, we investigate the genetic diversity and structure of Antarctic populations of trebouxioid lichen photobionts and compare them with populations from South America, Europe and Asia. We are especially interested in how strongly Antarctic populations of *C. aculeata* select for certain photobiont strains and whether Antarctic photobiont populations are genetically isolated from those of other continents. First results from ITS-sequences show low within-population variability and high differentiation among localities. This may indicate either clonal propagation at the local scale and long-standing genetic isolation of geographically isolated populations or association of mycobionts with locally adapted photobionts. More data, especially from arctic populations, are necessary to solve this question. (Poster: Symbiosis, Wednesday in Triton)

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Lichen photobiont diversity under changing pollution regimes

Lichen floras in urban areas have changed with changing air quality - less acidophytes, more nitrophytes. The general assumption that sensitivity to environmental stress is determined by the photobiont is examined using London's lichens as an example. Are specific photobionts associated with lichens recorded under different atmospheric regimes? ITS rDNA data generated directly from thalli with specific primers facilitate naming photobionts without culturing. Thus, green algal sequences from mostly foliose lichens generated by us and information available in GenBank are used to assess correlation between lichens abundant under contemporary conditions and their photobionts on the one side and lichens occurring under acidic conditions (1960-70s) and their photobionts on the other side. Mycobiont sequence data were obtained simultaneously, and advantages and limitations of such a 'DNA barcoding' approach to investigate lichen and photobiont diversity will be discussed. (*Symposium*: Selectivity in the Lichen Symbiosis)

DUCKETT, JEFFREY G

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The Origins and Evolution of Land Plant Symbioses

Recent molecular, cytological and palaeobotanical data now provide the basis for a comprehensive synthesis of the evolutionary history of land plant-fungal symbioses. Highly differentiated associations in paleozoic fossils, where fungi are both inter- and intracellular, mirror glomeromycote symbioses in /Haplomitrium/ and /Treubia,/ the earliest lineage in liverworts. These primitive relationships were replaced by glomeromycote associations that are widespread today in thalloid liverworts, lycophytes and ferns. Identification of the same fungi in all these groups suggests frequent host swapping. Subsequently two clades of liverworts, the leafies and Metzgeriidae II, lost glomeromycotes only to acquire ascomycetous or basidiomycetous mycobionts.

The former are restricted to the rhizoids and all contain /Rhizoscyphus ericae/, the common fungus in ericalean mycorrhizas. Dating of leafy liverwort phylogeny suggests that these liverwort associations long predated those in the Ericales. The basidiomycete associations are probably more recent and involve the Tulasnellales in the Aneuraceae and Sebacinaceae in leafy liverworts. Failure to regain endophytes in some liverwort lineages is almost certainly related to epiphytism as is absence of mycobionts from most ferns. Pteridophytes, having lost glomeromycotes, never reacquired other fungal associates. Whereas the land plant-fungal symbioses are characteristic of nutrient-poor soils rich in organic matter, lichens thrive on a much wider range of substrates including bare rocks and bark. (*Symposium*: Endolichenic Fungi & Bacteria: Implications for Symbioses)

DYMYTROVA, LYUDMYLA

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Epiphytic lichens and bryophytes as indicator of air pollution in Kyiv city (Ukraine)

Kyiv city is the biggest industrial and transport centre and the capital of Ukraine. Totally 67 lichen and 20 bryophyte species were found. According to 6 different modifications of the IAP four zones of different air pollution were described. The indicator species of heavy (*Phaeophyscia orbicularis, Xanthoria parietina, Physcia adscendens*), moderate (*Parmelia sulcata*), slightly polluted (*Hypogymnia physodes, Evernia prunastri*) and unpolluted zones (*Pseudevernia furfuracea, Usnea hirta, Ramalina pollinaria*) were proposed. It was established that distribution of bryophytes did not correlate with air pollution in Kyiv and defined a presence of old trees and large parks. In a built-up area only 5 epiphytic bryophytes (*Orthotrichum pumilum, Pylaisia polyantha, Leskea polycarpa, Bryum argenteum, Ceratodon purpureus*) were found. Furthermore, it was established that Kyiv is the most polluted Ukrainian cities, where lichen indication mapping was carried out. The air pollution in Kyiv is caused by factories (especially power and construction industries) and exhaust fumes of cars. The essential distinctions of air quality in different area of Kyiv are caused by the different location and the specialization of factories, main road position and the direction of prevailing winds. (Poster: Ecological Monitoring, Friday in Merrill Hall)

EDWARDS, BRYAN[1] and ***WOLSELEY, PAT[2]**

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Progress and problems with lichen conservation in Europe

Since biodiversity was targeted in Europe through Natura 2000, many regional and country red lists for very different sized areas have been drawn up, some of these red lists including a large percentage of the total flora (e.g. Netherlands). The Important Plant Areas (IPA's) in Europe are defined within 11 biogeographical zones which are not necessarily associated with national borders. This necessitates a structural change in gathering information for each zone, and in defining threatened species, endemics and species of international importance in Europe according to the IUCN guidelines. This is especially important as threatened species are the first criterion on which IPAs are selected. Are these definitions compatible with lichens and with the larger biogeographical zones? If we can accomplish this for Europe it will become a test case for lichens in other geographical regions across the world. (Conservation Discussion Section)

***ERTZ, DAMIEN[1], MIADLIKOWSKA, JOLANTA[2], LUTZONI, FRANÇOIS [2] and DIEDERICH, PAUL[3]**

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A Three-Gene Phylogeny of the Order Arthoniales

A phylogenetic study of the order Arthoniales is presented here based on the nuclear ribosomal large subunit (nucLSU), the mitochondrial ribosomal small subunit (mitSSU) and the second largest subunit of RNA polymerase II (*RPB*2). These genes were sequenced from 43 collections or culture isolates representing 35 species from this order and including for the first time a large number of crustose species. Our study revealed that morphological characters traditionally used to circumscribe genera within the Arthoniales, such as exciple carbonization and ascomatal structure led to the establishment of non-monophyletic genera and families. Species previously recognized as *Opegrapha* were found to be distributed across all main monophyletic groups of the Arthoniales. The inclusion of *Opegrapha atra* and *O. calcarea* within *Arthonia* would allow recognizing the family Arthoniaceae as monophyletic. The following new combinations are proposed: *Arthonia calcarea* (basion. *Opegrapha calcarea*) and *Opegrapha anguinella* (*Stigmatidium anguinellum*). (Poster Taxonomy and Systematics, Wednesday in Nautilus)

FARKAS, EDIT

Institute of Ecology and Botany, Hungarian Academy of Sciences, H-2163 Vácrátót, Hungary.

Contributions to the foliicolous lichen flora of the Fiji Islands

Nine species of foliicolous lichens have been known from the Fiji Islands since 1860. Recent records come from the collections of G. Thor from 1985 and T. Pócs from 2003. G. Thor visited lowland rainforests of Island Viti Levu, T. Pócs collected also in higher elevations (up to c. 1000 m) in submontane, montane and montane mossy (cloud) forests on Kadavu, Taveuni and Viti Levu Islands. These relatively small collections (of c. 300 and 150 leaves respectively) resulted in over 30 species new for the foliicolous lichen flora of the area. The most interesting records are presented in three groups: 1) Species with wider (pantropical, palaeotropical) distribution, *e.g.*, *Arthonia cyanea, Calenia thelotremella, Coenogonium subluteum, Eremothecella macrocephala, Mazosia phyllosema, Tapellaria nigrata*, 2) Species described from other areas, *e.g. Badimia elixii, Coenogonium usambarense*, and 3) Some taxa of Asterothyriaceae, Ectolechiaceae, Trichotheliaceae new for science. The work was supported by the Hungarian Scientific Research Fund (OTKA T047160) (Poster: Biogeography and Floristics, Monday in Nautilus)

FAVERO-LONGO, SERGIO E. [1], **GAZZANO, CLAUDIA**[1], **CARBONE, FRANCESCO** [2], **BAIOCCHI, CLAUDIO**[2], **TRETIACH, MAURO**[3] and **PIERVITTORI, ROSANNA** [1]

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Siderophore-like chelants act as "calciophores" in endolithic lichens

The biogeochemical process driving the penetration and pitting effect of eukaryotic euendoliths in carbonatic substrata is totally unknown. Here we show that mycobionts of the calcicolous euendolithic lichens *Bagliettoa marmorea*, *B. baldensis* (Verrucariales) and *Acrocordia conoidea* (Pyrenulales) secrete siderophore-like chelants, first reported for lichen-forming fungi. Three low-mass compounds compatible with siderophore hydroxamates were shown to chelate both iron and calcium by HPLC-mass on *B. marmorea* cultures. Under high calcium:iron concentration ratio, calcium strongly competed with iron for complexation and high amounts of Ca-complexes were detected. Such finding indicates that siderophores, previously considered for iron nutrition and dissolution of iron minerals only, in iron-poor, calcium-rich substrates, as calcareous rocks, may act differently, promoting dissolution by scavenging calcium. Accordingly, limestone dissolution increased upon 24 hrs incubation with the siderophore desferrioxamine. These results account for a siderophore-driven dissolution of calcareous substrates by euendoliths, highlighting a new ecological role as "calciophores" for siderophore-like compounds. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

FEDORENKO, N.M.[1], **STENROOS, S.**[2], **THELL, A.**[3], **KÄRNEFELT, I.**[3] and **KONDRATYUK, S.**[1]

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A phylogenetic analysis of xanthorioid lichens (Teloschistaceae, Ascomycota) based on ITS and mt SSU sequences

A phylogenetic analysis based on ITS and mtSSU sequences for the lichen family Teloschistaceae, focussed on xanthorioid lichens, was performed. The data set included 140 specimens of 59 species, representing most genera and species groups of xanthorioid lichens, which resulted in 183 new sequences. Five well-supported main groups were recognized in the parsimony analysis: 1) the *Teloschistes villosus* group, 2) the *Xanthoria-Xanthodactylon* group, 3) the *Xanthoria candelaria* group, 4) the *Xanthoria elegans* group, and 5) the *Xanthomendoza* group, In addition, two of the five groups included seven well-supported subgroups: 2a) the *Xanthoria parietina* group, 2b) the *X. elixii* group, 2c) the *Xanthodactylon flammeum* group, 5a) the *Xanthomendoza alfredii* group, 5b) the *X. novozelandica* group, 5c) the *X. mendozae* group, and 5d) the *X. poeltii* group. The groups are described, and alternative ways to treat the taxonomy of xanthorioid lichens, based on the presented phylogeny, are discussed. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

FERNÁNDEZ, SAMANTHA and **LLIMONA, XAVIER**

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Lichens from the Cap de Creus Natural Park (Spain)

The Cap de Creus Peninsula is the easterly part of the Axial Zone of the Pyrenees, which geology is formed by Hercynian basement rocks (sedimentary rocks, gneiss series and Hercynian granitoids). This area hosts diverse saxicolous and terricolous lichen communities. We have identified 115 species of lichens inside 60 genera and 15 lichenicolous fungi using morphological and chemical techniques. An annotated list of the lichen and lichenicolous fungi species is included and interesting species like *Arthonia molendoi*, *Caloplaca aegaea*, *C. furax*, *C. inconnexa*. var. *nesodes*, *Cercidospora caudata*, *Epiphloea terrena*, *Gyalideopsis athalloides*, *Psora gresinonis* or *Stigmidium squamariae* are highlighted. (Poster: Biogeography and Floristics, Monday in Nautilus)

***FERNÁNDEZ-MENDOZA, FERNANDO[2,3], FREGO, KATHERINE A.[1], BALAGUER, LUIS[4]** and **CRESPO, ANA[3]**

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Early estimates of edge size using chlorophyll fluorescence (Fv:Fm) measurements in *Parmelia sulcata* Taylor

In this study we used chlorophyll fluorescence to estimate the effective size of forest patches, in terms of penetration of microclimatic edge effects, during the early stages of postharvest recovery. Our goal is to offer a prompt estimate of edge size to be implemented in forest conservation planning. We pretend to complement ongoing long term monitoring projects on bryophyte and vascular plant communities developed by UNB and the Fundy Model Forest. Chlorophyll fluorescence techniques have long been used in lichens to study the effect on physiological performance of changed environmental conditions. Previous studies that dealt with forest edges were always laboratory or field-lab experiments that involved transplants. We used field measurements of predawn Fv:Fm as an indicator of the physiological response to the complex environmental gradients that occur at the forest-clearcut interface. As a result of the study we developed a model that incorporates fluorescence with forest structure, canopy cover and substrate variables to predict lichen responses. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

FERRARO, LIDIA ITATI

Instituto de Botánica del Nordeste, UNNE-CONICET. Cc. 209, 3400 Corrientes, Argentina

Biological and taxonomic studies of the Graphidaceae, lichenized mycobiota of the parks and reserves of northern Argentina

Northern Argentina includes various phytogeographic regions, in all of which it is possible to find Graphidaceae. There are two approaches to study the family: the classic, in which spore characteristics are given much value, and although this is still current, the tendency is to follow a modern approach, using the structure of the ascomata, characteristics of the exciple, hymenium, and spore reaction with iodine. The Catalog of Lichens of Argentina mentions the genera *Glyphis, Graphina* y *Graphis*, with a total of 17 species and 4 infraspecies. This contribution announces 12 genera with 40 species, 12 of which are new. This increase in the number of identified taxa constitutes a significant contribution to the knowledge of the family within Argentina. The genera best represented are *Graphis, Phaeographis*, and *Glyphis*, whereas *Acanthothecis*, *Anomomorpha*, *Diorygma*, *Hemithecium*, *Leiorreuma*, *Thalloloma*, *Sarcographa* and *Platygramme* are represented by a small number of species that had not been mention before for Argentina. (Poster: Biogeography and Floristics, Monday in Nautilus)

FERRARO, LIDIA ITATI and **ANDREA SILVIA MICHLIG**

Instituto de Botánica del Nordeste (UNNE-CONICET). Cc. 209, 3400 Corrientes, Argentina

Parmeliaceae (Lichenized Ascomycetes, Lecanorales) in Argentina.

The neotropical Parmeliaceae (lichen forming Ascomycota: Lecanorales) comprise 45 species in 10 genera: *Canomaculina*, *Canoparmelia*, *Bulbothrix*, *Hypotrachyna*, *Parmotrema*, *Parmelia*, *Punctelia*, *Pseudoparmelia*, *Rimelia* and *Xanthoparmelia*. Two taxa are described as new. Keys are provided for the species. Synonymy, typifications, descriptions, distribution maps, habitats and a selection of herbarium voucher specimens are given for each species. Most of the species are restricted to the NE of Argentina. (Poster: Biogeography and Floristics, Monday in Nautilus)

FEUERER, TASSILO

Hamburg, Germany

The calculation of global centers of endemics based on checklists data

"Checklists", an internet accessible data base, containing about 300.000 distributional records for more than 620 geopolitical units, has been used to calculate various characters of biodiversity. For the first time the number of species common to the different continents, the percentage of parasites, distribution types, the endemites, orphaned species and types per geopolitical unit are known exactly. Each geopolitical unit is characterized by an index of endemism, based on the number of species which are common to the specific unit and few additional units. (*Symposium*: Endemics, especially in California and Poster: Biogeography and Floristics, Monday in Merrill Hall)

***FIGUERAS, GEMMA** and **HLADUN, NESTOR L.**

Universitat de Barcelona, Departament de Biologia Vegetal (Botànica), Fac. de Biologia, 08028, Barcelona, Espanya.

The upper surface in *Physciaceae* family: more than a simple layer

The use of Scanning Electron Microscope (SEM) has been broadly used for several studies about cortical structures and surfaces of some lichens. This method has revealed morphological characteristics not detected before using light microscope, becoming a good tool in the study of lichens morphological structures. The *Physciaceae* family is a well studied group, and their cortical structures have turned out as an important attribute to establish a good classification of their genera. The surface features of six foliaceous genera (*Anaptychia, Heterodermia, Hyperphyscia, Phaeophyscia, Physcia* and *Physconia*) are shown and compared. (Poster: Symbiosis, Wednesday in Triton)

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Nitrogen stress induces metabolic variation in the reindeer lichen *Cladonia portentosa*

The deposition of atmospheric pollutants is recognized as a major driver of biodiversity change at mid to high latitudes. As lichens are well known as indicators of air quality, we investigated the effects of wet nitrogen deposition on the metabolic response of the reindeer lichen *Cladonia portentosa.* This was achieved by correlating spectral data obtained from Fourier-Transform Infrared (FT-IR) analysis with both measured and modelled wet nitrogen deposition and nitrogen concentration in precipitation using partial least squares regression analysis (PLS). The calculated models showed strong potential for detecting specific metabolic responses to N deposition gradients. Data confirming the metabolic responses of *C. portentosa* to N enrichment and identification of key biomarkers will be presented. Although FT-IR is an excellent tool for a broad metabolite analysis, more sensitive analytical techniques such as mass spectrometry are now required for the identification of key metabolites that respond to nitrogen load. (Poster: Ecology, Thursday in Nautilus

***FRITZ, ÖRJAN, CALDIZ, MAYRA,** and **BRUNET, JÖRG**

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Bark pH - a key factor for epiphytes on beech *Fagus sylvatica*

This study focuses on the importance of bark pH and bark characteristics to epiphytes on European beech. We examined 100 age-determined living beeches (58-277 yrs) in 15 beech-dominated stands in a forest landscape in southern Sweden. In total we recorded 118 species (75 lichens, 43 bryophytes) of which 33 were of conservation concern (20 red-listed and 13 indicator species). Bark pH (H_20), tree age and tree viability were the most important variables for species composition. Bark pH (min 4.93 - mean 6.04 – max 7.17) was negatively correlated with tree viability but uncorrelated with tree age or DBH. Species richness of lichens and bryophytes of conservation concern and of other bryophytes was positively related to pH, whereas richness of other lichens was independent of bark pH. The study emphasizes the importance of old damaged trees in conservation, as many species are associated to the relatively high bark pH of such trees. (*Symposium*: Community Structure and Dynamics)

GARTY, JACOB[1], LEHR, HAYA[1] and **GARTY-SPITZ, RACHEL LENA[2]**

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Temporal fluctuation of Ca, K, Mg, Na, P and Pb concentrations in the lichen *Ramalina lacera*: a retrospective study

Of six mineral elements detected in thalli of *R. lacera* from a forested rural site in NE Israel, Ca was found to accumulate in significant amounts in the years 1978-2002. The P content on the other hand decreased whereas the K content did not change significantly. The Mg and Na content measured between the years 1993 and 2002 did not show a clear pattern. The accumulation of Ca coincided with the significant increase of dust storms originating in the Sahara desert, in terms of dust- stormy days. The Pb content of *R. lacera* collected in the forest in the years 1974-2002 did not rise as expected along the years, despite the increase of vehicular density, due to the introduction of unleaded gasoline in September 1990. (*Symposium*: Nutrient Exchange in Lichens and Bryophytes)

***GASULLA, FRANCISCO[1], GUÉRA, ALFREDO[2], ZAPATA, JOSÉ MIGUEL[2], ESTEBAN-CARRASCO, ALBERTO[2]** and **BARRENO, EVA[1]**

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Responses of the lichen photobiont *Trebouxia erici* to desiccation and rehydration (I). Regulation of photosynthesis and antioxidant mechanisms

The response of the photobiont *Trebouxia erici* was studied during desiccation and recovery after slow (5 h) and rapid (<60 min) drying. Chlorophyll fluorescence, xanthophylls, superoxide dismutase and peroxidase activities, ascorbate, and integrity of cell membranes were analyzed. Slow dehydration allowed the recovery of higher values of PSII electron transport than in rapid-dried algae. The main component of NPQ after a slow dehydration was the energy dependent (q_E), meanwhile after a rapid dehydration is photoinhibition (q_I). Although NPQ seems to play a role during desiccation recovery, significant variations in the xanthophyll cycle components were not detected. Dehydration did not affect PSI functionality. The activity of antioxidant enzymes decreased during desiccation/rehydration. Desiccation tolerance of lichen phycobionts might be achieved by means of a constitutive cellular protection system, like the antioxidant system, coupled with induction of an unidentified recovery/repair mechanism since a minimal drying rate is required. (Poster: Symbiosis, Thursday in Triton)

***GASULLA, FRANCISCO[1], JAIN, RENUKA[2], THELEN, JAY[2], GUÉRA, ALFREDO[3], CAMPO, EVA M[3], BARRENO, EVA[1]** and **OLIVER, MEL J[4]**

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Responses of the lichen photobiont *Trebouxia erici* to desiccation and rehydration (II). Proteomics

Lichen desiccation tolerance is associated with cellular protection mechanisms directed against the oxidative stress produced during dehydration and/or rehydration, however, these mechanisms are not well understood. In other poikilohydric organisms changes in the synthesis of proteins have been implicated in recovery/repair mechanisms following rehydration. In this study we used an isolated strain of the desiccation-tolerant lichen phycobiont *Trebouxia erici* to analyse protein synthesis during dehydration and rehydration. We employed the strategy of 2-D Difference Gel Electrophoresis (DiGE) coupled with individual protein identification via trypsin digestion (from silver stained replicates) and LC-MS/MS. Two families of proteins increased in response to desiccation: heat shock proteins, HSP90s that act as chaperones in the non-covalent folding/unfolding of proteins and the assembly/disassembly of macromolecular structures; and β-tubulins, cytoskeleton proteins whose synthesis could be important in the recovery of the normal cellular organization upon rehydration. Surprisingly, we detected no change in antioxidant enzyme levels. (*Symposium*: Biochemistry and Physiology of Poikilohydry)

GAYA, ESTER[1]; BALL, BERNARD[1]; ROBBERTSE, BARBARA[2]; **SPATAFORA, JOSEPH[2];** and **LUTZONI, FRANÇOIS[1]**

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Selecting the next generation of genes for phylogenetic studies on lichen-forming fungi; Teloschistales as a case study

The order Teloschistales has been recently redelimited by Miadlikowska *et al.* (2006) to encompass two suborders: Physciineae (*Physciaceae*) and Teloschistineae (*Letrouitiaceae*, *Megalosporaceae*, and *Teloschistaceae*). In Gaya *et al.* (2008) we conducted the most exhaustive phylogenetic survey of species within the *Teloschistaceae* (the largest family within the Teloschistineae) by restricting the sequencing to ITS. This was the most logical alternative based on previous published studies (*e.g.*, Arup & Grube 1999, Gaya *et al*. 2003, Søchting & Lutzoni 2003). The expected consequence in adding more taxa without adding characters was the loss of significant support for deep internodes. In this context, more loci need to be sequenced to pursue further phylogenetic studies on the *Teloschistaceae* and the Teloschistales in general. Our current research seeks to assess the phylogenetic affiliations and composition of the redefined Teloschistales using a multi-gene approach and selecting the best loci developed as part of the AFTOL2 project, which main goal is to sequence 25 gene for 160 species across the Fungi. These 25 genes are selected among 71 putative orthologous single copy nuclear genes derived from all available fungal genomes that were sufficiently annotated by the end of 2007. Using the Teloschistales as a case study, this is the first time that this set of new genes are used to prove their utility at resolving phylogenetic relationships within an order of lichen-forming fungi. (*Symposium*: Roots, trunks, branches and leaves: Systematics and Phylogenetics)

GAZZANO, CLAUDIA, *FAVERO-LONGO, SERGIO ENRICO, MATTEUCCI, ENRICA, and **PIERVITTORI, ROSANNA**

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Image analysis for measuring lichen colonization of Cultural Heritages

A quantification of the biological presence in monumental areas is increasingly requested to envisage a sustainable preservation of both cultural and biodiversity heritages. We investigated the suitability of image analysis to quantify the lichen colonization on/in three lithic substrates, commonly found in the Cultural Heritage framework, namely marble, travertine and mortar. High resolution images (400 dpi) of monumental surfaces were acquired using a scanner Epson V10. Specific cover was measured as function of colour using the software WinCAM Pro 2007d (Regent's Instruments), thus avoiding invasive surveys. Furthermore, polished cross-sections were stained using the periodic acid-Schiff method to visualize the hyphal penetration component (HPC) of the most common lichen species. Images of the stained sections were elaborated by the same software to quantify the extension of the HPC within the rock. Different suitability of this approach to analyse colonization of the different substrata will be addressed. (Poster: Ecology, Thursday in Nautilus)

***GEISER, LINDA[1], SCHRLAU, JILL[2], GLAVICH, DOUGLAS[1], DILLMAN, KAREN[3], SIMONICH, STACI[4], and MARLER, ADRIENNE[1]**

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Lichens as indicators of semi-volatile organic pollutants in western North America

Thousands of semi-volatile organic compounds (SOCs) are emitted annually world-wide via agriculture, industry and combustion. Many resist bio-deterioration, accumulate in food chains, and are harmful to biota at low levels due to mutagenic and hormone disrupting properties or direct toxicity. Recent advances in analytical technology have simplified the accurate quantification of SOCs in lichens and other media, greatly facilitating ecological monitoring and assessment of these pollutants. Lichens from 21 western US national parks were analyzed for ~100 organic contaminants during the 2004-2005 Western Airborne Contaminants Assessment project. 41 current- and historic-use pesticides, PCBs and PAHs (combustion products) were detected. Pesticide concentrations generally increased with elevation (cold temperature condensation) and proximity to intensive regional agricultural activities, only a small fraction was attributable to trans-Pacific sources. PAHs decreased with elevation and correlated with urban area proximity. Accumulation was species-specific: *Platismatia, Hypogymnia> Letharia, Usnea, Xanthoparmelia >Alectoria > Flavocetraria >> Masonhalea*. The northern Rockies, southern California, and northwest

Washington were hotspots; interior and arctic Alaska was cleanest. Compared to sediments, snow, lake water, conifer needles and fish, lichens were particularly good accumulators and warrant use in future studies. (*Symposium*: Air Pollution)

***GILBERT, EDWARD[1]** and **GRIES, CORINNA[2]**

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SYMBIOTA, a new approach to online species identification

The Symbiota/SEINet web application is a specimen-based virtual floristic model that is capable of dynamically generating identification keys for any taxonomically complex species list, as denoted by specimen distributions or user input. The innovative data model and set of algorithms store morphological character data within a taxonomic hierarchy thus establishing an extremely efficient method for processing descriptive data and dynamically generating interactive keys for any subset of organisms. The implementation of inheritance and object oriented principles in Symbiota greatly reduces data entry efforts, handles species concepts for vastly different taxonomic groups in one system and accommodates multiple taxonomic views and phylogenies. The flexibility of this system has enormous potential as it can be customized to meet a full spectrum of needs - from the middle school student just being introduced to local species to the professional taxonomist who expects a highly comprehensive dataset. (*Symposium*: Integrated Data Networks in Lichenology)

***GIORDANI, PAOLO[1], INCERTI, GUIDO[2], RIZZI, GUIDO[1], BRUNIALTI, GIORGIO[3]** and **MODENESI, PAOLO[1]**

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Scale-dependency effects of environmental factors on epiphytic and epilithic lichen diversity in Mediterranean ecosystems

Mediterranean ecosystems, in spite of summer climatic drought, host peculiar epiphytic and epilithic lichen communities, ranging from xerophytic to igrophytic. Previous studies showed that water availability is a limiting factor at regional and landscape level, while at ecosystem and community scale lichen diversity is affected by several substrate- and stand-related factors. We explored this complex ecological framework in an intensive field-study carried out in Sardinia (Mediterranean Italy). Seventy-five variables, from bark and rock micro-topography to vegetation structure, macroclimate and landcover, were collected at 53 macro-plots, following a nested stratified random design, including 4008 bark quadrats, 668 grids, 167 trees for epiphytes and 5000 quadrats and 200 grids for epilithic lichens. By applying nonparametric multivariate statistics and multiplicative regressive models different predictors resulted significantly related to lichen diversity (e.g. host-tree morpho-structural gradient), distribution of most representative species (light radiation through the canopy) and of morpho-functional guilds (bark texture and competitors frequency). (*Symposium*: Community Structure and Dynamics)

***GIORDANI, PAOLO[1], INCERTI, GUIDO[2], RIZZI, GUIDO[1], BRUNIALTI, GIORGIO[3], MACCHERINI, SIMONA[3], BACARO, GIOVANNI[3], FRATI, LUISA[3]** and **MODENESI, PAOLO[1]**

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Exploring the variability of lichen biomonitoring data through spatial scales and ecological complexity

The reliability of lichen biomonitoring survey results depends on sampling design, observer and measurement errors. Most adopted methods are based on nested multilevel sampling design, which allows a more homogeneous distribution of sampling units, but implies high sampling error budget, because of the occurrence of several sources of variation. In this work, we aim to investigate at which spatial level the maximum variance of lichen diversity occurs and if it is consistent through spatial gradients of ecological complexity and anthropogenic pressure. For a set of case studies in Italy, we explore the partitioning of variance components of Lichen Diversity Value (LDV) into nested spatial level, ranging from the trunk scale up to the landscape level. We show how the higher variability is often related to within-sampling unit levels (e.g. between trees at the same site) and may in some case affect the assessment of pollution-related effects. (Poster: Environmental Monitoring, Friday in Merrill Hall)

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Dispersal and colonisation of Lobarion lichens in a highly fragmented landscape

Knowledge on dispersal ability of species is crucial for development of conservation strategies in landscapes. We investigated the colonisation of Lobarion lichens in a former treeless heathland in SW Norway. 92 sites of potential Lobarion lichen habitat were found in a 16,000 ha study area. They were small patches of aspen forest (totally 0.4% of area) with age ranging from 20 to >100 years. Ten old potential source areas were found scattered within the area, and distance to younger sites varied between 0.2 and 6.0 km. We recorded 32,000 thalli belonging to 23 species. Species richness increased with forest age, whereas no effect of distance from potential source areas was detected. Genetic variation in *Lobaria pulmonaria* supported these results. This suggests that dispersal ability of diaspores is not limiting the distribution, whereas time for colonisation does. Habitat amount seems to be of greater importance than habitat configuration within the landscape. (Poster: Ecology, Thursday in Nautilus)

GLEW, KATHERINE

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What Can Seattle's Cedar River Watershed Tell Us About Lichen Diversity and Forest Management?

The Cedar River Watershed, lies east of Seattle, Washington. Management of these forest lands recently included a lichen survey for maintaining safe water and preservation of the forests found in this natural area. Lichen collecting took place in the fall of 2006 and spring of 2007. Because of the close proximity to pollution sources from cities, lichen diversity was not expected to be high, especially for cyanolichens. Thinning practices were anticipated to have a negative effect on lichen diversity. Age class of forest was also considered in the analyses. Lichen species recorded were limited to macrolichens, but included a few microlichen species. The main factor affecting lichen diversity appeared to be diversity of habitat and substrate within a plot. Older sections of the watershed displayed higher biodiversity, especially when the habitat was diverse and older fallen trees were allowed to remain in the forest. Several plots provided unexpected results. (Poster: Ecology, Thursday in Nautilus)

GONZÁLEZ-MIQUEO, LAURA[1], UNSWORTH, CATHERINE[2], and ***PURVIS, WILLIAM O.[2]**

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Rare earth element patterns in lichens and other environmental samples

The purpose of the study was to investigate the hypothesis that there is a relationship between REE element signatures and element ratios in lichens and other environmental samples at Burnham Beeches.
REE signatures have proved useful to quantify numerous earth processes including the origin of rocks. The multi-element including rare earth element content of 13 powdered samples sampled from Burnham Beeches in 2000 was analysed using a HF digest and data compared with previously determined soil data from the same sites. Analytical precision for most of the elements with an atomic number higher than Gd is low. This is partly due to the sample nature and preparation procedures. REE enrichment relative to chondrite and adjacent soils, the extent of Eu anomalies, the enrichments of heavy REE (HREE), and element ratios were calculated. Results are considered in relation to other lichen and long-term moss biomonitoring studies. (Poster: Ecology, Thursday in Nautilus)

GRAHAM, LINDA[1], GRAHAM, JAMES[1], and ***COOK, MARTHA[2]**

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Resistant tissues of modern liverworts resemble Early Paleozoic microfossils

Specimens of the modern simple thalloid liverwort *Blasia pusilla* were treated with acetolysis to simulate the harsh conditions plants would have encountered as they became part of the fossil record. Specimens treated with UVA light prior to acetolysis displayed pink cell walls and produced 3.5 times more resistant carbon than did untreated specimens. Resistant tissues that survived the treatment were in the form of tubes (rhizoids) and sheets of cells (gemmae and gametangial jackets) that have

phenolic-type autofluorescene and resemble enigmatic Cambrian-Devonian microfossils. These results expand on our previous work demonstrating that degraded mosses (Graham et al. 2004a) and complex thalloid liverworts (Graham et al. 2004b) resemble ancient microfossils and may serve as proxies for estimating the amount of carbon sequestered by the earliest plants. They also provide evidence that physiological responses to environmental variables may affect the amount of carbon sequestered by these plants. (*Symposium*: Oldest Bryophytes and Lichens)

GREEN, T. G. ALLAN

Biological Sciences, Waikato University, Hamilton, New Zealand and Vegetal II, Farmacia Facultad, Universidad Complutense, Madrid, Spain

The world of lichens as revealed by ecophysiology

Ecophysiology is the interrelationship between the organism's physical functioning and its environment. Lichens provide particularly interesting opportunities for ecophysiological research because they are poikilohydric with thallus water content adding an extra variable missing for higher plants. Advances in equipment in recent decades have allowed more and better studies of performance both in the laboratory and in the field and a summary of the major advances will be presented. Some of the results from this research may require us to rethink our accepted views about what factors are important in the lichen world. It will be suggested that that lichens are as metabolically agile as higher plants but actually live in a suboptimal world with internal factors playing an important role in influencing productivity. Also, although much has been achieved, much remains to provide excellent opportunities for present and future ecophysiologists. (Invited lecture)

***GUEIDAN, CECILE[1], SAVIC, SANJA[2], THUES, HOLGER[3], ROUX, CLAUDE[4], KELLER, CHRISTINE[5], TIBELL, LEIF[2], PRIETO, MARIA[6], HEIDMARSSON, STARRI[7], BREUSS, OTHMAR[8], ORANGE, ALAN[9], FROBERG, LARS[10], AMTOFT-WYNNS, ANJA[11], NAVARRO-ROSINES, PERE[12], KRZEWICKA, BEATA[13], PYKALA, JUHA[14], GRUBE, MARTIN[15],** and **LUTZONI, FRANCOIS[16]**

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Generic delineation and character evolution in Verrucariaecae

Verrucariaceae are a family of crustose lichens colonizing aquatic to arid habitats. Phylogenetic relationships among members of the *Verrucariaceae* are mostly unknown and the current morphology-based classification has never been confronted to molecular data. A multilocus phylogeny was reconstructed for 83 taxa representing all main genera of this family. Four main well-supported monophyletic groups were recovered, one of which contains seven robust monophyletic subgroups. Most genera as traditionally delimited were not monophyletic. Character evolution was investigated using ancestral state reconstructions. Results show that the most recent common ancestor of *Verrucariaceae* was most likely crustose, with a weakly differentiated upper cortex, simple ascospores, and hymenium free of algae. The use of symplesiomorphic traits to define *Verrucaria*, as well as the non-monophyly of the genera *Polyblastia*, *Staurothele* and *Thelidium*, explain most of the discrepancies between the current classification based on morphological similarity and a classification using monophyly as a grouping criterion. (*Symposium*: Roots, trunks, branches and leaves: Systematics and Phylogenetics)

GUO, SHOUYU

Institute of Microbiology, Chinese Academy of Sciences, No.3 Datun Road, Chaoyang District, Beijing 100101, P. R. China.

Distinguishing lichen species and genera using ITS2 nrRNA sequence-structure

Case studies revealed that a compensatory base change (CBC) in the helix II or helix III ITS2 nrRNA secondary structure between two organisms correlated with sexual incompatibility. In plants and fungi (mainly nonlichenized fungi), 95.56% and 92.96% of the 945 and 412 cases, respectively, where two sequences taken from the same genus show a CBC, they belong to different species. In lichens, however, only about 65% of 300 cases match this hypothesis. We design the simple software GenCAT (Genetic Coherence Analysis Tool) use the Mendel's Genetic Distance (MGD) to analyze the data set of ITS2 nrRNA sequence-structure alignment. The results indicate that the MGD is a sufficient condition to distinguish species and genera of lichens. In MGD, Dominant substitutions (base N to N, not the same one) are proposed to include Transitions and Transversions in the Nucleotide Substitution Model of Kimura 2-parameter distance, and Recessive substitutions (base N to gap) are adopted. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***GUO, SHOUYU**[1] and **ZHAO, ZUNTIAN**[2]

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Comparative floristics of macrolichens among three key ecological regions in China

Surveys of lichen flora and lichen biodiversity are very important to understand the structures and functions of terrestrial ecosystems profoundly. Changbai Mountain (Jilin), Taibai Mountain (Shaanxi) and Gongga Mountain (Sichuan) are three key ecological regions with terrestrial biodiversity of international importance. About 14000 lichen specimens from the regions mentioned above have been examined and identified. As a result, 106 genera and 529 species are reported with annotation (Mt. Changbai, 96 genera and 481 species; Mt. Taibai, 89 genera and 432 species; Mt. Gongga, 80 genera and 286 species). The biogeographical elements and the vertical distribution of lichens in relation to plant vegetation were analyzed and compared. Distribution patterns of chemical strains are also addressed, *Rhizoplaca chrysoleuca*, and *Thamnolia subuliformis - T. vermicularis* complex are considered as the key species for the further investigation on speciation and population structure. (Poster: Biogeography and Floristics, Monday in Nautilus)

***GUO, SHOUYU** and **ZHOU, QIMING**

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Multiple inserting positions of Group I intron in SSU nrDNA of the lichen family Physciaceae

Group I introns are autocatalytic RNAs that are widespread in nuclear genomes of eukaryotes, especially in lichen-forming fungi. Twelve inserting positions (S114, S287, S292, S516, S788, S943, S1049, S1199, S1210, S1384, S1506, and S1516) were found on SSU nrDNA of the 8 samples (5 species, 2 genera) in the lichen family Physciaceae with 1 sample containing 4 (*Physcia aipolia* P9), 5 samples 5 (*P. aipolia* P1, P2; *P. alnophila* P7, *Physcia caesia* P5; *P. stellaris* P11), 1 sample 6 (*P. caesia* P8), and 1 sample 8 insertions (*Phaophyscia hispidula* P13). All 8 samples were detected to contain introns at S788 and S1516, respectively. We illustrated these positions and analyzed the introns according to their secondary structures. Our data support the idea that the group I introns at the same sites can be used to analyze the phylogenetic relationship of the taxa in Physciaceae and that the widespread occurrence of the S788 and S1516 introns could be ancestral. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***HAJI MONIRI, MAHROO**[1] **and SIPMAN, HARRIE. J. M.**[2]

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[2]Botanic Garden & Botanical Museum Berlin-Dahlem, Free University of Berlin, Berlin, Germany.

Some Lichens from Tandoureh National Park (Iran)

This study is the first investigation of lichens through Tandoureh national park (prov. Razavi Khorasan). It consists of 312 collecting specimens on rocks, soil and some trees from five sampling sites. The survey area is located in the dried part of the northern chain, the Hazar Masjid mountains. It covers 73,435 hectares (37˚18´-37˚35´N, 58˚33´-58˚57´E), reaching up to ca 3000 m above the see level and with an annual precipitation of ca. 200-300 mm. Due to the strong altitudinal variation the temperature varies considerably in different parts of the park. Geologically the bedrock in area dates from the Cretaceous period and includes limestone, sandstone and shale rock as well as alluvial deposits. A list of species including several new to Iran and the province is reported. (Poster: Biogeography and Floristics, Monday in Nautilus)

HALICI, MEHMET GÖKHAN[1*], AKSOY, AHMET[1] and **KOCAKAYA, MUSTAFA[2]**

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Lichenioclous Fungi of Aladaĝlar National Park (Turkey)

In the course of determining the lichenized and lichenicolous fungal biota of Aladağlar National Park, one of the largest national parks in Turkey with 54.514 hectare area, located in the south of Turkey, 48 species of lichenicolous fungi belonging to 27 genera, 15 families were identified. Of these, 1 genus (*Gemmaspora*) and 5 species (*Endococcus variabilis, Polycoccum acarosporicola, P. aksoyi, Stigmidium johnii* and *Weddellomyces turcicus*) were recently described from the study area. The host lichen species which harbour most lichenicolous fungi species are *Caloplaca chalybae, C. crenulatella, C. flavescens* and *Rhizocarpon geographicum*. As the saxicolous lichen species are dominant in the study area, this situation is normally excepted. The host index of the species is provided and also if present, the variations of the species are discussed by comparing the original descriptions. (*Symposium*: Lichenicolous Fungi: Taxonomy and Diversity)

***HARA, KOJIRO[1], HIRUTA, ERIKO[1], TAKAHASHI, KANAE[1], KOMINE, MASASHI[1], YAMAMOTO, YOSHIKAZU[1], TAMOGAMI, SHIGERU[1],** and **NAKAMURA, KAORU[2]**

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Biotransformation of sesquiterpenes in essential oil by lichen mycobionts

Lichens have been used as medicines, dyes and perfumes. They are well known to produce a variety of characteristic compounds, indicating capabilities of their unique metabolic system to transform foreign compounds. In this study, we investigated the biotransformation of essential oil by cultured mycobionts. First, 42 strains were cultured in liquid media containing a small amount of each essential oil (ylang ylang, camphor, bergamot, melissa) for a day or a week. Next, changes in fragrance were evaluated by five organoleptic notes; sweet, perfumery, cooling, spicy and minty. It was found that 16 and 8 strains converted ylang ylang and bergamot fragrance to good or faint fragrance, respectively. Subsequently, static headspace gas chromatography-mass spectrometry analysis was performed, revealing that sesquiterpenes in the ylang ylang oil, such as isocaryophyllene and beta-cubebene, were mainly converted. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

HARTARD, BRITTA[1,2], MÁGUAS, CRISTINA[2] and **LAKATOS, MICHAEL[1,2]**

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Aspects of $\delta^{18}O$ performance of lichens during water exchange

The oxygen ($\delta^{18}O$) stable isotope composition can be used to qualitatively trace water exchange processes. During de- and rehydration processes in cryptogams, isotopic fractionation strongly depends on prevailing thallus water potential/vapour pressure gradients and temperature conditions. Novel data on the $\delta^{18}O$ performance of lichens show that thallus water constantly isotopically equilibrates with atmospheric moisture in the immediate microhabitat. Accordingly, equilibrium conditions occur faster compared to vascular plants and irrespective of relative humidity – an aspect of particular interest in view of still existing constraints in the assessment of $\delta^{18}O$ of vapour. Along with first data on lichen organic matter $\delta^{18}O$, these principle achievements provide the basis for applying $\delta^{18}O$ to obtain further information regarding the functioning and performance of lichens. Moreover, the findings stress the potential use of lichen organic matter $\delta^{18}O$ as long term indicator and thallus water $\delta^{18}O$ as short term tracer of environmental vapour. (*Symposium*: Functional Ecology)

HARUTYUNYAN, SHAHANE and ***MAYRHOFER, HELMUT**

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The lichen mycota of Armenia

The lichen mycota of Armenia has been poorly studied so far, especially in comparison to the neighbouring Caucasian countries Georgia and Azerbaijan. The current study is based on a comprehensive evaluation of the literature and of herbarium specimens as well as recent field studies conducted in 2005 and 2006. There are only very few papers dealing with lichens published by

Armenians. Nikogosyan has contributed several smaller studies in the 1960s, including two remarkable papers about the association of bacteria with lichens in collaboration with Panosyan. Abrahamyan has investigated the Lake Sevan region and has evaluated the small lichen collections of both herbaria of Yerevan (ERE, ERCB). The Azerbaijani Barchalov has mentioned more than 200 taxa in a series of papers, including his impressive monograph dealing with the lichens of the Caucasus region. Based on 61 references, on the specimens kept in four public herbaria (ERE, ERCB, GZU, W) and on the results of field studies, the known lichen mycota comprises 407 taxa belonging to 110 genera. Of those 407 taxa, 110 have been added during the recent field studies. Saxicolous crustose species are dominating the Armenian lichen mycota. For comparison the actual checklist of Syria covers 399 species, including the lichenicolous fungi. (Poster: Biogeography and Floristics, Monday in Nautilus)

HEINDL-TENHUNEN, BAERBEL[1], ZEDDA, LUCIANA[1,2], NASH III, THOMAS H.[3], BARBER, ANNE[3], NEUBACHER, DIETER[4], TRIEBEL, DAGMAR[4] and **RAMBOLD, GERHARD[1]**

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"LIAS light" – an online-identification tool for lichens

The LIAS project (www.lias.net) was started in 1993 as a multi-authored information system for phylogeny and biodiversity data on lichens and non-lichenized ascomycetes. It includes several database applications and web interfaces, that are under constant development as to software and content: (1) "LIAS main", with species descriptions and interactive keys, (2) "LIAS names", with taxonomy data, (3) "LIAS checklists", with distribution data, (4) "LIAS glossary", providing definitions for terms used in descriptions and during identification, and (5) "LIAS light", created for rapid online identification. For "LIAS light" (http://liaslight.lias.net/), published lichen descriptions are entered into the Diversity Workbench database component DiversityDescriptions, using a data matrix of about 70 "core" characters. After export to the DELTA format the data are processed by the JAVA applet NaviKey (www.navikey.net). So far, about 3500 lichen species are available to be keyed out online. The features of the interactive key including the option for image presentation are described. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

HEIÐMARSSON, STARRI

Icelandic Institute of Natural History, Akureyri Division, Borgir Nordurslod, IS-600 Akureyri, Iceland

Lichenological Occurrences Data in the International GBIF Network

GBIF (Global Biodiversity Information Facility) is an international co-operation aiming at making biodiversity information freely and openly available world-wide via the internet. Since GBIF started in 2001 available data have increased enormously and at present (May 2008) 155310567 records (both information on specimens and observational data) can be browsed at www.gbif.org. Data shared via GBIF must either follow the standards Darwin-Core or ABCD. The data can be browsed in several ways, based on geographical distribution, data providers, collections or taxonomy. Assessing data via GBIF is, however, not problem-free. When browsing for higher taxonomic groups your success is dependent on how thoroughly the data-owner has filled out the higher taxonomic fields. Therefore better results are obtained when browsing for lower categories as genera or species. One of GBIF´s programmes, ECAT (the Electronic Catalogue of Known Names) should, when better developed, make taxonomic browsing easier independent of taxonomic category. (*Symposium*: Integrated Data Networks in Lichenology)

HEIÐMARSSON, STARRI

Icelandic Institute of Natural History, Akureyri Division, Borgir Nordurslod, IS-600 Akureyri, Iceland

Lichens and bryophytes of different aged nunataks of Vatnajökull ice sheet, SE-Iceland

In Iceland glaciers reached a temporary maximum in the year 1890. Since then Icelandic glaciers have been retreating at an accelerating rate and this has caused more and more nunataks to emerge from the Vatnajökull ice sheet in southeastern Iceland. Esjufjöll mountains, reaching about 1300 m a.s.l. have probably been exposed since soon after the end of last Ice-Age. Further down in the outlet-glacier, Breiðamerkurjökull, three younger nunataks are located. Kárasker emerged before 1940, Bræðrasker around 1960 and the youngest one, Maríusker, emerged in 2000. More than 100 species of bryophytes s. lat. have been found growing on the nunataks. The lichens of the nunataks are under study at present but lichens seem to be slower colonizers on the

recent nunataks than the bryophytes. In Esjufjöll some rare species as *Umbilicaria virginis* and *Dermatocarpon bachmannii* have been found. (Poster: Ecology, Thursday in Nautilus)

HERNÁNDEZ M., JESÚS E.

Fundación Instituto Botánico de Venezuela

Lichens of the cloud forest and subparamo of El Avila National Park, Venezuela

Due to its closeness to the Venezuelan capital Caracas, it was expected that El Ávila Nacional Park would be lichenologicaly well characterized, but there have been collections and almost no publications. In VEN, only 63 species are documented. For cloud forests in Colombia and Costa Rica, close to 400 species have been reported, and it would be expected that El Ávila has a similar amount. The general objective of this project is to contribuye to the knowledge of the lichen biota of El Avila and compare the diversity of species between cloud forest and subparamo. In Four field trips covering various localities, a total of 350 specimens has been collected up to date, with half of them identified. The majority belong in Parmeliaceae and Cladoniaceae. The data shows a difference in species composition between cloud forest and subparamo. There are at least two new genus reports for Venezuela and more than 20 new reports for the park. (Poster: Biogeography and Floristics, Monday in Nautilus)

***HERNÁNDEZ M., JESÚS E.[1,2], BOURG, AMANDINE[3], ROSABAL, DANIA[4], KOMPOSCH, HARALD[5], RIVAS PLATA, EIMY**[6] and **LÜCKING, ROBERT[6]**

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Microhabitat and substrate preferences of the families Porinaceae and Pyrenulaceae (Lichenized Ascomycota) in primary and secondary premontane rainforest in Las Cruces, Costa Rica

Microhabitat and substrate preferences of the families Porinaceae and Pyrenulaceae were studied in a primary and secondary rainforest in Las Cruces, Costa Rica. Sampling was performed using a 1400 m long transect through primary forest and adjacent secondary vegetation (700 m each). All species of the families growing on bark or other substrata below 2 m height were collected and various substrate and habitat parameters were recorded. Thirty-nine species of the genera *Porina*, *Trichothelium*, *Clypeopyrenis* and *Pyrenula* were found. A preference for primary forest was found for the majority of the Porinaceae. Corticolous species of *Porina* were found only in the primary forest, whereas usually foliicolous species were found on the smooth bark of vines in the secondary forest. The majority of the *Pyrenula* species were found in the secondary forest, whereas *Clypeopyrenis* was restricted to the primary forest. Three indicator species for primary forest were found: *Porina conspersa*, *P. distans* and *P. tetracerae*. Porinaceae and Pyrenulaceae can be used to distinguish between primary and secondary forest. (*Symposium*: Tropical Lichens and Bryophytes)

HERRERA-CAMPOS, MARÍA ANGELES

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Species of *Usnea* from Mexican Cloud Forests

Mexican cloud forests (bosques mesófilos de montaña) are characterized by an insular distribution mainly along the humid hillsides, representing less than 1% of the total surface of the country. These forests are latitudinally, variable in species composition and physiognomy ranging from elfin forest to pluriestratified forests where trees can reach over 30 m in height with occasional emergent up to 80 m. In these forest the highest numbers of *Usnea* species in the country are found, being the more conspicuous those with pendulous habit, such as *U. merrillii* Mot., *U. ceratina* Ach., *U. subscabrosa* Mot, and *U, schadenbergiana* Göpp. & Stein., as well as shruby species as *U. brasiliensis* (Zahlbr.) Mot., *U. ramillosa* Mot. *U. cirrosa* Mot., *U. silesiaca* Mot., and *U. strigosa s. lat.* (Ach.) Eaton. Anthropogenic disturbance has increased the fragmented character of these forests causing a noticeable reduction in their biodiversity. (Workshop following IAL 6)

***HOCHMAN, AYALA[1], WEISSMAN, LIOR[2], SEMYATICH, VICTORIA[3]** and **GARTY, JACOB[3]**

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of Molecular Gerontology, National Institute on Aging, National Institutes of Health, 5600 Nathan Shock Drive, Baltimore, MD 21224, USA

Desiccation and Rehydration of the lichen *Ramalina lacera* Results in Production of Reactive Oxygen Species, Nitric Oxide and Alterations in Antioxidants

As poikilohydric organisms the lifestyle of many lichens is composed of alternating periods of desiccation with low metabolic activity, and rehydration that induces increase in their metabolism. Desiccation of the lichen *Ramalina lacera* caused a decrease it photosynthetic yield, while rehydration resulted in initiation of- and rapid increase in photosynthetic activity. Recovery of photosynthesis, as well as desiccation were accompanied by bursts of intracellular production of reactive oxygen species (ROS) and nitric oxide. While ROS production was associated with both symbiotic partners of the lichen, NO was detected only in the fungal hyphae. Rehydration of the thalli resulted in a decrease in SOD activity, a transient decrease in total catalase activity and water-soluble low-molecular weight antioxidant, as well as a decrease in the antioxidant auxiliary enzymes glutathione reductase and glucose-6-phosphate dehydrogenase. Desiccation, on the other hand, caused an increase in the activities of catalase, glutathione reductase and glucose-6-phosphate dehydrogenase. (*Symposium*: Biochemistry and Physiology of Poikilohydry)

***HOCHMAN, AYALA[1], WEISSMAN, LIOR[2], SHINE, LIOR[1], SELA, ELA[1],** and **GARTY, JACOB[3]**

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of Molecular Gerontology, National Institute on Aging, National Institutes of Health, 5600 Nathan Shock Drive, Baltimore, MD 21224, USA

Responses of Antioxidants in Lichens May Serve as an Early-Warning Bioindicator System for the Detection of Air Pollution Stress

Air pollution was shown to cause production of deleterious reactive oxygen species (ROS). The aim of this project was to study the effects of air pollution on antioxidants in lichens, in order to identify early warning parameters for detection of air pollution. The lichens *Ramalina lacera* and *Ramalina maciformis* were transplanted from their relatively unpolluted natural habitat to sites with industrial air pollution, in the Haifa Bayand Ramat Hovav (Negev) in Israel, respectively. In general it was found that low levels pollution and short periods of exposure resulted in increase in antioxidant enzymes. These changes were evident before any structural damage, such as pigment breakdown and membrane leakage, were detected. Under higher pollution load the enzymatic activities declieded to levels lower than the control thalli. These findings indicate that lichen antioxidants may serve as improved early-warning indicators of air pollution stress. (Poster: Environmental Monitoring, Friday in Merrill Hall)

***HODKINSON, BRENDAN P.[1], LOVELESS, TELISA M.[2], BISHOP, PAUL E.[2]** and **LUTZONI, FRANÇOIS[1]**

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Nitrogen-fixing non-photobiont bacteria and lichens: an alternative lifestyle?

Nitrogen-fixing non-photobiont bacteria have previously been found to associate with lichens, and it has been suggested that the nutrients that they provide may be crucial for lichen growth on nutrient-poor substrates. However, the particular nitrogen fixation pathways employed by lichen-associated bacteria have never been elucidated. The most common and efficient pathway is dependent upon molybdenum, while an alternative pathway uses iron in its place. Iron is generally much more available than molybdenum in nutrient-poor and/or acidic environments, suggesting that the alternative iron-dependent pathway may be crucial in lichen-associated nitrogen fixation. The present study employs culturing, acetylene reduction assays, and PCR amplification to provide evidence for the presence of both the molybdenum-dependent and iron-dependent nitrogen fixation systems in non-photobiont lichen-associated bacteria. These findings contribute greatly to our understanding of lichen ecology and physiology, and demonstrate the potential importance of non-photobiont bacteria in the development of lichens. (*Symposium*: Endolichenic Fungi and Bacteria: Implications for Symbioses)

***HOGAN, ERIKA, MINNULLINA, GULNAZ and CRITTENDEN, PETER**

The University of Nottingham, School of Biology, University Park, Nottingham, NG7 2RD, England, UK

Phosphatase activity and nitrogen and phosphorus relations in lichens

There is abundant evidence that phosphatase activity in plants and micro-organisms is promoted by N enrichment. In *Cladonia portentosa*, there is up-regulation of acid phosphomonoesterase (PME) activity in response to N pollution. This is associated with a marked increase in thallus N:P mass ratios suggesting a shift towards P-limitation. Fluorescence microscopy shows the location of PME to be on the outer and inner surfaces of the hollow tube-like thallus and exclusively associated with cell lumina of the fungal symbiont, consistent with a membrane location. Phosphatase activities in N_2-fixing lichens have also been investigated, revealing a complex picture. 5' nucleotide diesterase activity was readily detected in lichens containing a cyanobacteria and particularly active in foliose terricolous species, consistent with the utilisation of organic phosphates from soil and litter sources. Maximum rates of PME activity were expressed by fruticose mat forming lichens, which are considered to source nutrients predominantly through atmospheric deposits. (*Symposium*: Nutrient Exchange in Lichens and Bryophytes)

***HOGAN, ERIKA[1], WANEK, WOLFGANG[2],** and **CRITTENDEN, PETER[1]**

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Phosphorus and nitrogen uptake kinetics in *Cladonia portentosa*

Cladonia portentosa occurs in oligotrophic heathlands and is an effective bio-indicator for nitrogen pollution, evidenced by increased thallus N concentration, N:P ratio and phosphomonoesterase activity. Such physiological changes are consistent with a shift towards P limitation with increasing N availability. We report the first investigation in a lichen into the effect of N enrichment on N and P uptake kinetics. Uptake of ^{33}P-labelled PO_4^{3-}, ^{15}N-labelled $NO_3^-$and NH_4^+, and $^{13}C/^{15}N$-labelled glycine followed Michaelis-Menten saturation kinetics and involved a dual affinity PO_4^{3-} uptake system. Phosphate uptake increased significantly in response to N enrichment, and was associated with elevated K_m and V_{max}. This might suggest an increased concentration of transporters which would enhance PO_4^{3-} intake capacity. There were no significant effects of N enrichment on N uptake; however V_{max} for NH_4^+ and NO_3^- uptake decreased indicating that *C. portentosa* might experience N saturation at high N deposition sites. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

***HONEGGER, ROSMARIE[1], SCHERRER, SANDRA[2]**, and **EICHENBERGER, CHRISTOF[1]**

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The private life of lichen-forming ascomycetes: reproduction in focus

While ascocarp ontogeny and ascus structure and function are well investigated in various lichen-forming ascomycetes, the genetics of sexual reproduction is very poorly understood. This is mainly due to experimental problems since sexual reproductive structures are not normally formed by sterile cultured isolates. The impact of changes in mating systems (i.e. from cross- to self-fertilization) on speciation was studied in selected Teloschistaceae. Results from fingerprinting techniques applied to the progeny of meiosis, sequence analyses of the entire MAT loci and multi-locus phylogenies of the respective taxa support the view that homothallism is a derived character. The most common and widespread Teloschistaceae turned out to be homothallic. As many Lecanoromycetes are rarely fertile and disperse mainly via vegetative symbiotic propagules, the mating systems of selected Parmeliaceae, Ramalinaceae and Physciaceae were analysed, the focus being on rarely fertile and/or rare species. Our data give new insights in population genetics of lichen-forming ascomycetes. (Invited lecture)

***HYVÄRINEN, MARKO[1], BENCUROVA, ELENA[2], MOLCANOVA, VIKTORIA[2], BACKOR, MARTIN[2]** and **PÖYKKÖ, HEIKKI[1]**

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Can optimal defence theory (ODT) explain intrathalline variation in the levels of lichen phenolics?

According to ODT an organism should allocate chemical defenses in a way that maximises its fitness. It is known that many lichen phenolics act as anti-herbivore compounds and phenolic contents in reproductive exceeds that in somatic ones. Hence, it is plausible that in the absence of chemical defence the attack rate of herbivores on reproductive parts should increase more than on somatic ones. This theory was subjected to a simple experimental test by feeding lichenivorous moth (*Cleorodes lichenaria)* with chemically manipulated pieces of *Hypogymnia physodes* and *Ramalina farinacea*. Consumption of *R. farinaceea*, which is a natural food for the moth, was higher than *H.physodes*. In *H. physodes* lowered phenolic contents resulted in increased feeding and reproductive parts were more vulnerable for attack. However, the results fell short in one ODT prediction: there was no significant interaction between thallus parts and chemical treatment in explaining the attack rate. (Poster: Ecology, Thursday in Nautilus)

***INSAROV, GREGORY[1], MUCHNIK, EUGENIA[2], DAVIES, LINDA[3], PURVIS, 0.WILLIAM[4], CHIMONIDES, P.D. JIM[4], BELL, J. and NIGEL B.[3]**

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Establishing Epiphytic Lichen Biomonitoring in Moscow and London

The purpose of the study was to establish a base-line survey in each city using the same protocol with a view to monitoring changes in assemblages on a regular basis. A total of 62 species were recorded in both cities. Climatic conditions limit direct comparison of the sites but 14 species were common to both cities and most of these are considered pollution tolerant with 6 nitrophytes included (van Herk, 2002). This reflects changes in atmospheric conditions due to reduced industrial emissions and an increase in transport use. Comparisons were made with historical records. 9 new species were found in Moscow and 3 species were new to Richmond Park in London. This study was part of a review of air quality management in both cities where physico-chemical measurements and computer modelling are used but not biomonitoring (www.moscow-london.org). (Poster: Environmental Monitoring, Friday in Merrill Hall)

***INSAROV, GREGORY[1], MUCHNIK, EUGENIA[2], and INSAROVA, IRINA[3]**

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[3]Moscow State University, Department of Biology, Vorobievy Gory, Moscow 119899, Russia.

Lichen Monitoring in Moscow: Base-line Survey

Background methodology for lichen monitoring described in (Insarov, 2002) was modified for monitoring in urban environment. We measured epiphytic lichen cover and frequency on oak (*Quercus robur* L.) and lime-tree (*Tilia* sp.) trunks in 2006-2007 following this methodology. 28 lichen species were recorded, including 11 nitrophytes and 5 acidophytes. On limes, both cover and frequency estimates of nitrophytes significantly exceed corresponding estimates of acidophytes. On oaks, frequency estimate of nitrophytes also exceeds corresponding estimates of acidophytes. Comparison of number of nitrophytes and acidophytes for more than 150 years was also undertaken. Our analysis demonstrates that changes in epiphytic lichen community structure in Moscow follow main changes in conditions of the atmospheric surface layer. Program for long-term monitoring of epiphytic lichens in Moscow is suggested. (Poster: Environmental Monitoring, Friday in Merrill Hall)

ISOCRONO, DEBORAH[1], MATTEUCCI, ENRICA[2], BUFFA, GIORGIO[2], BEONE, GIAN MARIA[3] and ***PIERVITTORI, ROSANNA[2]**

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[2]University of Torino, Department of Plant Biology and Centre of Excellence for Plant and Microbial Biosensing (CEBIOVEM), Viale Mattioli 25, Torino 10125, Italy; [3]Università Cattolica del Sacro Cuore, Institute of Agricultural and Environmental Chemistry,Via Emilia Parmense 84, Piacenza 29100, Italy.

Integrated monitoring network: looking at differences and correlations between two biomonitors

Biodiversity of epiphytic lichen communities was assessed in 25 sites before the construction of a power station in North Italy that started operating in 2008. Following the results of this investigation, a smaller network was established to monitor trace elements concentrations [Al, As, Cd, Cr, Cu, Ni, Pb, V] in transplanted biomonitors [*Pseudevernia furfuracea* (L.) Zopf and

Hypnum cupressiforme L.]. Lichen-bags were exposed in 16 sites and moss-bags in 4 sites, for a two-months period during 4 surveys. We observe in most data a good accordance between the two biomonitors, although in few cases one of the bioaccumulators lacks to reveal a peak in one element, or reveals the peak with a very different magnitude. The geographical trends suggested by the lichen bioindication are confirmed and can be locally attributed to different kinds of metal pollution, with anomalies on Cr and Ni and on Cu and Pb. (Poster: Environmental Monitoring, Friday in Merrill Hall))

***JANSSON, K. ULRIKA**[1] and **FREGO, KATHERINE A.**[2]

[1]Umeå University, Department of Ecology and Environmental Sciences, SE-901 87 Umeå, Sweden; [2]University of New Brunswick, Department of Biology, P.O. Box 5050, Saint John, NB, Canada E2L 4L4.

Does edge aspect affect edge effects in a lichen community in eastern Canada?

The lichen community on *Picea* branches was studied in north-south belt transects in two 1ha tree islands, where the surrounding forests had been harvested 5 years prior to investigation. Over 9200 thalli of fruticose, foliose and crustose lichens were identified on 100 branches. The total lichen cover varied between 20 and 170 % (overlapping thalli) where foliose lichens constituted 80 % of total cover. The cover of crustose species increased with increased distance from the north facing edge of one island (R^2=0.33), but showed no pattern at the other edges. The cover of the foliose lichen *Platismatia glauca* decreased with distance into the forest in one south facing edge (R^2=0.31), but the pattern was not consistent between islands. The effects on the lichens community appear to be site–specific. Data on other explanatory factors such as branch length, bark cover and direction as well as light availability will be presented. (Poster: Ecology, Thursday in Nautilus)

***JAYALAL' UDENI**[1], **WOLSELEY, PAT**[2], **WIJESUNDARA, SIRIL**[3], and **KARUNARATNE, VERANJA**[1]

[1]Department of Chemistry, University of Peradeniya, Sri Lanka; [2]Department of Botany, Natural History Museum, UK; [3]Department of National Botanic Gardens, Peradeniya, Sri Lanka

Macrolichen diversity as an indicator of environmental changes in montane forest of Horton Plains, Sri Lanka

Horton Plains National Park (HPNP) includes extensive areas of cloud forest, which occurs as continuous forest on the upper slopes, and as islands of different sizes interspersed in grassland. Macrolichens were sampled on trees in plots in both continuous and island forests together with tree data. A total of 1515 specimens of macro lichens belonging to 21 families, 48 genera and 293 species were identified. Highest diversity (170 species) of macro lichens was found in forest islands compared to continuous forest (123 species). Using genera selected as indicators of ecological continuity there was a significant difference (p=0.05) between continuous forest and forest islands, the former supporting fewer taxa at lower frequency and cover. Indicator taxa restricted to the forest islands included species of *Nephroma* and *Teloschistes.* Large foliose species of *Pseudocyphellaria, Lobaria* and *Sticta* occurred in both forests, but at lower frequency and cover in continuous forest. (Poster: Environmental Monitoring, Friday in Merrill Hall)

***JOHANSSON, OTILIA** and **PALMQVIST, KRISTIN**

Umeå University, Department of Ecology and Environmental Science, 90187 Umeå, Sweden

Responses of epiphytic lichens to increased nitrogen

Nitrogen (N) is an important nutrient for lichens, involved in many processes in both photobiont and mycobiont. However, N can also be stressful with many lichens and lichen communities disappearing with increased N-deposition. We have initiated a large and long-term experiment aiming to understand the underlying dynamic processes that lead to altered structure and die-back of epiphytic lichen communities with increased N load. An old-growth forest stand in northern Sweden, where back-ground deposition of biologically reactive N is low, has been chosen for the experiment. The stand has a rich epiphytic lichen flora, particularly on spruce. The trees are irrigated with NH4NO3, mimicking how lichens are naturally exposed to N-deposition. The dosage ranges from 1 to 50 kg N ha-1 year-1 to define the critical N-load, and the lichen responses are followed from the mere physiological effects to effects on the lichen community structure. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

JOHANSSON, VICTOR[1,2], BERGMAN, KARL-OLOF[1], *LÄTTMAN, HÅKAN[1,3] and **MILBERG, PER[1]**

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Tree preferences of three epiphytic lichens

Oaks (*Quercus robur*) can reach considerable age which makes them an important substrate for many epiphytic lichens, including several red-listed species. In this study the importance of tree size on the occurrence and abundance of three epiphytic lichens were investigated, in south eastern Sweden. The effects of tree circumference were analysed and the results showed that the lichen species responded differently. This study shows that the maintenance of old trees is crucial for some lichen species, which highlights the importance of long-term management plans. (Poster: Ecology, Thursday in Nautilus)

***JONESON, SUZANNE, LUTZONI, FRANÇOIS** and **ARMALEO, DANIELE**

Duke University, Department of Biology, Box 90338, Durham, North Carolina, 27708-0338, U.S.A.

Differentially regulated genes of *Cladonia grayi*, and the early stages of lichen symbiosis

Although one fifth of all known fungi form obligatory lichens with photobionts, we know nothing of the genetic or molecular mechanisms underlying this nutritional mode. Using the symbiosis between *Cladonia grayi* and *Asterochloris* sp., we have investigated differentially expressed genes in early lichen development. We used Suppression Subtractive Hybridization to find up-regulated genes between the mycobiont and the photobiont in in vitro resynthesis. We sequenced over 2000 fungal and algal clones, and used BLAST and FASTA algorithmic searches of protein and conserved protein domain databases to characterize our sequences. This dataset represents the first global survey of fungal and algal gene sequences involved in lichen symbiosis, and a summary of the mycobiont genes and their putative functions will be presented here. We will also discuss how the addition of sequenced symbiont genomes will help in our efforts in identifying candidate genes of early lichen development. (*Symposium*: *Xanthoria* and *Physcomitrella* Genomics: Potentials for New Research)

***JONESON, SUZANNE, LUTZONI, FRANÇOIS** and **ARMALEO, DANIELE**

Duke University, Department of Biology, Box 90338, Durham, North Carolina, 27708-0338, U.S.A.

Revisiting thigmotropism and the early stages of lichen symbiosis

Lichen thalli are formed by intimate symbiotic interactions between a mycobiont and a photobiont. The development of a complex stratified thallus is made through stages of emerging phenotypic interactions. The second stage of development in lichens with trebouxoid photobionts, is marked by fungal envelopment of the photobiont through increased hyphal branching. Lichenologists have long used the thigmotropic growth of the mycobiont around non-specific biotic and abiotic objects as evidence that the mycobiont's growth response in stage two is non-specific. Here we revisit classic experiments begun by Bonnier in 1889, using the mycobiont *Cladonia grayi* in various symbiosis pairings. Achieving the same results, we conclude differently that while *C. grayi* will grow over objects in its environment thigmotropically, it has a different and specific response to its photobiont. Early investigations into differential gene expression of *Asterochloris* sp. with *C. grayi* in stage 2 of lichen development will be discussed. (*Symposium*: Together and Separate: The Lives of the Lichen Symbionts)

***JONSSON, ANNA, MOEN, JON,** and **PALMQVIST, KRISTIN**

Umeå University, Department of Ecology and Environmental Science, 901 87 Umeå, Sweden

Predicting growth of mat-forming lichens across large-scale gradients of light, moisture and temperature in northern Scandinavia.

Growth of the two mat-forming lichens *Cladonia stellaris* and *Cetraria islandica* were studied along a large-scale temperature and precipitation gradient ranging from the north-east Swedish coast to the Norwegian mountain boarder in the west, displaying a natural temperature and precipitation gradient from -0.5 to 2.9 °C and 493 to 748 mm, yearly normal averages and sums respectively. At each of eight locations along the larger-scale gradient, the lichens were transplanted across a landscape-scale light-gradient, from dense forests to exposed clear cuts, for 16 months. The aim of the study was to examine to what extent relatively easily obtained variables can be used to predict lichen growth on these scales. Lichen growth in relation to relative light

exposure, precipitation and temperature was compared with their inherent growth capacity through measurements of the samples chlorophyll *a* concentration, in this way evaluating the relative contribution of external *vs* internal factors. (*Symposium*: Functional Ecology)

***JONSSON, ANNA[1], MOEN, JON[1],** and **PALMQVIST, KRISTIN[1]**

[1]Umeå University, Department of Ecology and Environmental Science, 901 87 Umeå, Sweden

Predicting lichen hydration using biophysical models

Two models for predicting the hydration status of lichens were developed as a first step towards a mechanistic lichen productivity model. A biophysical model included the water potential of the air, derived from measurements of air temperature, relative humidity and species-specific rate constants for desiccation and rehydration. A reduced physical model included only the environmental parameters. These models were developed using field and laboratory data for three green algal lichens; the foliose epiphytic *Platismatia glauca*, the fruticose epiphytic *Alectoria sarmentosa*, and the fruticose, terricolous and mat-forming *Cladina rangiferina*. Both models predicted length and timing of lichen hydration periods with high accuracy for *A. sarmentosa* and *P. glauca*. The model accuracy was lower for *C. rangiferina* compared to the epiphytes, mainly due to altered micro-climate conditions induced by the mat-forming growth form. The results demonstrate that the stochastic and continually varying hydration status of lichens can be simulated from biophysical data. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

JORDAN, PATRICK[2], PRINTZEN, CHRISTIAN[2] and **SPRIBILLE, TOBY[1]**

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[2]Forschungsinstitut Senckenberg, Abt. Botanik und Molekulare Evolutionsforschung, Frankfurt am Main, Germany; E-mail: pjordan@senckenberg.de.

Genetic variability of the bipolar lichen *Cetraria aculeata*

The fruticose lichen *Cetraria aculeata* is widely distributed in both hemispheres and displays a huge ecological amplitude. It occurs from alpine and arctic environments to dry grasslands in temperate and mediterranean regions. Based on DNA-sequences we are studying the genetic variability of the mycobiont in order to compare it with photobiont diversity and estimate the frequency of photobiont shifts in *C. aculeata*. A preliminary phylogenetic analysis of >150 ITS-sequences using tree-based and network-based methods shows more genetic diversity in temperate than in Antarctic populations. Individuals from South America and Antarctica seem genetically more closely related to North American than to Eurasian individuals. A genetically deviating clade includes individuals from Germany, Spain, Sweden and Turkey but apparently does not show morphological differences. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***JOVAN, SARAH[1], GEISER, LINDA[2], FENN, MARK[3], PORTER, MATT[4],** and **GLAVICH, DOUGLAS[2]**

[1]Oregon State University, Department of Botany and Plant Pathology, 2082 Cordley Hall, Corvallis, Oregon 97331-2902, USA; [2]US Forest Service, Pacific Northwest Region Air Program, PO Box 1148, Corvallis, OR 97330, USA; [3]Pacific Southwest Research Station, Forest Fire Laboratory. 4955 Canyon Crest Dr. Riverside, CA 92507, USA;.[4]Washington State University, Laboratory for Atmospheric Research, Pullman, WA 99164-2910, USA

Developing lichen-based critical loads for nitrogen deposition in western North America.

Critical loads (CLs) are an anticipated management tool in the US. We summarize progress toward lichen-based critical loads for nitrogen (N) in West Coast temperate coniferous forests. In the California Sierra Nevada, N deposition (n=11) was regressed against %N in *Letharia vulpina* (L.) Hue and abundance of N-sensitive and N-tolerant lichens. The uppermost limit of the natural range of %N in *L. vulpina* defined the most conservative CL (3.1 kg/ha/yr). Management to this CL would preempt major loss of acidophytes, including species utilized by wildlife. At 5.2 kg N ha-1 yr-1, N-tolerant neutrophytes dominate; complete acidophyte extirpation occurs at 10.2 kg/ha/yr. In western Oregon and Washington, epiphytic macrolichen community scores were linearly correlated to total N deposition across a network of 1500 survey sites. The CL, based on moderate sensitive species declines, was 3.7-5 kg/ha/ yr at 186 cm mean annual precipitation; and 1.5 to 9.2 kg/ha/yr 1 for the driest (44 cm) and wettest (451 cm) sites. We conclude that no single lichen-based CL will apply to the entire landscape; instead CLs must account for the diluting effect of precipitation. (*Symposium*: Air Pollution)

***JÜRIADO, INGA[1], LIIRA, JAAN[1], PAAL, JAANUS[1]** and **SUIJA, AVE[2]**

[1]Institute of Ecology and Earth Sciences, University of Tartu, 40 Lai St., 51005 Tartu, Estonia; [2] Natural History Museum of the University of Tartu, 38 Lai St., 51005 Tartu, Estonia.

Diversity of epiphytic lichens in boreo-nemoral forests in northern Europe: the effect of substrate-related factors and stand environmental conditions

The species richness, cover and composition of lichens were quantified for six temperate broad-leaved tree species in boreo-nemoral forests of Estonia (northern Europe). A total of 220 trunks of *Acer platanoides*, *Fraxinus excelsior*, *Quercus robur*, *Tilia cordata*, *Ulmus glabra* and *U. laevis* were analysed using 20 × 20 cm sample plots on tree boles. Host tree species, substrate properties and stand characteristics were evaluated by multivariate analysis and general linear mixed models, examining relationships between the characteristics of epiphytic lichen community and environmental conditions. Altogether 123 lichen species were found on the trunks of six broad-leaved tree species. The lichen communities on the studied trees were rather similar in terms of species composition. The most pronounced factors affecting the species richness, cover and composition of lichens on tree boles were bark acidity and cover of bryophytes. (Poster: Ecology, Thursday in Nautilus)

***KAASALAINEN, ULLA[1], JOKELA, JOUNI[2], FEWER, DAVID[2], SIVONEN, KAARINA[2]** and **RIKKINEN, JOUKO[1]**

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Toxic cyanobacteria in lichens

Microcystins are hepatotoxic heptapeptides produced by several types of cyanobacteria and they have caused poisonings of both humans and livestock. One lichen-associated *Nostoc* sp. strain has previously been reported to produce microcystins in pure culture. We have recently found a lichen-symbiotic *Nostoc* strain that produces biologically significant amounts of microcystins *in situ*. This is the first direct evidence for the production of microcystins in cyanolichens or other symbiotic associations. The finding is especially interesting because lichens are important winter food for reindeer and caribou. In parts of Asia some cyanolichen species are also used in traditional medicine and others are eaten by humans. (Poster: Symbiosis, Wednesday in Triton)

KANTVILAS, GINTARAS

Tasmanian Herbarium, Private Bag 4, Hobart, Tasmania, Australia 7001

Tasmania and its lichens: Antipodean hot-spot or just a nice place to work?

Tasmania's location, environment and biogeographical connections are outlined briefly. The first botanical investigations are traced, with reference to how perceptions of the uniqueness of the island's lichen flora have evolved. Historically, the description of the island's lichens has involved, on the one hand, the imposition of European names on superficially similar taxa, and, on the other, the description of many discoveries as new taxa, regardless of their relationships. Much of the task today involves a rationalisation of these opposing trends. The current census of Tasmania's lichen flora numbers approximately 1000 species of which c. 10% are endemic. However, these estimates are very fluid given the proportion of the island's flora that is yet to be named (estimated at *c.* 20%) and the incomplete knowledge of the lichens of nearby or related floras. Whereas Tasmania's lichen flora is undeniably rich in restricted and/or unusual species and genera, the current levels of endemism are likely to be overstated. Some of the more unusual lichen habitats and the remarkable taxa they contain, including species of *Austropeltum, Cladia, Jarmania, Parasiphula, Pseudoramonia, Siphulella* and *Wawea*, are illustrated. (*Symposium*: Endemics, especially in California)

KASZTA, Z[1,2] *PINHO, P[1], CRUZ, C1, DIAS, T[1], ROSA, AP[1], MÁGUAS, C[1], MARTINS-LOUÇÃO, MA[1], and **BRANQUINHO, C[1]**

[1]Universidade de Lisboa, Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Portugal;
[2]Jagiellonian University, Department of Biology and Earth Sciences, Institute of Environmental Sciences, Poland

Changes on lichens thallus pH caused by atmospheric ammonia: differences between species

In order have an insight into the effect of atmospheric ammonia (NH_3) on lichen ecophysiology, we have investigated the effect of this pollutant on thallus pH of epiphytic lichens in a cork-oak woodland, Portugal. For this purpose, we monitored the changes

in thallus pH in different lichen species and under different atmospheric ammonia conditions. This was done: i.) in the field (measuring at different months and at different distances from a cattle barn) and ii.) in laboratory conditions (where lichens were kept wet under different NH_3 concentrations for 72 hours). Under laboratory conditions, we found that the lichens thallus pH increased rapidly, and that the rate of thallus pH change depended on the initial thallus pH, being the more acidic thallus the fastest ones. In accordance to laboratory results we have observe that lichen thallus pH in the field were higher under greater atmospheric ammonia concentrations. Moreover, the pH changed over time at the different months, responding to the atmospheric ammonia concentrations observed. The results are discussed focusing in the implications of lichens thallus pH for the survival of the different lichen species. We also address the importance of the seasonality of water availability, typical of the Mediterranean climate, for the species tolerance/sensitivity to atmospheric ammonia. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

KELLER, CHRISTINE and ***SCHEIDEGGER, CHRISTOPH**

Swiss Federal Research Institute WSL, Zuercherstrasse 111, CH-8903 Birmensdorf

Paternity analyses reveal multiple mating events in apothecia of *Lobaria pulmonaria*

In *L. pulmonaria*, vegetative diaspores are regularly formed on thalli whereas sexual reproduction is often lacking in populations. Nonetheless, populations of *L. pulmonaria* investigated in natural forests revealed a genetic structure of an outcrossing species. We collected spores from single apothecia and extracted their DNA as well as the DNA of vegetative thalli of *L. pulmonaria* from the same population and analysed the sequence length of three fungus-specific microsatellite markers. We confirmed the haploid state of vegetative thalli but found up to three different alleles per marker in the multi-spore samples originating from single apothecia, which indicates (i) a heterothallic mating system and (ii) multiple mating events in apothecia with multiple sires involved. Comparison of the multilocus genotypes of vegetative thalli with the multi-spore extracts allowed to identify possible sires and to identify their position and distance to the maternal thallus. (*Symposium*: Between Individuals and Species: The Genetics of populations)

KNEŽEVIĆ, BRANKA[1], BILOVITZ, PETER O.[2] and ***MAYRHOFER, HELMUT[2]**

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Lichenized fungi of Montenegro

The project is based on an evaluation of literature records, on specimens kept in the herbarium GZU from short field trips in 1974 (leg. J. Poelt), 2004, 2005, 2007, 2008, and on specimens kept in H from a field trip in 1971 (leg. O. Vitikainen & P. Uotila). The Boka Kotorska region along the northern part of the Adriatic coast of Montenegro has been visited by several collectors (Weiss, Baumgartner, Vierhapper). The specimens of Weiss have been determined by Körber, the samples of the others by Zahlbruckner. Servít has investigated the same region and the mountain Lovćen. Kušan has sampled in the north-westernmost mountains close to the border to BiH. Vězda has distributed 32 taxa mainly collected along the coast in his famous exsiccati. Savić and Žukovec have reported lists of specimens from the Durmitor National Park. Recent floristic studies have included the Biogradska gora National Park and some sites in the environs of the unique Skadarsko lake. Based on more than 130 references and on the specimens kept in GZU the currently known lichen mycota comprises approximately 700 species of lichenized fungi. For comparison the recent checklist of Serbia includes 586 species. (Poster: Biogeography and Floristics, Monday in Nautilus)

***KNOWLES, REBECCA[1], PASTOR, JOHN[2]** and **BIESBOER, DAVID[3]**

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Increased soil nitrogen and foliar litter decay associated with terricolous dinitrogen-fixing lichens of the genus *Peltigera* in northern Minnesota

Dinitrogen (N_2)-fixing lichens (cyanolichens) have long been recognized as a source of exogenous N, yet ecosystem effects of this nitrogen input have been little studied. Cyanolichens of the genus *Peltigera* Willd. occur in diverse habitats globally. *Peltigera* often dominates the earth-dwelling (terricolous) cyanolichen community. Our objectives were to determine whether soil N availability and foliar litter decay are increased near healthy thalli of *Peltigera*. We measured available soil N, soil %N, potentially mineralizable N, and litter decay along transects extending away from *Peltigera*. Studies were conducted in ten types

of forest across northern Minnesota including contrasting sites that represent extremes of habitat for *Peltigera*. Soil N availability, soil %N, potentially mineralizable N, and rates of decay and net release of N and P from foliar litter increased significantly with proximity to *Peltigera* (P-values < 0.05). Our results suggest a potential zone of influence extending 1.5 m from thalli of *Peltigera*. (*Symposium*: Nutrient Exchange in Lichens and Bryophytes)

KNUDSEN, KERRY[1] and **KOURKOVÁ, JANA**[2]

[1]UCR Herbarium, Department of Botany and Plant Sciences, University of California, Riverside, California 92521-0124 USA; [2]National Museum, Department of Mycology, Václavské nám. 68, Praha 1, CZ-115 79 Czech Republic

Lichenicolous fungi of California

Over 500 lichenicolous fungi have been reported from North America. Comparatively over 400 lichenicolous fungi have been reported from Great Britain, a much smaller area. Currently we accept over 118 reports of lichenicolous fungi from California in our working checklist. Our field work in southern California has discovered many new records for North America and California as well as taxa new to science. A new genus and species, *Acaroconium punctiforme* Kocourková & Hawksworth, is discussed as well as a revision of lichenicolous *Polysporina* and studies of *Stigmidium* and *Gelatinopsis* taxa in press. The need for North Americans to study lichenicolous fungi is addressed. (*Symposium*: Lichenicolous Fungi: Taxonomy and Diversity)

***KOMINE, MASASHI, SATOH, HOTAKA, TAKAHASHI, KANAE, YAMAMOTO, YOSHIKAZU** and **HARA, KOJIRO**

Akita Prefectural University, Department of Biological Production, Shimoshinjo-nakano, Akita, Akita 010-0195, Japan

Observation of micro-thallus reproduction from the segments of thalli of *Cladonia* spp.

Lichens are thought to be useful industrial resources. Because of their slow growth, it is difficult to obtain a lot of lichens, so that we have studied about the forced cultivation technique of lichens. One of the problems related to forced cultivation is how lichen thalli is proliferated. The main objectives of this study were to develop the methods of artificially lichen increase, and in this presentation, micro-thallus reproduction from the segments was observed microscopically. The lichen species used were *Cladonia scabriuscula, C. krempelhuberi* and *C. macilenta*. Each lichen was cut or grained, and those segments were scattered on the gauze which was put upon the moss packed into laboratory dishes. After 90 days, the cross sections of reproduced micro-thallus were observed with the microscope. The reproduced micro-thallus was constructed independently from the original thallus. Their cortexes were thin, and their hyphae of the medulla were merged loosely. (Poster: Symbiosis, Wednesday in Triton)

***KOSUGI, MAKIKO**[1], **ARITA, MAIKO**[1], **SHIZUMA, RYOKO**[1], **MORIYAMA, YUFU**[1], **KASHINO, YASUHIRO**[1], **KOIKE, HIROYUKI**[1], **HANDA, SHINJI**[2] and **SATOH, KAZUHIKO**[1]

[1]Department of Life Science, School of Life Science, University of Hyogo, Harima Science Garden City, Hyogo, 678-1297, Japan; [2]Hiroshima Environment and Health Association, 9-1 Hirosekita-machi, Naka-ku, Hiroshima, Hiroshima, 730-8631, Japan.

Responses to desiccation stress in lichens are different from those in their photobionts

In order to clarify the role of symbiotic association in desiccation tolerance of photosynthetic partners in lichens, responses to dehydration in chlorolichens (*Ramalina yasudae* and *Graphis* sp.) and green algae (free-living, freshly released or cultured) were studied. Responses to dehydration in the isolated *Trebouxia* sp. were different from *R. yasudae.* That is, (1) the photosystem II (PSII) reaction was totally inhibited in *R. yasudae* when photosynthesis was completely inhibited by desiccation, but it remained active in *Trebouxia* sp. (2) Dehydration-induced quenching of PSII fluorescence was smaller in the *Trebouxia* sp. compared to that in *R. yasudae*. (3) The isolated and dried *Trebouxia* sp. showed a higher sensitivity to photoinhibition than *R. yasudae*. Depending on the culture conditions, desiccation tolerance of Trentepohliales and *Trebouxia* sp. decreased. These results show that the desiccation tolerance of photobionts is inducible and that association of the photobionts with the mycobionts increases tolerance to photoinhibition. (Poster: Symbiosis, Thursday in Triton).

***KRAICHAK, EKAPHAN**[1], **WHEELWRIGHT, NATHANIEL**[1], and **POPE, RALPH**[2]

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Community Structure of Macrolichens on a Boreal Island in the Bay of Fundy

This study is the first systematic investigation of the macrolichen flora and community structure of Kent Island, New Brunswick, Canada. A total of 43 species and 13 genera were identified, representing 20.4% and 27.7% of the numbers found in the mainland Fundy National Park. Low species richness on Kent Island is the result of isolation from the mainland, small size, and low habitat diversity of the island. The majority of lichen species have boreal and oceanic distributions, suggesting boreal characteristics of the island despite its low latitude (44°35´N). Coniferous forests on Kent Island have different lichen communities than deciduous forests, possibly as a result of forest structure and species' preference. However, macrolichen species seem to be more generalized than other taxa previously studied on the island. (Poster: Biogeography and Floristics, Monday in Nautilus)

***KRISHNAMURTHY, Y.L** and **VINAYAKA, K.S**

Department of P.G Studies and Research in Applied Botany Kuvempu University, Shankaraghatta, Shimoga-577451, Karnataka, India.

An Enumeration of Macrolichens from Central Western Ghats Karnataka, Southern India

The present paper deals with the diversity, distribution and ecology of 56 species of macrolichens from Central western Ghats, Karnataka, India. Lichens, the most successful of symbiotic organisms on earth, constitute the dominant life form over as much as 85 % of earth surface. India is a center of high lichen diversity and Western Ghats is one of the 34 biodiversity hot spots of the world. The present study was carried out in the area located at 11º31' N latitude to 78º 40' E longitude covering an area of 100 sq.km of central Western Ghats parts with high mountain regions at an elevation of 520m to 2150 above MSL. The area is situated in foot hills of central Western Ghats covering the Shimoga, Chickmagalur and Hassan Districts with different vegetation including evergreen, semi-evergreen, deciduous and montane types. This area receives annual rainfall of 100 to 380 cm, with an average temperature of 25.5°C. Thirty two localities belonging to different forest types in the study area were surveyed for macrolichens. The lichens were extensively collected from various substrates. The data on locality , altitude vegetation type , microhabitat and host tree were recorded . The collected specimens were dried, identified by using standard manuals(Awasti, 2000) and also by morphological, anatomical , chemical tests . The lichens specimens are preserved in the herbaria of Department of Applied Botany Kuvempu University,Shimoga, Karnataka and also kept another set in the herbarium of National Botanical Research Institute, Lucknow(LWG), India. The present study enumerated 56 species of macrolichens out of which 10 species are newly reported to Karnataka and 2 are newly reported to Western Ghats. They are *Heterodermia dendritica, Heterodermia albidiflava, Leptogium burnetiae, Phaeophyscia orbicularis, Ramalina hossei, Parmelia macrospora, Pyxine coccifera, Usnea aciculifera, Usnea vegae,* and *Usnea galbinifera.* The members of families Physciaceae and Parmeliaceae exhibited the maximum abundance and diversity. (*Symposium*: Tropical Lichenology)

LACKOVIČOVÁ, ANNA[1], *GUTTOVÁ, ANNA[1], PIŠÚT, PETER[2] and **GALVÁNEK, DOBROMIL[3]**

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Response of epiphytic lichens to the changes in air quality of Bratislava (Slovakia)

Historically relatively rich lichen flora of the town Bratislava (SW outskirt of the Western Carpathians; 368 km^2) almost totally declined due to high air pollution. Unfavourable situation changed after significant decrease of emissions after 1990. Current study refers to the ability of lichens to indicate positive changes in a short time period. Total up-to-date diversity of epiphytes is 61 species (mostly nitrophilous and toxitolerant, of the genera *Physcia* and *Physconia*). Air quality in urban districts was compared based on total diversity of epiphytic lichens, distribution of indicator species (using GIS techniques) and accumulation capacity of transplanted *Evernia prunastri*, *Parmelia sulcata* and *Hypogymnia physodes*. Seven elements (Cu, Cd, Cr, Mn, Ni, Pb and Zn) were analyzed by Atomic Absorption Spectroscopy. Spatial variation in concentration of the elements, correlation with vehicular traffic and the data from national monitoring system of emissions from stationary sources (NEIS) were analyzed by multivariate methods. (Poster: Environmental Monitoring, Friday in Merrill Hall)

LAKATOS, MICHAEL[1], HARTARD, BRITTA[1], and **MÁGUAS, CRISTINA[2]**

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Lichens as tracers of microenvironmental sources: a tool to study ecological changes

Due to their unique characteristics as well as their cosmopolitan distribution and sensitivity to a wide range of environmental changes, with both natural and human origin, lichens may also be used as good indicators of complex environmental changes that are normally associated with forestry and land-use changes. The objective is to show that lichens' $\delta^{13}C$ can be used as tracers for carbon acquisition, environmental change of CO_2 sources, and global change; while $\delta^{18}O$ of thallus water and respired CO_2 operates as a tracer for varying water sources to serve as an environmental integrator and recorder for soil-atmosphere exchange processes. For these variations in carbon sources, water exchange, and carbon dioxide fluxes were assessed by $\delta^{13}C$ and $\delta^{18}O$, in two distinct lichen communities from two different ecosystems: tropical forest and sand dunes in meso-mediterranean regions. Our results raised the value of the lichens' poikilohydry and the consequent possibility to trace changes associated with microhabitats and climate changes. (Poster: Environmental Monitoring, Friday in Merrill Hall)

LARSEN, ELLEN

University of Toronto, Cell and Systems Biology, 25 Harbord Street, Toronto, M5S 3G5, Canada.

Towards the development of a lichen model organism: will a foliicolous lichen fulfill the need?

A lichen model organism that develops and matures rapidly and reliably in the laboratory would be a boon to understanding how cells with two widely different genomes and properties can collaborate to produce morphologies that each alone is incapable of. Foliicolous lichens growing on plastic coverslips could offer many advantages. Gyalectidium sp. were chosen as potential models since they are widespread, common and reproduce both asexually and sexually. Asexual propagules seeded on the under side of plastic coverslips in a drop of water, developed thalli under tropical field conditions. In less than 4.5 months a hyphophore had developed from one thallus. Studies attempting to grow lichens from propagules in a laboratory growth chamber are underway. Equipment for facilitating microscopic examination of lichen containing coverslips in the field and returning them to continue growth will be described as will the current design of the growth chamber. (*Symposium*: Together and Separate: The Lives of the Symbionts)

***LARSSON, PER** and **GAUSLAA, YNGVAR**

Dept. of Ecology and Natural Resource Management, Norwegian University of Life Sciences, PO Box 5003, N-1432 Ås, Norway

Growth *in situ* of *Lobaria pulmonaria, L. scrobiculata and Pseudocyphellaria crocata*, area measurements with digital photography

The area growth of juvenile *Lobaria pulmonaria, L. scrobiculata* and *Pseudosyphellaria crocata* is quantified *in situ* on twigs of *Picea abies* in boreal Atlantic rain forests in Norway. Growth is monitored four times in a two years period by means of repeated digital photography. In addition, the first appearance and enlargement of surface areas devoted for vegetative reproduction propagules is recorded. Size-dependent growth curves and onset of reproductive stage will be used to assess the generation time under natural conditions. Data from the first 106 days show a relative rapid area growth of *L. pulmonaria* (53.8±7.4%), *L. scrobiculata* (37.8±3.8%) and *P. crocata* (46.1±6.4%). The data also support size dependent relatively growth rates of the two *Lobaria* species. Methodology and data for the two first recording intervals will be presented. (Poster: Ecology, Thursday in Merrill Hall)

LARSSON, PER, GAUSLAA, YNGVAR, and ***SOLHAUG, KNUT ASBJØRN**

Norwegian University of Life Sciences, Department of Ecology and Natural Resource Management, PO Box 5003, NO-1432 Ås, Norway.

Chlorophyll fluorescence as a method to quantify the light screening in lichen cortices

Radiation screening has been proposed as one functional role of secondary compounds in lichens. Since cortex samples for direct transmission measurements are difficult to prepare, indirect estimation of cortical radiation transmission is often necessary. Lichen compounds can be extracted by 100 % acetone from air-dry living thalli without any detrimental effects. The foliose lichen *Physcia aipolia* contained 2% atranorin of total dry mass. Control thalli of *P. aipolia* are pale gray both in dry and hydrated state, whereas acetone-rinsed thalli become green in the hydrated state. This colour change suggests a screening role of atranorin. Apparent electron transport rate (ETR) measured by chlorophyll fluorescence at light saturation was 40% higher in control thalli compared with thalli in which the atranorin had been removed. This indicates that atranorin located as white

extracellular crystals in the lichen cortex, screens about 40% of visible light in vivo presumably due to their high reflectance. (*Symposium*: Functional Ecology)

***LÄTTMAN, HÅKAN[1,2], MILBERG, PER[2], PALMER, MICHAEL W[3]** and **MATTSSON, JAN-ERIC[1]**

[1]School of Life Sciences, Södertörns Högskola, SE-181 49 Huddinge, Sweden and IFM Biology, Division of Ecology, Linköping University, SE-581 83 Linköping, Sweden; [2]IFM Division of Ecology, Linköping University, SE-581 83 Linköping, Sweden; [3]Department of Botany, Oklahoma State University, Stillwater, Oklahoma 74078, U.S.A.

Changes in the ranges of epiphytic lichens between 1986 and 2003, as assessed by presence-absence data

Past studies on changes in species ranges have mainly been based on analysis of range boundaries. In contrast, the method used here evaluates shifts in species' geographic centroids within a predefined area. Epiphytic lichens were collected 1986 and 2003 from 64 sites in southern Sweden and a geographic centroid was calculated each year for each lichen species and substrate. The shift of lichen centroids of *Hypogymnia physodes* (L.) Nyl. and *Vulpicida pinastri* (Scop.) J.-E. Mattsson & M. J. Lai on the tree species *Juniperus communis* L. was 50 and 151 km with the direction 26.9° and 47.7°, respectively. For *Hypogymnia physodes* on *Pinus sylvestris* L., corresponding values were 41 km 30.5°. We interpret the NNE shifts of these species in Sweden as a response to a warming climate. (Poster: Biogeography and Floristics, Monday in Nautilus)

***LAWREY, JAMES[1], LÜCKING, ROBERT[2], ERTZ, DAMIEN[3], SIPMAN, HARRIE J.M.[4],** and **BUNGARTZ, FRANK[5]**

[1]George Mason University, Department of Environmental Science and Policy, 4400 University Dr., Fairfax, Virginia 22030-4444, USA; [2]Department of Botany, The Field Museum of Natural History, 1400 South Lake Shore Drive, Chicago, Illinois 60605-2496, USA; [3]National Botanic Garden of Belgium, Department of Bryophytes-Thallophytes, Domaine de Bouchout, B-1860 Meise, Belgium; [4]Botanischer Garten & Botanisches Museum, Freie Universität Berlin, Koenigin-Luise-Strasse 6-8, D-14195 Berlin, Germany; [5]Charles Darwin Foundation for the Galápagos Islands, Av. 6 de Diciembre N 36-109 y Pasaje California, Post Box 17-01-3891, Quito, Ecuador.

Phylogenetic and ecological diversity of lichenized basidiomycetes

Although lichenization is an uncommon theme in the Basidiomycota, a wide range of associations can be observed in basidiolichens. Phylogenetic analyses indicate that this diversity is the product of recent, independent origin of lichenization in at least five separate clades of basidiomycetes, the Agaricales (*Dictyonema* spp., *Lichenomphalia* spp., *Acantholichen pannarioides*), Cantharellales (*Multiclavula* spp.), Corticiales (*Marchandiomphalina foliacea*), Hymenochaetales (*Cyphellostereum* spp.), and a family containing *Lepidostroma* spp. that appears to be derived from the Atheliales. Most clades contain only a single group of chlorolichens. In the Agaricales, however, lichenization is the dominant characteristic of a single, well-resolved clade that includes two major lichen-forming lineages, one made up of cyanolichens (*Dictyonema*, *Acantholichen*) and another of chlorolichens (*Lichenomphalia*). (*Symposium*: Together and Separate: The Lives of the Lichen Symbionts)

***LEAVITT, STEVEN D.[1]** and **ST.CLAIR, LARRY L.[1,2]**

[1]Brigham Young University, Department of Biology, 401 WIDB, Provo, Utah 84602, USA; [2]Brigham Young University,M.L. Bean Life Science Museum, 645 East 1430 North, Provo, Utah 84602, USA.

A multi-locus molecular evaluation of chemical and morphological characters in selected members of the lichen genus *Xanthoparmelia* (Ascoymycota, Parmeliaceae) from the Intermountain Western United States

In this study we evaluate taxonomically important morphological and chemical characters in *Xanthoparmelia chlorochroa*, *X. coloroadöenis*, *X. cumberlandia*, and *X. wyomingica* using phylogenetic analyses of five nuclear and a single mitochondrial marker. *Xanthoparmelia* specimens representing the above taxa were collected from eleven sites distributed throughout western North America. In all molecular analyses, taxonomic, chemical, and morphological groups were not found to be reciprocally monophyletic. Molecular markers that have been shown to be useful in delimiting species boundaries in other lichenized ascomycetes suggest a very recent morphological and chemical divergence between these species, or that characters preciously used to delimit these species' boundaries may have been overestimated. Whether some level of chemical and morphological diversity within *Xanthoparmelia* is environmentally induced or the result of a recent divergence remains in question. However, empirical operational criteria for delimiting species provide additional methods for evaluating species boundaries within *Xanthoparmelia*. (*Symposium*: Parmeliaceae: Development of a New Systematics)

***LEITH, IAN. D[1], SHEPPARD, LUCY. J[1], VAN DIJK, NETTY[1], CAPE, J. NEIL[1], SUTTON, MARK. A[1], ELIX, JACK. A[2] and WOODS, CLIVE[3]**

[1] Centre for Ecology and Hydrology Edinburgh, Bush Estate, Penicuik, Midlothian, EH26 0QB, UK; [2]Department of Chemistry, Faculty of Science, Australian National University, Canberra ACT 0200, Australia; [3]Centre for Ecology and Hydrology Lancaster, Lancaster Environment Centre, Library Avenue, Bailrigg, Lancaster, LA1 4AP, UK.

Does nitrogen form or the addition of phosphorus and potassium influence nitrogen deposition effects on lichens and bryophytes?

Although the sensitivity of many lichens and bryophytes to nitrogen (N) deposition is well established, the long-term effects of the different forms of reactive N on nutrient sensitive habitats are not fully known. We report the results from a large-scale N field manipulation study, which compared directly the impacts of dry N deposition (gaseous ammonia) and wet N deposition (ammonium or nitrate) and additional phosphorus and potassium (P&K, in proportion to N) on lichen and bryophyte species of an ombrotrophic bog in south-east Scotland. The influence of N form, dose and P&K additions on foliar nutrition, visible damage, species abundance/diversity and secondary metabolites of lichens and bryophytes will be presented. Per unit N, dry deposition (ammonia) is more damaging to lichens and bryophytes than wet N deposition (ammonium or nitrate). There were specific N form and dose impacts with the addition of P&K to selected N treatments. (*Symposium*: Nutrient Exchange in Lichens and Bryophytes)

LINDBLOM, LOUISE[1] and **SØCHTING, ULRIK[2]**

[1]Department of Biology, University of Bergen, P.O. Box 7800, NO-5020 Bergen, Norway; [2]Department of Biology, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark.

***Xanthomendoza borealis* - a bipolar lichen species**

Xanthomendoza borealis (Poelt & Santesson) Søchting, Kärnefelt & S.Kondratyuk and *Xanthoria mawsonii* C.W.Dodge are two xanthorioid taxa with separate geographical distribution. Since they have been hypothesized to be conspecific, they were revised. We provide a haplotype network based on total ITS data, showing no discontinuous molecular variation between the two taxa. *Xanthoria candelaria* is distinct from both. These results are in accordance with observations from morphology, anatomy, and secondary chemistry. We conclude that most specimens determined to *X. mawsonii* from Antarctica are conspecific with specimens labelled *X. borealis* from the Northern Hemisphere. In addition, several specimens labelled *X. mawsonii* are wrongly determined *X. candelaria*. This includes the holotype of *Xanthoria mawsonii.* Accordingly, the name *Xanthoria mawsonii* is synonymous with *X. candelaria*. Most collections from the Northern Hemisphere (named *X. borealis*) and from Antarctica (named *X. mawsonii*) belong to one true bipolar species and the correct name is *Xanthomendoza borealis*. (Poster: Biogeography and Floristics, Monday in Nautilus)

***LLOP, ESTEVE**

Universitat de Barcelona, Departament de Biologia Vegetal (Botànica), Avda. Diagonal 645, E-08028 Barceona, SPAIN.

What's behind *Bacidina*: the Mediterranean experience?

The genus *Bacidina* in the sense of Vězda has been so controversial, and its entity has been questioned recently. The presence of species from the Mediterranean region, which can be included in *Bacidina* in the basis of morphological features, is discussed. Two groups of species can be distinguished based on biogeography. There is a temperate to boreal group and a tropical group; both are reaching the limits of their area of distribution. (Poster: Biogeography and Floristics, Monday in Nautilus)

***LLOP, ESTEVE** and **GÓMEZ-BOLEA, ANTONIO**

Universitat de Barcelona, Departament de Biologia Vegetal (Botànica), Avda. Diagonal 645, E-08028 Barceona, SPAIN.

Evaluation of the quality of holm oak forests using lichen species richness

The study has been carried out on old-growth stands of holm oak forests, from an area in the north eastern of the Iberian Peninsula. The study has included not only epiphytic lichens but also saxicolous and terricolous, in order to obtain a global view of lichen communities. The analysis of lichen flora from several holm oak forests is correlated with forest parameters such as

diameter at breast height, in order to assess their quality. Relationships between the lichen flora and the criteria applied to describe some forests as mature are evaluated. (Poster: Ecology, Thursday in Merrill Hall)

LÜCKING, ROBERT

Department of Botany, The Field Museum, 1400 South Lake Shore Drive, Chicago, IL 60605, U.S.A.

How many tropical lichens are there – really?

Estimates for the number of lichen species range between 13,500 and 20,000. This uncertainty is due to the lack of knowledge of tropical taxa. We used these assumptions to come up with an estimate of how many species occur in the tropics: (1) Species richness is logarithmically correlated with area; (2) observed Neotropical versus Costa Rican ratios range between 1.5:1 and 3:1; (3) the ratio of total versus foliicolous species is 6–12:1; (4) both longitudinal (Neotropics versus Paleotropics) and latitudinal (tropics versus extratropics) differentiation increase species richness roughly by the factor 2:1. Based on 2,800 total and 400 foliicolous species in Costa Rica and 700 foliicolous species for the entire Neotropics, the total for the Neotropics is estimated at 7,000 and for the entire tropics at 13,000. This would raise global richness to 24,000 species. Half of the Neotropical species are epiphytic microlichens, 50% of which remain to be documented. (*Symposium*: Tropical Lichens and Bryophytes)

LÜCKING, ROBERT[1], PÉREZ-PÉREZ ROSA EMILIA[2] and **HERRERA-CAMPOS, MARÍA ANGELES[3]**

[1]Botany Department Botany, Field Museum, 1400 South Lake Shore Drive, Chicago, Illinois 60605-2496, USA; [2]Facultad de Ciencias Biológicas. Av. Universidad 1001, Col. Chamilpa, Cuernavaca Morelos. CP. 62210, UAEMor.; [3]Instituto de Biología, UNAM, Departamento de Botánica, Apdo. Postal 70-233, Coyacán 04510, México, D. F.

Preliminary studies on microlichens from tropical forests in Mexico

Corticolous microlichens in Mexico have mainly been studied in the frame of the Sonoran Desert Region survey headed by Arizona State University, lacking a systematic inventory for important tropical humid and dry ecosystems. In order to change this situation, a program was initiated to study the corticolous crustose lichens in the rainforests and cloud forests, as well as in the deciduous forests. Up to date, collections from the humid forests of southern states of Puebla, Oaxaca, Veracruz, and Quintana Roo add more 200 species, half of which represent new records for the country. We will be able substantially increase this number with the collections at the tropical deciduous forest of Jalisco. The data are used to establish floristic and biogeographic differences and similarities among these sites. (Poster: Biogeography and Floristics, Monday in Nautilus)

LÜCKING, ROBERT[1], RIVAS PLATA, EIMY[1,2], MANGOLD, A.[1,3] and **LUMBSCH, H. THORSTEN[1]**

[1]Department of Botany, The Field Museum, 1400 South Lake Shore Drive, Chicago, IL 60605, U.S.A.;[2]Ecology and Evolution Program, Department of Biological Sciences, University of Illinois at Chicago, 845 West Taylor Street, Chicago, IL 60607, U.S.A.; [3]Fachbereich Biologie und Geographie, Universität Duisburg-Essen, Universitätsstr. 15, D–45149 Essen, Germany

TaxaBLAST: A simple yet effective method to identify taxa in species-rich, complex taxonomic groups

We present a simple, effective method to identify taxa in species-rich and taxonomically complex lichen groups. TAXBLAST uses spreadsheet software, coding characters as ordinable integer variables. Selected characters are observed for unidentified samples and a simple algorithm calculates correlation coefficients between the unidentified sample and the taxa in the spreadsheet, which are then sorted in descending order. TAXBLAST has several advantages over traditional and interactive keys: 1) it works fast even for large and heterogeneous datasets; 2) no decision-making process is required, neither for producing a key nor for the actual identification work itself; 3) no taxa are excluded during the identification process and results can be immediately compared across all taxa; 4) the dataset can easily be modified and improved; and 5) the method can be used and implemented by anyone familiar with spreadsheet software. Sophisticated details such as links to images directly from spreadsheet records are possible. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

LUO, HENG, KOH, YOUNG JIN, and ***HUR, JAE-SEOUN**

Korean Lichen Research Institute, Sunchon National University, Sunchon 540-742, Korea

Usnic acid production by culture of lichen-forming fungus of *Usnea longissima*

This study was aimed to optimize the culture conditions for the production of usnic acid in the cultured cell aggregates of lichen-forming fungus isolated from Chinese lichen *Usnea longissima* in vitro. Growth of the fungus was strongly affected by different culture conditions. The addition of excess carbon and nitrogen sources in malt-yeast extract (MY) medium has significantly enhanced fungal growth as well as usnic acid content. The fungus in MY medium having 1% ribitol and 0.5% peptone gave 2.78 mg dry biomass per 1 ml of the medium. Addition of 1% glucose and 0.5% ammonium produced 0.08μM of usnic acid in 1 ml medium. The fungus showed feasible growth at 15^{o}C and pH 7. This study suggested that modification of cultural conditions can enhance lichen-forming fungal growth and usnic acid production in vitro. (Poster: Symbiosis, Wednesday in Triton)

LUTZONI, FRANÇOIS

Department of Biology, Duke University, Durham, NC, USA 27708.

A symbiotic approach to the study of lichens

Major advances in lichenology are more likely to be attained through a coordinated multidisciplinary approach, involving the interplay of theoretical and empirical research, and focusing on the study of closely related symbiont species expressing variability for traits of interest. A synthesis of the results from evolutionary, genetic/genomic, and ecological studies centered on lichen symbiosis will be presented. Phylogenetics provides a logical and primary framework for this integrative research. A phylogenetically based reconstruction of the past sheds new light on our understanding of current biological trends. The testing of hypotheses derived from this more comprehensive knowledge has a greater potential to yield major discoveries in all fields of biology. Large-scale phylogenetic studies are essential to this endeavor and necessitate data management pipelines to generate large and high quality data sets. The latest bioinformatic tools (WASABI) developed as part of the Assembling the Fungal Tree of Life (AFToL 2) project as well as its overarching phylogenomic goals will also be presented. (Invited lecture)

***MARMOR, LIIS** and **RANDLANE, TIINA**

University of Tartu, Institute of Ecology and Earth Sciences, 38 Lai St., Tartu 51005, Estonia. E-mail: marmor@ut.ee

Effects of road traffic on bark pH and epiphytic lichens in Tallinn

The relationships between traffic-related air pollution, bark pH and epiphytic lichen mycota on *Pinus sylvestris* (acid bark) and *Tilia cordata* (subneutral bark) were studied. The effects of traffic pollution depended on tree species. Traffic affected bark pH of *P. sylvestris*, but not of *T. cordata*: the normally acid bark of *P. sylvestris* was modified to subneutral near roadways. Lichen species richness increased on *P. sylvestris* near roadways but decreased on *T. cordata*. The influence of dust pollution, connected with traffic, was clearly observed on epiphytic lichen composition of *P. sylvestris*: alkaline pollution sensitive acidophilic species had disappeared and neutrophytic species appeared. Therefore, alkaline dust pollution can be indicated by the presence of neutrophytic lichens in the species composition of *P. sylvestris* but not by epiphytic lichens on *T. cordata*. (Poster: Ecological Monitoring, Friday in Merrill Hall)

***MARTIN, JÜRI** and **MARTIN, LJUDMILLA**

Eurouniversity, Department of Environmental Protection, 4 Mustamäe Rd., 10 621 Tallinn, Estonia

Lichen collection from Great Smoky Mountains National Park at EuroUniversity, Tallinn

All the six Appalachian Mountains endemic lichen species recorded to GRSM have been confirmed by our collection: *Alectoria fallacina, Heterodermia appalchensis, Cetradonia linearis (Gymnoderma lineare), Hypogymnia krogiae, Hypotrachyna virginica*, and *Punctelia appalachensis.* The following endemic lichen species belonging to different geographic regions have been confirmed to GRSM NP: five of the six endemic lichen species for Appalachian Mountains-Great Lakes region; the presence of *Dirinaria frostii*, endemic species to Appalachian Mountains - Ozark Mountains region; three of the five endemic species for southeastern United States have been recorded to GRSM NP; five of the six endemic species of the region of Eastern United States - Southernmost Eastern Canada; five species recorded from Tennessee are endemic to North America north of Mexico: four of them have been recorded to GRSM NP and also confirmed by our collections. Our Great Smoky Mountains lichen collections include 250 species. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

MARTIN, LJUDMILLA, ŠADRINA, TATJANA and **MARTIN JÜRI**

EuroUniversity, Department of Environmental Protection, 4 Mustamäe Rd., 10621 Tallinn, Estonia

Lichens on concrete

Lichens comprise a substantial component of urban vegetation. They find habitat in new ecological niches including surfaces of concrete structures. Concrete may be viewed as an initially free surface, and it is essential to study the composition of pioneering lichen synusia under the conditions of anthropogenic impact. It is for the first time that research has been conducted in Estonia into the lichen floristic composition on concrete surfaces. The material collected at 93 experimental sites has enabled to single out 61 species of lichens. New locations have been established for 11 species rare for Estonia´s lichenoflora. A species has been discovered not encountered in Estonia previously—*Sarcopyrenia gibba*. Two rare lichen species in Estonia – *Lecania erysibe* and *Aspicilia moenium* were found in 25% of sample sites on concrete structures of different age. (Poster: Ecology, Thursday in Merrill Hall)

***MATTSSON, JAN-ERIC[1], VINTER, TIINA[1], ROBECK, ALEXANDRA[1]** and **WEDIN, MATS[2]**

[1]Södertörn University College, School of Life Sciences, SE-141 89 Huddinge, Sweden; [2]Swedish Museum of Natural History, Cryptogamic Botany, P.O. Box 50007, SE-104 05 Stockholm, Sweden

Parmeliaceae - a family with obscure relations revisited

The Parmeliaceae has been studied by phylogenetic methods during the last 20 years which have resulted in fairly weakly supported evolutionary hypotheses but with strongly supported groups. In order to evaluate the importance of sample selection and the number of genes used a renewed analysis with the similar taxon sampling as a previously published analysis but with other individuals is presented. The analysis is based on DNA sequence data from four nuclear and one mitochondrial marker from about 120 taxa. The results are mainly in concordance with earlier hypotheses but some interesting differences will be discussed. (*Symposium*: Parmeliaceae: Development of a New Systematics)

***McCUNE, BRUCE** and **CALDWELL, BRUCE**

Oregon State University, Department of Botany & Plant Pathology, 2082 Cordley Hall, Corvallis, Oregon 97331-2902, USA.

A single phosphorus treatment doubles growth of cyanobacterial lichen transplants

Lichens are reputedly slow growing and become sick or die in response to supplements of the usual limiting resources, such as water and nitrogen. We found, however, that the tripartite cyanobacterial lichen *Lobaria pulmonaria* doubled in annual biomass growth after a single 20-minute immersion in a phosphorus solution (K_2HPO_4), as compared to controls receiving no supplemental phosphorus. This stimulation of cyanolichens by phosphorus has direct relevance to community and population ecology of lichens, including improving models of lichen performance in relation to air quality, improving forest management practices affecting old-growth associated cyanolichens, and understanding the distribution and abundance of cyanolichens on the landscape. Phosphorus may be as important a stimulant to cyanobacterial-rich lichen communities as it is to cyanobacteria in aquatic ecosystems. (Poster: Ecology, Thursday in Merrill Hall)

***MCDONALD, TAMI, ARMALEO, DANIELE,** and **LUTZONI, FRANCOIS**

Duke University, Department of Biology, Durham, North Carolina 27708, USA.

DNA methylation in the lichen-forming fungus *Cladonia grayi*

C5 DNA methylation is an epigenetic modification of cytosine associated with gene silencing in eukaryotic development and genome protection. When DNA methylation is present in fungal genomes, usually only repetitive elements or regions of foreign DNA are subject to methylation. However, DNA from lichen-forming fungi appears to be heavily methylated genome-wide. Interestingly, the DNA is methylated only when the fungus is in association with the alga, and is unmethylated when the fungus is grown alone, suggesting a link between lichenization and DNA methylation. We attempt to determine which genes or regions of DNA are subject to DNA methylation in a symbiosis-specific manner using Methylated DNA Immunoprecipitation (MeDIP) and other molecular techniques. We use southwestern blotting on a selection of lichens to demonstrate the generalization of DNA methylation to the symbiosis. We also clone and characterize two genes involved in gene silencing upstream of DNA methylation in eukaryotes. (*Symposium*: *Xanthoria* and *Physcomitrella* Genomics: Potentials for New Research)

***MIKHAILOVA, IRINA** and **BOULDAKOV, MIKHAIL**

Institute of Plant and Animal Ecology, 202 8 Marta Str., Ekatertinburg 620144, Russia

Pollution tolerance in lichens: population approach

Population structure, anatomy of thalli, composition, viability and toxitolerance of soredia were studied in several vegetatively reproducing lichen species in the vicinity of a copper smelter in the Middle Urals. Viability and toxitolerance of soredia under controlled laboratory conditions were shown to be species-specific characteristics. Comparison of germination rates of soredia of four lichen species at different Cu concentrations of the culture medium showed that soredia of pollution-resistant species tolerated higher Cu concentration as compared to soredia of sensitive species. However, pollution regime of a habitat might influence viability and toxitolerance of soredia. Though pollution suppresses vegetative reproduction (which is evident from low number of sorediate thalli in polluted areas), there are certain evidences for the existence of pollution-tolerant *Hypogymnia physodes* populations near the emission source. The evidences include high toxitolerance of adult thalli (existence of undamaged native thalli where transplants showed signs of injury after few months of exposure) and soredia (shown in both field and laboratory culture experiments). (Poster: Ecological Monitoring, Friday in Merrill Hall)

MIKRYUKOV, VLADIMIR[1], WIDMER, IVO[2], *MIKHAILOVA, IRINA[1], and **SCHEIDEGGER, CHRISTOPH[2]**

[1]Institute of Plant and Animal Ecology, 202 8 Marta Str., 620144 Ekatertinburg, Russia[2] Swiss Federal Institute for Forest, Snow and Landscape Research, WSL, CH-8903 Birmensdorf, Switzerland

Genetic structure of *Lobaria pulmonaria* populations in the Ural Mountains (Russia) studied with microsatellites

Three mycobiont-specific microsatellite loci were used to investigate genetic diversity and differentiation of populations of *Lobaria pulmonaria* from the Ural Mountains. DNA was isolated from 752 lichen thalli sampled from 8 localities raging from southern to northern parts of the mountain system. The analysis of the data with a Bayesian clustering method for inferring population structure revealed that all samples were grouped in four major populations according to their geographical origin. In all genotyped specimens, 185 (25%) different multilocus genotypes were found. Interpopulation analysis revealed a low but statistically significant genotypic differentiation between spatially distant localities. Relatively high levels of variation within and moderate genetic variation among populations of *L. pulmonaria* were found. Because of a generally low level of genetic differentiation among areas and a substantial level of shared genotypes, our data suppose high levels of gene flow among populations. In spite of the absence of *Lobaria* samples from the Middle Urals, our study does not reveal any indications of gene flow restrictions in the area. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***MILLANES, ANA M[1], DIEDERICH, PAUL[2]** and **WEDIN, MATS[3]**

[1]Universidad Rey Juan Carlos, Departamento de Biología y Geología, E 28933 Móstoles, Madrid, Spain; [2]Musée national d'histoire naturelle, L-2160, Luxembourg; [3]Naturhistoriska riksmuseet, Sektionen för kryptogambotanik, S-10405 Stockholm, Sweden

Phylogenetic relationships among lichenicolous and non lichenicolous *Tremellales*

Tremellales (Basidiomycota, Fungi) mainly comprises fungi growing on other fungi, including lichens. Most species of the order with a lichen-inhabiting life-style were described in 1996, together with other lichenicolous Heterobasidiomycetes. The majority of them are gall-inducing fungi that are easily observed on the lichen hosts, although an increasing number of macroscopically asymptomatic taxa have recently been detected when these fungi interfere in PCR experiments on lichens. Phylogenetic relationships among lichenicolous *Tremellales* and their non-lichenicolous relatives is here investigated for the first time based on DNA sequence data. A general phylogeny including representatives of all nutritional habits is presented and the intra and suprageneric relationships in the group are investigated, including aspects of generic delimitation. The evolution of the nutritional habit in *Tremellales* will be discussed. (*Symposium*: Lichenicolous Fungi: Taxonomy and Diversity)

***MIRAMONTES-ROJAS, NOEMI[1], QUIROZ-CASTELÁN, HÉCTOR[2]** and **PÉREZ-PÉREZ, ROSA[1]**

[1]Facultad de Ciencias Biológicas-UAEM, [2]Centro de Investigaciones Biológicas-UAEM. Av. Universidad 1001, Col. Chamilpa 62210, Cuernavaca, Morelos, México.

Diversity of corticolous macrolichens on *Pinus ayacahuite* in the Nacional Park Lagunas de Zempoala, Estado de México.

This study evaluates the effects of anthropogenic perturbation on the richness and cover of corticolous macrolichens on *Pinus ayacahuite* Ehren. A total of 20 corticolous macrolichens were found. In forest structure, K-W test did not show any significant difference in DBH only in height. Species richness and cover varied significantly among the north and south side of *P. ayacahuite*. The results obtained with the randomized block experimental design, indicated significant differences among the orientation in the tree. The results suggest that corticolous macrolichens are indicators of perturbation because they were affected by the lost and transformation of the ecosystem caused by the fire and the anthropogenic disturbance. (Poster: Ecology, Thursday in Merrill Hall)

***MISHLER, BRENT D., NORRIS, DANIEL H.** and **SHEVOCK, JAMES R.**

University and Jepson Herbaria, University of California, Berkeley, CA 94720, USA

California and its Endemics with an Emphasis on Bryophytes

California is a place of high diversity, a natural laboratory for the study of evolution. Its climate is Mediterranean: hot, dry summers and cool, wet winters. Localized moisture, soil, and microclimatic conditions give rise to a diverse number of communities. The biogeography of California is further influenced by its "island" aspect-- the relatively humid strip west of the Sierran axis is isolated from the Rockies and the eastern US by very dry deserts. This results in a rich and unusual biota for the state, with many endemic species. For example, fully 24% of the 3,425 native species of vascular plants in California are endemic; far more than in any other state, including Hawaii. There are comparatively few endemic species of bryophytes, but comparisons of endemicity with vascular plants are problematic because species concepts in bryophytes are quite different, and exploration of the bryoflora of the state is far from complete. (*Symposium*: Endemics, especially in California)

***MIRANDA, RICARDO**[1] and **CASTILLO, JOSÉ**[1]

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Lichen succession on the cactus *Myrtillocactus geometrizans*, an extreme process. Mexico

It is well known that corticolous lichen communities change when the bark ages, and that lichen richness and cover tend to increase. But, how does the succession process works on a living green bark? In order to answer this, we measure the lichen richness and cover of several cacti, and correlate the results with tree age, health and some chemistry and physical factors of the bark. The preliminary results show that most of the cacti do not present lichens at all. It seems that when *M. geometrizans* has a healthy, green bark, lichens can not grow, but once the bark starts to die a single cactus can have more than 70% of the total corticolous lichen species in the area, which is more than any other tree in the area. We also found that *M. geometrizans* have species that typically grow on rocks, like C*andelina mexicana* and *C. submexicana*. (Poster: Ecology, Thursday in Merrill Hall)

MOLINA, M. CARMEN[1], **DEL PRADO, RUTH**[2] and ***CRESPO, ANA**[2]

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***Parmelia mayii* sp. nov., a new species in the *Parmelia saxatilis* complex located in North America**

In recent studies, it has been demonstrated that the morphological species concept in *Parmelia saxatilis* complex does not always coincide with genetically monophyletic unit. *P. serrana* was segregated from P. saxatilis s. str. primarily based on molecular phylogenetic monophyletic group and also supported by morphological traits. *P. ernstiae* was also separated from *P. saxatilis* complex on the basis of molecular, morphological and ecological character. In North America and Japan, the identification of species within the *Parmelia* group has been traditionally difficult. For example, most specimens usually identified as *P. saxatilis* in herbaria, have proved to be *P. squarrosa*. And also, *P. saxatilis* could morphologically be confused with *P. kerguelensis* or *P. hygrophyla* without a carefully examination. Molecular studies of samples from three different regions of North America revealed that populations collected from Montana belong to the *P. saxatilis* s. str. clade, but other populations located in the Northeast Coast emerged as a new evolutionary linage. Consequently, Northeast Coast population is described as a new species (*P. mayii*) to science. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

MOLINA, M. CARMEN[1], DIVAKAR, PRADEEP. K. [2], HAWKSWORTH, DAVID. L.[2] and ***CRESPO, ANA[2]**

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***Parmelia sulcata* s. lat. (Parmeliaceae; Ascomycota), a sympatric monophyletic species complex**

The species is the fundamental unit in biology and biodiversity conservation but frequent reports of cryptic species in fungi make necessary molecular studies for identifying species within species complex. *Parmelia sulcata* (Parmeliaceae, Crespo *et al.* 2007) is a widely distributed species and one of the most common taxon in temperate Europe. The first intra-specific molecular studies on *P. sulcata* showed an unexpectedly high genetic variability. Crespo et al., (1999) reported differential distribution of haplotypes in relationship with environmental parameter. In this research project, we use extensive taxa sampling to examine 1) the genetic diversity and 2) phylogeny of *P. sulcata* species complex. Specimens from four continents including type locality, America, Africa, Europe and Antarctica are sampled. Besides, the use of the intron as species marker in Parmeliaceae and the beta-tubuline partial gene as molecular marker in phylogenies is also discussed here. Like wise in other species within *Parmelia* genus, an important genetic diversity was detected in *P. sulcata*, which supports the establishment of new phylogenetic species within a morpho-species complex. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***MONCADA, BIBIANA**

Universidad Distrital Francisco José Caldas. Bogotá –Colombia. Lic. en Biología. Cra. 4 #26B-54 Herbario Forestal Emilio Mahecha –Sección Criptógamas.

New records for the lichen flora of Colombia

Thirteen species of lichens are presented as new records for Colombia: *Canomaculina leucosemotheta* (Hue) Elix, *Cladonia humilis* (Withering) J. R. Laundon, *Cladonia polystomata* Ahti y Sipman, *Coccocarpia myriocarpa* L.Arvidss., *Dichosporidium nigrocinctum* Ehrenb., *Heterodermia angustiloba* (Müll. Arg.) Awas, *Hypotrachyna lineariloba* (Kurok) Hale, *Hypotrachyna steyemarkii* (Hale) Hale, *Leptogium hibernicum* Match. Ex P. M. Jorg., *Parmeliella triptophylla* (Ach.) Müll. Arg., *Parmotrema louisianae* (Hale) Hale, *Parmotrema sorediiferum* Hale y *Physcia albata* (F. Wilson) Hale. Anatomical and morphological descriptions are provided for each species, together with results from chemical tests with K, P, C y KC, and ecological and distributional data. Distributional ranges in Colombia for 45 genera and 145 species are broadened to include records from the northern extreme of the Eastern Cordillera in the department of Norte de Santander, near the Venezuelan border. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

MOTIEJŪNAITĖ, JURGA[1] and KUKWA, MARTIN[2]

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***Pronectria minuta*, a new lichenicolous ascomycete from Poland and Russia**

A new species *Pronectria minuta* (Bionectriaceae, Hypocreales) is described from *Cladonia* (subgen. *Cladina*). It was first found in NW Russia growing on *C. stellaris*, later additional specimen was collected in Poland on *C. arbuscula* s. l.. The new species is characterized by combination of both very small ascospores and minute ascomata. The separation of the fungus from *P. tibellii* Zhurb.(Zhurbenko and Alstrup 2004), the only other *Pronectria* species known as occurring on *Cladonia*, as well as some other species with small spores is discussed. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

MRAK, TANJA[1], *JERAN, ZVONKA1, BATIČ, FRANC[2], WONISCH, ASTRID[3], REMELE, KLAUS[3], SANITA DI TOPPI, LUIGI[4], VURRO, EMANUELA[4]

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[2]University of Ljubljana, Biotechnical Faculty, Department of Agronomy, Jamnikarjeva 101, 1000 Ljubljana, Slovenia;
[3]University of Graz, Institute of Plant Sciences, Schubertstrasse 51, 8010 Graz, Austria; [4]University of Parma, Department of Evolutionary and Functional Biology, viale delle Scienze 11/A, 43100 Parma, Italy

Thiol status in lichens exposed to arsenic in controlled conditions

Thalli of epiphytic *Hypogymnia physodes* (L.) Nyl. and terricolous *Cladonia furcata* (Huds.) Schrad. collected from an area with background arsenic concentrations were exposed to 0, 0.1, 1 and 10 µg/mL arsenate (As(V)) solutions for 24 h. After exposure they were kept in metabolicaly active state for 0, 24 and 48 h in the growth chamber. In freeze dried samples total and oxidized glutatione were analysed and induction of phytochelatin synthesis checked by reversed phase chromatography coupled to fluorescence/UV spectrometry. Total arsenic content in thalli was measured by INAA. In *H. physodes*, containing higher amounts of arsenic in comparison to *C. furcata*, total glutathione content significantly decreased in samples exposed to 10 µg/mL As(V), whereas in *C. furcata* a significant increase was observed. In both species, phytochelatin synthesis was induced in thalli exposed to 10 µg/mL As(V). (Poster: Physiology and Ecophysiology, Friday in Nautilus)

MUCHNIK, EUGENIA

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Evaluation of the significance of different abiotic factors for species of the Parmeliaceae family in the Russian forest-steppe zone

We have examined requirements of 38 lichen species of Parmeliaceae family growing in the Russia forest-steppe zone for a number of ecological factors (substrate type and pH, habitat transformation level, illuminance, humidity). A 3-point scale was employed to evaluate the factor significance. The resulting "total point" of a species in the 5 factors cited above allows to assess the breadth of a species ecological niche and, based upon that, to predict the species "vulnerability level": because a higher total point means a narrower ecological niche, and, correspondingly, a higher risk of the species extinction. We managed to establish a relationship of a species "total point" to its occurrence in the region, and to form an approximate scale for the sensitivity of epiphytic species of the Parmeliaceae family to air pollution. We noted species supposed to be the most sensitive to climate change in the region. (*Symposium*: Community Structure and Dynamics)

***MUGGIA, LUCIA[1]** and **GRUBE; MARTIN[1]**

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Polyketide synthase genes in lichens: evolution and diversity

Most of lichen secondary metabolites are polyketides. These compounds are synthesized by type I polyketide synthase (PKS) enzymes. Several catalytic domains constitute these large proteins. Analyses of the ketoacyl synthase (KS) domains indicated the presence of several PKS paralogs in the lichen genomes. Purifying selection, suggesting that all paralogs are functional, largely drives their evolution. The strong evidence for purifying selection and the wide distribution of certain paralogs in ascomycetes suggests early gene duplication events in the evolutionary history of PKSs in the Ascomycota. We use a heterologous primer approach to amplify paralogs of different classes. We find a rich diversity of PKS genes in lichens, not only representing fungal type I genes and not only from the lichen mycobiont. (*Symposium*: Functional Ecology)

***MUGGIA, LUCIA[1], GRUBE; MARTIN[1],** and **ZELLNIG GÜNTHER[1]**

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Characterization of the trebouxioid photobiont of *Tephromela atra* (Lecanorales, Ascomycota) from the Mediterranean region

Ultrastructural characters were long used in the classification of the lichen photobionts. As their observation is only possible when the algae are axenically cultured, the isolation of lichen photobionts in cultures was essential for describing new species. Many lichenized ascomycetes form associations with algae belonging to the genus *Trebouxia*. The *Trebouxia* species differ in the type of spore formation, cell shape, structure of the cell walls, morphology of the chloroplast, and pyrenoid structure. The latter represent a very stable character, which is usually not influenced by different culture conditions. Recent molecular analyses of the photobiont diversity in lichenized taxa of the *Tephromela atra* group from the Mediterranean region revealed the presence of two well resolved lineages, not assignable to any known photobiont species. Here we present a first anatomical investigation of one of these apparently new photobionts. The photobiont was isolated from *Tephromela atra* growing on siliceous rocks and was maintained in axenic culture on TM medium. Young and old cells were studied in light and transmission electron microscopy. Cultured cells are characterized by a central lobed chloroplast with a morphologically variable pyrenoid, which resembles mainly the *gigantea*- and *arboricola*-type (*sensu* Friedl). The nucleus occupies a marginal position, and no thickening of the cell walls was observed. Autospore formation is rather abundant in culture but absent in the lichen thallus. (*Symposium*: Selectivity in the Lichen Symbiosis)

***MUGGIA, LUCIA[1], GUEIDAN, CECILE[2],** and **GRUBE, MARTIN[1]**

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Phylogenetic affiliation of granulose genera formerly attributed to Verrucariaceae

Recent studies have helped to unravel the phylogenetic relationships between main genera of Verrucariaceae using molecular data. Nonetheless, the position of many genera traditionally attributed to this family remains unknown. Molecular data are lacking for their members mainly because of their rare occurrence in the field and problematic DNA extractions. This study aims to investigate the phylogenetic position of five genera suspected to belong to Verrucariaceae: *Agonimia*, *Leucocarpia*, *Macentina*, and the supposed members of the genera *Normandina* and *Flakea*. Data of one mitochondrial (mtSSU) and three nuclear (ITS, nucSSU, and nucLSU) ribosomal markers were used. The resulting phylogenetic reconstruction confirms that these five genera belong to the Verrucariaceae. *Leucocarpia* and *Macentina* are sister taxa nested with species of *Bagliettoa*. *Normandina* is closely related to a main group of *Agonimia*, whereas *Flakea* forms a separate well-differentiated clade. (Poster, Taxonomy and Systematics, Wednesday in Nautilus)

***MUGGIA, LUCIA[1], NADYEINA, OLGA[2],** and **GRUBE; MARTIN[1]**

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Diversity of fungal associates in lichens assessed by single strand conformation polymorphism

Long-living thalli of lichens are frequently colonized by additional fungi. About 1000 lichenicolous fungi are described by phenotypic characters, whereas the diversity of other superficially or endolichenically occurring fungi is hardly assessed. Recently, culture techniques give first insights of their actual ubiquity. However, the results are biased towards the better growing endolichenic fungi under the used culture conditions. Therefore culture techniques cannot clearly display the diversity of these fungi nor their abundance within the lichen structures. Moreover the host-specificity of many lichenicolous fungi raises some doubts whether isolates from lichenicolous infections actually represent the wanted species and not other fungi which may occur concomitantly in the host lichen. We use single strand conformation polymorphism (SSCP) of ITS regions to assess the diversity of lichen-associated fungi. We studied both lichens without external symptoms and with infections of lichenicolous fungi. Our results demonstrate that several fungi occur in these samples. We excised all detected bands and sequenced them for further analyses. SSCP is an efficient method to obtain sequence data from lichenicolous fungi, and after careful sequence analyses it allows the discrimination of these epi- and endolichenic fungi. (Poster: Symbiosis, Thursday in Triton)

MUNZI, SILVANA, PISANI, TOMMASO and **LOPPI, STEFANO**

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Lichen ecophysiological parameters as early indicators of nitrogen stress

Aiming at finding out rapid and efficient indicators of nitrogen stress, physiological responses of two lichen species with a markedly different tolerance to nitrogen compounds, namely the acidophytic *Evernia prunastri* and the nitrophytic *Xanthoria parietina*, were analysed after treatment with KNO_3, NH_4NO_3 and $(NH_4)_2SO_4$ solutions. Photosynthetic efficiency (Fv/Fm), cell membrane damage (electrolyte leakage) and chlorophyll degradation (OD_{435}/OD_{415}) were checked as stress indicators. Photosynthetic efficiency and cell membrane damage resulted suitable indicators of heavy nitrogen load. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

NADYEINA, OLGA

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The lichen diversity of the Donetsk Upland (Ukraine)

Donetsk Upland (DU) is highland situated on the south-east of Ukrainian Steppe with forest-steppe landscapes and numerous sandstone, schist and limestone outcrops. The list of lichens and lichenicolous fungi of the DU contains 202 species, of which 120 are new for the DU and 5 species (*Caloplaca raesaeneni, Chromatochlamys muscorum, Cladonia magyarica, C. peziziformis, Endococcus rugulosus*) are recorded firstly for Ukraine. The arid-temperate character of lichen biota of the DU was

discovered due to floristic-comparative and geographical analysis. The lichens of arid, nemoral and boreal geoelements are dominated in lichen biota of the DU, while montane and arcto-alpine species are in minorities. The lichens of DU were combined in 3 substrate complexes – epilithic, epiphytic-lignophilous and terricolous-bryophillus among which lichens of the epilithic complex are prevailed. Most of the steppe ecotopes on the DU were definited as disturbed, with the first recovery stages, but for the several areas the early and middle stages are characteristic due to presence of the soil lichens. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

NÆSBORG, RIKKE REESE

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Status on the Phylogeny of the Genus *Lecania*

Lecania is a genus of inconspicuous crustose lichens comprising about 40 species worldwide, mainly distributed in temperate areas. The genus includes corticolous, lignicolous, and saxicolous species, and it belongs in Ramalinaceae. Earlier studies have shown that *Lecania* is a polyphyletic genus. However, a well supported monophyletic group consisting of 16 *Lecania* species was found i.e. *Lecania* s. str. *Lecania* s. str. is composed of two major groups: a group of previously treated saxicolous species (*L. inundata* group) and a group of both corticolous and saxicolous species (*L. cyrtella* group). Using a combined morphological and molecular approach, I conducted a systematic analysis of the *L. cyrtella* group and included four morphologically similar species i.e. *L. leprosa*, *L. madida*, *L. sordida*, and *L. prasinoides*; the former three species are newly described in this investigation. Monophyly was revealed for each of the 11 members in the *L. cyrtella* group, and these species are distinguishable using morphological and anatomical characters. (*Symposium*: Roots, Trunks, Branches and Leaves: Lichen Systematics and Phylogeny)

NIMIS, PIER LUIGI[1], *RANDLANE, TIINA[2] and **SAAG, ANDRES[2]**

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Managing resources of high quality lichen image data in the context of the EU project KeyToNature

KeyToNature is an EU project (funded under eContentplus programme) which focuses on teaching the biodiversity by identification of organisms, incl. lichens. Until now, species identification was mainly based on paper-printed tools which have several educational drawbacks. Interactive digital identification tools are supplied with rich textual and iconographic support. High quality lichen images are linked not only to the species pages (final step of the identification process) but also to each stage of the identification pathway. Iconographic archive of *ITALIC* (The Information System on Italian Lichens) contains over 10 500 images of 2200 lichen species. More than one image (both coloured photos and black-and-white drawings) can be available for a single taxon, including magnified images of morphological details (fruiting bodies, soralia, isidia etc.). This archive is an example of integrated data network through internet as the original collection of coloured photos of Italian lichens was complemented by lichen photos and drawings from Estonian authors. (*Symposium*: Integrated Data Networks in lichenology)

***NYBAKKEN, LINE[1], JOHANSSON, OTILIA[2],** and **PALMQVIST, KRISTIN[2]**

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Simulated nitrogen deposition has contrasting effect on defensive compound concentration in four boreal lichen species

The increase in atmospheric nitrogen (N) deposition is a major concern in northern, nutrient-limited ecosystems. Even though lichens apparently are limited by N, most lichen species are negatively affected by increased N depositions. According to hypotheses developed for plants, increased N availability is expected to increase growth at the expense of carbon (C)-based defence. We investigated the effect of increased N on lichen defensive compound concentrations by simulating N deposition. Four boreal lichen species, *Alectoria sarmentosa*, *Lobaria scrobiculata*, *Platismatia glauca* and *Xanthoria aureola*, were sprayed with rainwater or rainwater with increased N concentrations once every day from June to September. Increased N availability significantly reduced the total concentration of lichen defensive compounds in *P. glauca* and some individual compounds in *L. scrobiculata*. In the two other species the defensive compounds were not significantly affected by the treatment. The contrasting responses to increased N deposition may reflect species specific priorities of defence and C use. Possible mechanisms and impacts are discussed. (*Symposium:* Functional Ecology)

OHMURA, YOSHIHITO

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DGGE analysis suggests the occurrence of photobiont exchange in vegetatively reproducing lichen

Vegetative reproduction in lichens is performed by propagules containing fungus and alga, and the dispersed thallus is thought to be genetically identical with the original one. However, high genetic photobiont diversity has been reported within a population of vegetatively reproducing lichens, such as *Evernia mesomorpha*, *Flavocetraria nivalis*, and *Parmotrema tinctorum*. This suggests photobiont exchange could be occurring in these species. The relationship between the *P. tinctorum* photobiont and related substrate algae was analyzed by Denaturing Gradient Gel Electrophoresis (DGGE) method based on partial rbcL sequence. The results showed that several *Trebouxia corticola* genotypes were present on the substrate, and one of the genotypes was identical with the photobiont of *P. tinctorum* growing at the same place. Early developmental stages from symbiotic propagules might incorporate free-living algae on substrate, resulting in photobiont exchange between the original and an external alga when the environment might be preferable for the free-living alga. (*Symposium*: Selectivity in the Lichen Symbiosis)

OTÁLORA, MÓNICA A.G.; ARAGÓN, GREGORIO; MOLINA, CARMEN M.;*PRIETO, MARÍA, and **MARTÍNEZ, ISABEL**

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Phylogeny and biogeography history of a lichen species complex with a disjunctive distribution pattern (*Leptogium furfuraceum – L. pseudofurfuraceum*)

Leptogium furfuraceum - L. pseudofurfuraceum correspond to hairy foliose *Leptogium* species complex with an intercontinental disjunction pattern. Populations of this complex are found in Western North America, Southern South America, Africa, and Southern Europe. We conducted a phylogenetic analysis of two nuclear ribosomal markers (nuITS, nuLSU) to reconstruct the phylogeography of this lichen species complex. We used two basic approaches to elucidated biogeographical history by inferring the ancestral areas distribution states; a parsimony-based approach as implemented in "dispersal vicariance analysis" (DIVA) and a Bayesian inference using SIMMAP. The results suggest that the populations are geographically structured and that vicariance is the main event that explains the current distributions of this species complex, which was induced by the breakup of two land masses, Gondwana and Laurasia. Also, it exists a sister relation between populations from the same hemisphere, contrary to previous assumptions using morphological and biogeographical classification. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***PAOLI, LUCA[1], GUTTOVÁ, ANNA[2], PISANI, TOMMASO[1],** and **LOPPI, STEFANO[1]**

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Monitoring lichen diversity for bioindication purposes in semi-arid environments of South Italy

Semi-arid environments in South Italy often feature limited vegetation cover. This trait, combined with land use and management, dry summer climate and fire risk, may reduce the availability of suitable trees for lichen sampling according to LDV methods. Recent bioindication studies based on the diversity of epiphytic lichens were carried out to assess environmental quality around industrial sites located in semi-arid environments of South Italy. Owing to these peculiarities and in view of a permanent monitoring programme, some adaptations to the standard methodology applied in Italy proved necessary, especially concerning the selection of phorophytes within sampling units, the widening of the unit area and the development of local scales to adequately interpret LDV values. Coherently with land use and climate features, an increase in nitrophytic species has been observed as ongoing process in semi-arid environments. (Poster: Environmental Monitoring, Friday in Merrill Hall)

***PAOLI, LUCA** and **LOPPI, STEFANO**

Department of Environmental Sciences, University of Siena, Via P.A. Mattioli 4, I–53100 Siena, Italy

Lichen biomonitoring and geothermal energy: recent applications in Tuscany (Central Italy)

The exploitation of geothermal energy for the production of electricity has a long tradition in Central Italy and during the last years there is increasing attention to this energy source as alternative to traditional fossil fuels. Although regarded as a clean resource, geothermal energy is by no means free from causing environmental concern and it is well known that a certain degree of air pollution (H2S, CH4, NH3, H2, CO2 and trace elements such as Hg, As, B and Rn) is associated with its industrial exploitation. Lichen biomonitoring proved to be a reliable tool for assessing biological effects resulting from the industrial exploitation of geothermal sources and for tracing deposition patterns of airborne pollutants emitted. More recently, these classical approaches were integrated with physiological measurements of lichen transplants aimed at identifying early stress symptoms. (Poster: Environmental Monitoring, Friday in Merrill Hall)

***PAPONG, KHWANRUAN[1], THAMMATHAWORN, ACHRA[2], BOONPRAGOB, KANSRI[3],** and **LÜCKING, ROBERT[4]**

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Taxonomy and ecology of foliicolous lichens in Thailand

The foliicolous lichens in Thailand were studied in several National Parks in different areas of Thailand. We found 265 species, 44 genera and 18 families. The highest species diversity was found in the tropical rainforest (70% of all species), followed by the dry evergreen forest (53%), the lower montane rainforest (48%), and the mixed deciduous forest (6%). About 125 species are reported for the first time from Thailand and several of the foliicolous lichens discovered in this study are new records for Southeast Asia. The number of known foliicolous lichens species in Thailand is higher than any other country in this region. The different forest types and altitudinal zonation are usually governed by atmospheric and edaphic factors. This study shows the highest species diversity at low altitude (50-200 m), with a decrease in diversity at elevations up to 500 meters, a subsequent increase and then a strong decrease at higher altitudes (600-1,000 m) in the lower montane rainforest. The data for the analysis of foliicolous lichen species ecology were gathered in 66 transects. Cluster analysis separates these roughly into three groups: a chiefly tropical rainforest group that includes a few lower montane sites, a chiefly lower montane rainforest group that also includes some transects from the tropical rainforest, and a group chiefly formed by the dry evergreen forest and mixed deciduous forest sites. Non-metric multidimensional scaling (NMS) confirms the results of the cluster analysis regarding relationships of foliicolous species with altitude, forest types and microhabitat. This study underlines richness of Thailand regarding its lichen biota; however, many more areas designed to preserve biodiversity need to be studied. (*Symposium*: Tropical Lichens)

PARK, CHAE HAENG[1,2], LEE, JIN SUNG[1], LEE, HONG KUM[1], JEONG, GAJIN[2], and ***HONG, SOON GYU[1]**

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Fungal diversity in the withered pine trees of Monterey

In the Monterey Pine Forest, the trees are seriously threatened by diverse fungal species. To examine the fungal diversity in the withered Monterey pines, lichen specimens, cultured molds, and rDNA clones from pine twings were phylogenetically analyzed. Sixteen specimens of lichens had close relationships with the genera, *Alectoria, Amandinea, Lecanora, Niebla,* or *Ramalina*. Sixteen fungal strains isolated from pine twigs were closely related to the genera, *Cladosporium, Fusarium, Penicillium,* and *Trichoderma.* Fungal biodiversity of two pine twigs were also analyzed by clone library analysis. 21 and 23 different ARDRA types from each pine twig were phylogenetically analyzed. They were clustered in twelve phylogenetic groups of Ascomycetes. Among them, sequences with close relationship to *Fusarium circinatum*, which is known to cause pine pitch canker, were included. (Poster: Ecology, Thursday in Merrill Hall)

***PARTL, ANAMARIJA[1]** and **OZIMEC, SINIŠA[2]**

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Lichen flora of Croatia

Over 50 years have passed since a check-list for lichens in Croatia was first published. During 2006 and 2007 revisions of the nomenclature and distribution of lichens in Croatia were made and new records noted since 1970s were added. After the revision,

it was concluded that some 900 taxa were recorded for Croatia. This check-list was a basis for first red listing of lichens, and is a starting point for further lichen inventarisation in Croatia. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***PEKSA, ONDŘEJ[1, 2]** and **ŠKALOUD, PAVEL[2]**

[1]The West Bohemian Museum in Pilsen, Kopeckého sady 2, CZ-30100 Plzeň, Czech Republic; [2]Charles University in Prague, Faculty of Science, Department of Botany, Benátská 2, Praha 2, Czech Republic.

Photobiont diversity in the *Lepraria neglecta* group (Lecanorales, Stereocaulaceae)

Molecular sequence data of the internal transcribed spacer (ITS) and actin type I locus as well as morphological data were used to investigate the diversity and phylogenetic position of photobionts in lichen taxa belonging to the *Lepraria neglecta* core group. Specimens of five species (*L. alpina*, *L. borealis*, *L. caesioalba*, *L. granulata*, *L. neglecta*) were sampled from different habitats and substrates mainly in central and east Europe. The photobiont species belong to several unrelated lineages in the genus *Asterochloris*, including described taxa *A. phycobiontica* and *A. magna*. Major part of *Lepraria* species was associated with two or more photobiont lineages. Extremely low degree of selectivity was revealed in common species *L. caesioalba*, associated with 8 algal clades. Some photobiont species seem to be adapted to specific ecological conditions (e.g. *A. phycobiontica* was found only in alpine habitats). (Poster: Symbiosis, Thursday in Triton)

PÉREZ-ORTEGA, SERGIO, CRESPO, ANA, GREEN, T. G. ALLAN and **GARCÍA SANCHO, LEOPOLDO**

Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense, Plaza de Ramón y Cajal s/n, Ciudad Universitaria, E-28040 Madrid, Spain

Photobiont genetic diversity and selectivity in extreme environments. A case in study: Lichen communties in Ross Island (Antarctica)

It has been shown that lichen photobionts have a high genetic diversity, both in intraspecific studies across distribution ranges or in interspecific studies in community approaches. Such diversity may be influentiated by several factors, being one of them the abiotic conditions of the stand. Antarctica has the most extreme climate of all continents, making it a good place to study how abiotic conditions can affect biological procesess as relichenization. Previous studies pointed an unsuspected high photobiont genetic diversity as well as a low selectivity towards the photobiont. nuITS marker were used to assess the degree of genetic diversity and selectivity towards the photobionts in a lichen community from Ross Island, at 77ºS. (Poster: Ecology, Thursday in Merrill Hall)

PÉREZ-ORTEGA, SERGIO[1]; DE LOS RIOS, ASUNCIÓN[2]; CRESPO, ANA[1] and **GARCÍA SANCHO, LEOPOLDO[1]**

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New insights on the biology of the borderline lichen *Mastodia tessellata* (Hook. f. et Harv.) Hook. f. et Harv.

Some few species of lichens have very loose interactions between symbionts. In these associations, usually one of the members is found easily free-living. These so-called 'borderline' lichens mostly live in aquatic environments. *Mastodia tessellata* is one of these loosely lichenized species examples, where the leafy algae *Prasiola crispa* forms the basis of the thallus, being surrounded after by the fungal hyphae and not developing specialized structures. Known from boreal and austral seashores, it was studied in the past both ecophysiologically and anatomically by mean of SEM and light microscopy. However, many questions remained answered in biology of this odd lichen. We studied specimens from Navarino Island (Tierra del Fuego, Chile) in order to assess the phylogenetic position of *M. tessellata* within the fungal tree of life, based on nuLSU and nuSSU markers. Also, we showed new interesting features on the nature of photobiont-mycobiont interactions, based on transmission and scanning electron microscopy. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***PÉREZ-ORTEGA, S.[1]** and **PRINTZEN, C.[2]**

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Plastic morphology in lichens misleads taxonomy and biogeography

Lichens display few systematically useful characters, which has lead to taxonomic confusion in several groups. The *Lecanora varia* group is a well-known example of such a group. Based on ITS sequences of >280 specimens of *Lecanora varia*, *L. burgaziae* and *L. densa* we studied whether morphological and genetic distinctions coincide. Nine morphological, anatomical and chemical characters of each specimen were recorded. We calculated statistical parsimony networks for the molecular data and classified specimens according to morphological and chemical characters by means of Bayesian classification. A nested Anova was carried out to test whether Bayesian classes coincide with the main clades of the haplotype networks. Our results show largely incongruent morphological and genetical patterns, indicating that taxonomic difficulties are caused by morphological plasticity. Different secondary compound patterns can be found within the same genotype, so that chemistry seems to be related to environmental factors rather than to fixed genetic differences. (*Symposium*: Between Individuals and Species: The Genetics of Populations)

***PÉREZ-PÉREZ, ROSA EMILIA[1]** and **QUIROZ-CASTELÁN, HÉCTOR[2]**

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Corticolous macrolichens as indicators of perturbation degree in protected versus managed forests in Mexico

Despite the diversity, Mexico's forests are disappearing at an alarming rate. The human activities are directly responsible for much of this destruction and forest degradation. Comparing the structure and dynamics of protected and managed forest in Morelos and Oaxaca; the results suggest that macrolichens face a mosaic of different degree of forest disturbance and regeneration in these areas. A total of 66 species were collected, 28 and 48 respectively and share 10 species. The most plots in the National Park Lagunas de Zempoala are intense disturbed and the density of tree is low contrary at the managed forest of Ixtlán de Juárez, furthermore have a large amount of coarse wood debris, providing additional substrate for lichens. (Poster: Ecology, Thursday in Nautilus)

***PERKINS, FERN S.[1], NEUFELD, HOWARD S.[1], THOMLEY JILL E.[2]** and **WALKER JOHN F.[1]**

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Complexities in the analysis of the response of the lichen *Umbilicaria mammulata* along a putative nitrogen deposition gradient

Atmospheric N has quadrupled due to anthropogenic inputs and is projected to double again by 2050. We investigated the potential impacts of N deposition on *Umbilicaria mammulata*. Thalli were collected along a N deposition gradient in the northeastern US and were analyzed for %C, %N, C:N, specific thallus weight, chlorophyll content, and chlorophyll fluorescence. Stepwise regression identified the most predictive model(s) using N deposition, environmental variables, and climate to predict differences in lichen ecophysiology and biochemistry. N deposition was important in predicting some responses, but the model that best predicted %N in lichen only included mean minimum temperature, mean annual precipitation, and substrate slope. In controlled experiments lichens were fertilized *in situ*. There were no significant differences between control and fertilized thalli; differences did exist among sites. The results of this study highlight the complexities associated with sampling along a gradient of one factor in a multivariate environment. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

***PERKINS, FERN S.[1], NEUFELD, HOWARD S.[1],** and **WYNNS, ANJA A.[2]**

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Impacts of elevated CO_2 and O_3 on the corticolous lichen community in the Aspen FACE free-air exposure system

Atmospheric concentrations of CO_2 and O_3 are increasing. Little work has been to investigate the effects of elevated CO_2 and O_3 on corticolous lichen communities, with no long-term studies (to our knowledge) conducted under field conditions. At the Aspen FACE free-air exposure system in Rhinelander, Wisconsin, aspen (*Populus tremuloides*) and birch (*Betula papyrifera*) trees have been subjected to free-air exposures of ambient air, elevated O_3, elevated CO_2, or elevated O_3+CO_2 for nearly a decade. In each

of the 12 exposure rings, we digitally photographed a 5cm x 20cm area of the lower trunk on the north-facing side of five randomly selected aspen and birch trees. From these images we will determine community composition (species richness, diversity, evenness) and relative species coverage (line intersect method). This will be the first study of the impacts of long-term free-air exposures to elevated O_3 and CO_2 on corticolous lichen communities. (Poster: Ecology, Thursday in Merrill Hall)

***PIERCEY-NORMORE, MICHELE[1]** and **DOERING, MATTHEW[2].**

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Gene flow in photobionts of the Parmeliaceae: hitch-hiking with soredia

Lichenized algae are shared among different mycobiont taxa suggesting that algae are not associated with specific fungal taxa and may be freely transferred between mycobionts. However, little is known about the process by which gene flow occurs within local populations of lichen algae or historical transfer of photobionts between fungal partners. The objectives of this study were to examine gene flow of photobionts among members of an epiphytic lichen community, and to infer historical gene flow of lichen algae transferred among fungal partners. Algal variation was determined from nucleotide sequences of the ITS rDNA, an 18S group 1 intron, the actin gene and intron. Gene flow is reported among photobionts from the same mycobiont species and between mycobionts. Dispersal by soredia may provide the forum for photobiont compatibility with different fungal partners and habitats, explaining an observed historical lateral transfer event between fungal genera. (*Symposium*: Between Individuals and Species: The Genetics of Populations)

PICCOTTO, MASSIMO[1], PAVANETTO, SILVIA[1], PITTAO, ELENA[1], VURRO, EMANUELA[2], SANITÀ DI TOPPI, LUIGI[2] and ***TRETIACH, MAURO[1]**

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NO_x and O_3 tolerance in transplants of *Flavoparmelia caperata*: the importance of being metabolically active

The effects of environmental concentrations of NO_x and O_3 in the foliose *Flavoparmelia caperata* were studied in the summer 2007 in four groups (A-D) of samples obtained from thalli collected in a deciduous wood near Trieste (NE Italy), and cut in four portions. Group A was exposed in the collection site, as reference; groups B-D were transplanted in a square with high NO_x and O_3 levels. Two groups of samples (C,D) were watered daily at the purported daily peaks of NO_x (C) and O_3 (D), whereas all the groups were exposed to the few natural rainfall events. The comparison between pre- and post-exposure measurements of CO_2 gas exchange, chlorophyll fluorescence, cell membrane permeability, malondialdehyde, and glutathione revealed that the thallus water status plays a fundamental role in the *F. caperata* tolerance to NO_x and O_3, as the watered, metabolically active thalli could evidently repair the damage caused by the pollutants. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

PICCOTTO, MASSIMO, PITTAO, ELENA and ***TRETIACH, MAURO**

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The photosynthetic performance of selected foliose chlorolichens grown under contrasting light regimes

The hypothesis that CO_2 gas exchange and chlorophyll *a* fluorescence (C_aF) of lichens vary according to the light regimes of their original habitat was tested by analysing the performance of twelve populations of seven foliose chlorolichens collected from low to high light habitats. CO_2 light response curves at optimum RWC and C_aF emission curves at the species-specific $PPFD_{Ik}$s and saturating light intensities were induced for each investigated species. Photosynthetic pigments were quantified in DMSO crude extracts. The results confirm that the maximum rate of gross photosynthesis is linearly correlated to the lichen chlorophyll content, and the latter is influenced by light as well as by nitrogen availability. Likewise leaves, shade-tolerant lichens emit more C_aF than sun-loving ones. The C_aF parameters F_0, F_m, rETR and NPQ show not only clear differences among lichens collected from different habitats, but also that the photosynthetic quantum conversion increases from low to high light habitats. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

***PINHO, PEDRO[1], , BRANQUINHO, CRISTINA[1], PEREIRA, ANA JULIA[1], PEREIRA, MARIA JOÃO[2], SOARES, AMILCAR[2], ROSÁRIO, LUCIO[2], MEIRA, JOÃO[3], CORREIA, OTÍLIA[1], FLÔR, ANTÓNIO[4]** and **MÁGUAS, CRISTINA[1]**

Universidade de Lisboa, Faculdade de Ciências, Centro de Biologia Ambiental (CBA), Portugal. [2]Universidade Técnica de Lisboa, Instituto Superior Técnico, Centro de Estudo de Recursos Naturais e Ambiente (CERENA), Portugal. [3]Universidade Federal de Viçosa, Departamento de Biologia Vegetal, Brasil. [4]Instituto da Conservação da Natureza (ICN), Parque natural da Serra d'Aire e Candeeiros, Portugal.

Effects of forest fragmentation on epiphytic lichens: role of geomorphologic conditions, vegetation structure, microclimate and neighbouringland-cover

The objective of this work was to determine the effects of forest fragmentation, and the associated major factors, in epiphytic lichen communities. For that we determined epiphytic lichens richness and abundance in a fragmented Portuguese-oak forest (*Quercus faginea* Lam.). Epiphytic lichens total richness and abundance were not affected by fragmentation (fragments area, perimeter and shape). However, when lichens were grouped into two distinct groups significant changes were observed: i) higher abundance of the green-algae lichens group in smaller fragments, near the margin, and ii) cyanolichens were more abundant and presented higher species richness in larger fragments, further from the margin. In addition to fragmentation we have considered four other hypotheses to explain this pattern: i.) geomorphologic conditions (altitude, aspect, orientation, and solar load of the sampling sites); ii.) vegetation characteristics (tree density and cover as well as vegetation index, from satellite images); iii) microclimate (temperature and relative humidity); iv) neighbourhood land-cover (fragments matrix occupied by artificial and agricultural areas). The results will be discussed regarding the relative importance of each group of factors and how this knowledge can be used for conservation purposes. (*Symposium*: Community Structure and Dynamics)

***PINHO, P[1], CRUZ, C[1], DIAS, T[1], ROSA, AP[1], KASZTA, Z[1,2], MÁGUAS, C[1], MARTINS-LOUÇÃO, MA[1],** and **BRANQUINHO, C[1]**

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The use of lichens as biomonitors of atmospheric ammonia in a Mediterranean climate: a functional perspective

The objective of this work was to provide a functional perspective of the changes induced by atmospheric ammonia in epiphytic lichens diversity at community level, in order to reinforce their use as biomonitors. For that we sampled epiphytic lichens in a cork-oak woodland using a standardize protocol (focusing in nitrophytic/oligotrophic groups) at different distances from a cow-barn and measured atmospheric ammonia concentration monthly during 18 months using ALPHA samplers (Adapted Low-cost Passive High Absorption). A geostatistical analysis of lichen and ammonia data was used to relate information from different locations and to analyse its spatial structure. The abundance of nitrophytic and oligotrophic species showed a highly significant log relation with atmospheric ammonia concentration. With previous information we calculated the critical level of atmospheric ammonia for lichen diversity and we found a threshold between 1 and 2 $\mu g\ m^{-3}$. A similar value was already found for other northern European countries. We also studied the influence of climate on atmospheric ammonia deposition and on its potential effect on lichen diversity and found that a more significant impact was observed during the wet periods rather than on dryer ones. This emphasizes the role of Mediterranean climate seasonality in lichens sensitivity to ammonia. The determination of thallus pH along the atmospheric ammonia gradient and the growth rate analysis in some lichen species will be presented and discussed as new insights for a better mechanistic understanding. (*Symposium*: Air Pollution)

***POLYIAM, WETCHASART[1], WANNALUK, BUNGON[1], PANGPET, MONGKOL[1]** and **BOONPRAGOB, KANSRI[1]**

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Growth and longevity of some tropical lichens in Thailand

Growths of about 300 lichen thalli have been monitored for nine years in various types of the tropical forests at Khao Yai National Park in Thailand. After seven years 49% of the observed thalli were completely dead and disappeared, of which 60% belong to the foliose and 36% of the crustose lichens. Among the existing lichens only 8% had intact whole thalli, contributed by 3% of foliose and 12% from crustose. The remaining thalli were either partially broken or regenerated into small lobes replaced the death ones. Regeneration of the crustose thalli was almost double of the foliose ones (47% and 24%). Growth rates were varied, and determined according to status of the thalli. (Poster: Ecology, Thursday in Merrill Hall)

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SEM-EDX and PIXE analysis of Elemental accumulation patterns of the lichen species *Physcia tribacoides* Nyl. & *Bacidia beckhausii* Körber within the Walayar RF region, Tamil Nadu, India

Lichen thalli due to the lack of a protective layer are known to accumulate airborne pollutants both by wet and dry deposition (Nash 1996). Accumulated elements can be analyzed using techniques such as Proton Induced X-ray Emission and Electron probe microanalysis that yield two-dimensional, quantitative element information with micron-level spatial resolution. Samples of thalli of selected lichen species from the study site Madukkarai - Walayar forest (polluted and unpolluted) were irradiated using 1.7 MV Tandem accelerator with 2000 KeV Proton beam and ion induced X-rays were detected by Si(Li) detector. Morphological analysis and localization of elements were carried out using SEM. PIXE output revealed the presence of As, Ba, Br, Ca, Cu, Fe, K, Mn, Zn, Cl, Ti, Cr and Pd with increased Calcium upto 99.75% (percentage by weight). *Bacidia beckhausii* Körber accumulate and tolerate higher levels of Calcium whereas *P.tribacoides* accumulate lesser levels and show thallus degradation. This data is vital to understand air quality in the study site and its impact to assess the tolerance and sensitivity of the selected lichen species. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

***PRIETO, MARÍA, ARAGÓN, GREGORIO, OTÁLORA, MÓNICA A.G.,** and **MARTÍNEZ, ISABEL**

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Phylogenetic study of *Catapyrenium* s.str. and related genus *Placidiopsis*

The latest work on *Verrucariaceae* (Gueidan *et al*. 2008) confirmed the division of *Catapyrenium* s.l. group and the relation between *Catapyrenium* s.str. and *Placidiopsis*. Nevertheless, the phylogeny of these two genera needs to be tested with a broader taxon sampling. The purpose of this study is to reconstruct a molecular phylogeny of *Catapyrenium* s.str. and *Placidiopsis* in order to test the monophyly of each genus and to evaluate the current classification at species level. To reach this goals we sequenced gene regions LSU and ITS for about 35 specimens. Individual and combined datasets were analyzed using maximum parsimony, maximum likelihood and a Bayesian approach. Resulting phylogenetic trees were compared and the value of morphological and anatomical characters as grouping criteria is discussed. Our results show two main supported clades containing most of the species from each genus. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***PRIETO, MARÍA; MARTÍNEZ, ISABEL** and **ARAGÓN, GREGORIO**

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The genus *Placidium* in the Iberian Peninsula and Balearic Islands

The aim of this work is to present new distributional and ecological data of the genus *Placidium*, in order to complete the knowledge in the Iberian Peninsula and Balearic Islands, as a part of the project Spanish Lichenological Flora. Data from some revised herbaria, fresh material collected by the authors and some bibliographic reports are used. Until now, ca. 1000 specimens of *Placidium* have been revised. This study shows that genus *Placidium* is represented by 16 species in the Iberian Peninsula and Balearic Islands. Three of them are new records from the Iberian Peninsula: *P. norvegicum*, *P. subrufescens* and *P. tenellum.* Most of the species constitute considerable expansions of their distribution ranges. A complete revision about distribution (including maps) and ecology is provided. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***PURVIS, O. WILLIAM[1], CREWE, ANNA T.[1,2,3], KEARSLEY, ANTON[1], CRESSEY, GORDON[1]** and **WEDIN, MATS[3]**

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Mineralization in rust-coloured *Acarospora*

The upper cortex and extracellular hyphal wall matrix are mineralized in both rust-coloured *Acarospora sinopica* and the paler *A. smaragdula* 'f. *subochracea*' in the form of microgranular or microbotryoidal phases. Analysis confirmed the distinctive colours are not simply due to hydrated iron oxides, 'rust', as previously believed, and suggests mixed sulphide and oxide phases with

little crystallinity, as well as other elements arising from clay minerals, are present. These aspects highlight the need for a more detailed study employing a range of micro-analytical techniques, including analytical TEM which will allow mineral characterisation and localisation down to the nanometre scale. (Poster: Ecology, Thursday in Merrill Hall)

***PURVIS, O. WILLIAM**[1] and **READ, HELEN**[2]

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20 years investigating lichen and bryopyhte biodiversity under globally changing atmospheric conditions

Burnham Beeches is a biodiversity hotspot providing an important reservoir of lichens and bryophytes. Following reductions in SO_2 concentrations, the lichen flora on free-standing trees has undergone rapid expansion from a near dominance by the SO_2-tolerant 'acidophyte' species *Lecanora conizaeoides* and *Hypogymnia physodes*. Survey results are summarised with reference to changes in atmospheric conditions, multi-element content, bark pH, museum historical collections spanning over a 200-year period and conservation management. (*Symposium*: Air Pollution)

***RADIES, DAVID and COXSON, DARWYN**

University of Northern British Columbia, Ecosystem Science and Management Program, Prince George, B.C., V2N 4Z9. CANADA

Predicting Canopy Macrolichen Distribution in Inland Temperate Rainforests.

Inland mountain ranges in BC support a unique inland temperate rainforest (ITR) ecosystem. Although total precipitation in the ITR is less than half that observed in coastal rainforests, old-growth forests support rich canopy cyanolichen communities. On first examination, the abundance and diversity of cyanolichens in the ITR is puzzling; at high elevations precipitation is abundant, but temperature limiting, at low elevations temperatures are warmer, but precipitation is limiting. In a study of old forest stands distributed over a 70 km^2 area of ITR we have found the answer to this paradox, namely that low-elevation sites with high groundwater availability represent major refugia for canopy lichen communities. We would speculate that lichen communities in wet toe-slope positions provide propagules that facilitate establishment of smaller, often ephemeral, metapopulations in surrounding landscapes. The preferential logging of wet toe-slope positions now threatens the extirpation of lichen communities over broad regional landscapes of BC's ITR. (Poster: Ecology, Thursday in Merrill Hall)

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Comparative study of the lichen biota in three ecosystems of Peru

The aim of this study is to compare the lichen biota in three major ecosystems in Peru, which are cloud forest, fog deserts (lomas), and vegetation of high altitudes in the Andes that includes shrublands and rocky areas. The biota was survey in Lachay's coastal hills (Lima) and Cerro Campana (La Libertad); in the Cordillera Blanca (Huascarán National Park) and C. Negra (Ancash) and in the cloudy forests of The Cedro (Yanachaga-Chemillén National Park -Pasco) and in sector Acjanaco (Manu National Park -Cusco). The lomas are characterized by winter mist, between the 200-700 m, the shrubland and rocky areas, between 4.000-4.800 m and the forests clouded, between the 2.400-3.500 m. Specimens were deposited in the herbarium San Marcos (USM). Species belonging to 50 genera were found in these three ecosystems, in lomas (L) 16 genera were recorded being *Chrysothrix* and *Lepraria* the most common; the high altitudes (HA) had 39 genera, including *Rhizocarpon* and *Thamnolia* as a most common; whereas the cloud forest (CF) had 24 genera, with *Sticta* and *Peltigera* species as most typical. Genera common in all ecosystems included *Everniastrum*, *Ramalina*, *Teloschistes* and *Usnea*. Comparisons are made between the ecosystems, with 2 genera restricted to L, 17 to HA, and 6 to CF, 8 genera were shared between L and HA, 11 between HA and CF, and 1 between HA and CF. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***RANDLANE, TIINA, TÕRRA, TIIU** and **SAAG, ANDRES**

University of Tartu, Institute of Ecology and Earth Sciences, Lai Street 38-40, Tartu 51005, Estonia

How many *Usnea* species are there in Europe? An interactive key

The number of species in genus *Usnea* varies from 300–600, according to different authors. The correct number of *Usnea* species in Europe is not known either due to numerous taxonomic uncertanties at the species level. We analysed ca 30 lichen checklists and floras of European countries published during the last 15 years, and compiled the list of *Usnea* species, reliably recorded in Europe. The list presently includes 31 *Usnea* species. An interactive key for these 31 *Usnea* species was compiled within an EU project KeyToNature. The key is traditionally dichotomous (at every step choice between two options). When the identification process is finished, the page of the according species is displayed. On this page diverse information is presented: nomenclatural data, characters, ecological and distributional data (incl. maps), images. At every step of identification (and also on each species page) one can link to other species' pages and compare the taxa of interest. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***RICO, VÍCTOR J.**[1] and **RAMBOLD, GERHARD**[2]

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The lichen genus *Rimularia* in the Iberian Peninsula

In the context of the Iberian Lichen Flora project (CGL2007-66734-C03-01), based on our own collections from Andorra, Portugal and Spain (VJR, *c*. 250 specimens, in MAF) and on Iberian and extra-Iberian herbarium material (*c*. 900 specimens from BCN, E, G, GZU, H, H-Ach, H-Nyl, LEB, M, MA, MAF, S, SANT, TUR and W), the following *Rimularia* species resulted from a taxonomic revision: *Rimularia furvella*, *R. gyrizans*, *R. insularis* and *R. limborina*. In addition and according to its morphology, anatomy, chemistry, habitat and host selectivity (lichenicolous species), three new species were recognized. *Rimularia* "sp. 1" and *Rimularia* "sp. 2" are brown lichenicolous lichens, separated from *R. insularis* by chemistry, thallus and spore characters, growing also on different silicicolous host families; thallus organization of the three lichenicolous species is also studied and compared. Finally, *Rimularia* "sp. 3" is a grey to brown silicicolous not parasitic lichen, close to *R. gyrizans*. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***RIDDELL, JENNIFER A.**[1], **PADGETT, PAMELA E.**[2], and **NASH III, THOMAS H.**[1]

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Toxic effects of two arid climate pollutants, ozone (O_3) and gaseous nitric acid (HNO_3) on two lichen species in the Los Angeles air basin.

What components of urban air pollution are most important in driving lichen community composition in the arid western United States? Previous field research had implied that oxidants, including O_3, were detrimental, but experimental work had yielded equivocal results. Subsequently, it has been shown that high nitrogen deposition gradients are superimposed on the previously demonstrated oxidant gradients. Current work is focused on gaseous HNO_3, which has a very high deposition velocity and diurnal concentration patterns paralleling those of O_3. We are working with *Ramalina menziesii* Tayl. and *Hypogymnia imshaugii* Krog., using both laboratory fumigations and field transplant experiments to tease apart the different effects of these pollutants. Our preliminary results suggest that gaseous HNO_3, not O_3, may be the driving force behind impoverishment of lichen communities in these semi-arid regions, where it is a major component of air pollution. (*Symposium*: Air Pollution)

RIVAS PLATA, EIMY[1,2], **LUMBSCH, H. THORSTEN**[2], and **LÜCKING, ROBERT**[2]

[1]University of Illinois at Chicago, Department of Biological Sciences, 845 W. Taylor St., Chicago, IL 60607, USA; [2]The Field Museum, Department of Botany, 1400 South Lake Shore Drive, Chicago, IL 60605, USA.

How reliable are morphological data in predicting molecular phylogenies? A test using the lichen family Graphidaceae

We compared the performance of morphological and molecular data in reconstructing the phylogeny of Graphidaceae and Thelotremataceae. We used two identical taxon sets of 82 species (77 ingroup taxa representing 27 genera): (1) 1,164 bp of nuLSU+mtSSU DNA data; (2) 280 binary coded morphological characters. Both datasets were analyzed using Bayesian, parsimony, and distance approaches. Most of the clades were equally recovered independent of the analysis method or data type. Differences in tree topologies between data sets were restricted to the placement of small clades which, in most of the cases,

lacked support. Further differences included the monophyly versus polyphyly of certain genera in the morphological or molecular analysis, and some unsupported differences among analytical methods. The morphological distance tree was most similar to the molecular trees in overall topology. In conclusion, the morphological data recovered many clades surprisingly well, but failed to recover most relationships with confidence. (Poster: Taxonomy and Systematics, Wednesday in Nautilus)

***SAAG, LAURI, SAAG, ANDRES** and **RANDLANE, TIINA**

University of Tartu, Institute of Ecology and Earth Sciences, Department of Botany, Lai 38, 51005 Tartu, Estonia

The world key of the genus *Lepraria* (Stereocaulaceae, lichenized Ascomycota)

The world key of the genus *Lepraria* comprising 58 species and 2 varieties is provided. For the first time, all taxa that are currently accepted in the world can be identified using a single key. It will be published as a part of a comparative review of genus *Lepraria*, and also will be freely available in the internet in interactive form. The online interactive key includes species sheets with various information: nomenclatural data, descriptions, discussion on diagnostic characters, and ecological and distributional data. The key is mainly based on the contents of secondary substances (e.g. protocetraric acid or fumarprotocetraric acid, stictic acid, terpenoids, usnic acid etc.), however, morphological characters (e.g. occurrence of lobes or well developed dark hypothallus, size of soredia etc.) are used as well, where necessary or possible. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

SAIPUNKAEW, WANARUK[1], POMPHUEAK, KRITTHIKA[1], *WOLSELEY, PAT[2]. and **SUWANNARATANA, SUTTHATHORN[1]**

[1]Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand; [2]The Natural History Museum, Cromwell Rd, London, SW7 5BD, UK

A Lichen pollution index for northern Thailand

Following a project in seven provinces of Northern Thailand sampling lichens on mango trees in major cities and their rural environs (Saipunkaew et al. 2007), we constructed a pollution index based on frequency of macrolichen indicators of polluted and clean air, and frequency of other taxa in the sampled units. A lichen investigator's handbook with sampling method and key to common lichens was prepared, and during a two day workshop it was trialled by 2 schools in 4 sites in and around Chiang Mai city. The results are presented from clean and polluted sites sampled by schools. A further project is planned with the chemistry department of Chiang Mai University to enable schools to make simple estimates of pollution levels in urban areas. (Poster: Environmental Monitoring, Friday in Triton)

SAIPUNKAEW, WANARUK[1] and ***WOLSELEY, PAT [2]**

[1]Department of Biology, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand; [2]Natural History Museum, London SW7 5BD

Mapping the effects of a pollution episode with lichens by the Thai School Network for Air Quality Protection

During a bad pollution episode in Chiang Mai city Thailand in March 2007, daily mean PM10s exceeded the standard limit of 120 ug/m^3 for several days and lichen thalli of common species of *Dirinaria* and *Pyxine* were observed to become bleached in areas most visibly impacted by the pollutants. In order to determine the geographical extent of the damage teachers and students from 10 schools in the Chiang Mai-Lamphun School Network for Air Quality Protection used the Lichen Investigators Handbook to identify and map lichens affected in Chiang Mai and Lamphun cities, and surroundings areas. A map of 'air quality' based on distribution and frequencies of indicator species and bleached lichens was prepared showing the extent of the pollution episode. (Poster: Environmental Monitoring, Friday in Triton)

***SANCHO, LEOPOLDO G.[1], PINTADO, ANA[1]** and **LAZARO, ROBERTO[2]**

[1]Biologia Vegetal II, Universidad Complutense de Madrid, 28040 Madrid, Spain
[2] Estación Experimental de Zonas Áridas, Consejo Superior de Investigaciones Científicas. General Segura, 1; 04001 - Almería; Spain

Microclimatic factors and photosynthetic activity of crustose lichens from the semiarid southeast of Spain: long-term measurements in *Diploschistes diacapsis*

The south-eastern corner of the Iberian Peninsula is the driest area of Western Europe. A common feature of this landscape is the extensive badlands formed by a complex mosaic of bare-ground and plant-covered patches highly variable in soil cover and morphology. Biological soil crusts occupy more than 30% of the surface being lichens the main component of this formation. *Diploschistes diacapsis* plays a dominant roll in most of the area. Its growth rate was calculated for three consecutive years from continuous measurements of microclimatic conditions coupled with fluorescence measurements of phosynthesis indicated by potential activity of photosystem II. The microclimatic measurements comprise recording of the photosynthetic photon flux density, thallus temperature and relative air humidity. Our data reveal that *D. diacapsis* was active more than 30% of the time. Winter and early spring were the most productive seasons. Strong differences in microclimate conditions were detected between active and inactive periods. (*Symposium*: The World under Your Feet: Biological Soil Crusts)

SANCHO, LEOPOLDO G., PINTADO, ANA, VIVAS, MERCEDES, and **RAGGIO, JOSÉ**

Biologia Vegetal II, Universidad Complutense de Madrid, 28040 Madrid, Spain.

Physiological resistance of *Aspicilia fruticulosa* to extreme interplanetary space conditions

In 2005 LICHENS experiment, belonging to the Europen Space Agency BIOPAN 5 project, was carried out. This experiment tried to evaluate the resistance of saxicolous lichens to the extreme interplanetary space conditions (cosmic and UV radiation and abolute vacuum). It was proved by means of chlorophyll a fluorescence that their metabolism could be reactivated after bearing sixteen days of Earth-orbiting (Sancho *et al*.,2007, Astrobiology 7: 443-454). A new experiment called LITHOPANSPERMIA was launched in 2007 including for the first time the vagrant lichen species *A. fruticulosa* from Guadalajara stepic highlands (Central Spain). After proving that the photosynthesis was not damaged by means of chlorophyll a fluorescence a more detailed analysis was made by gas exchange measurements. On this work we establish a comparison between thalli exposed to space conditions and others recently collected from the same place. (Poster: Physiology and Ecophysiology: Friday in Nautilus)

SANCHO, LEOPOLDO G., PINTADO, ANA, VIVAS, MERCEDES, and **RAGGIO, JOSÉ**

Biologia Vegetal II, Universidad Complutense de Madrid, 28040 Madrid, Spain

Ecophysiological comparison between different biotypes of high mountain lichens

Several studies concerning high mountain lichens ecophysiology have shown high diversity both between species and across altitudinal gradients. However, very few data about ecophysiological parameters between different lichen biotypes of the same locality have been reported so far. In this work, we used maximum net photosynthesis related to thallus surface so as to compare productivity of strictly crustose lichens (*Lecanora rupícola* (L.) Zahlbr.), with a species of intermediate biotype crustose-folious (*Rhizoplaca melanophthalma* (Ram.) Leuck. & Poelt) and a folious one (*Lasallia hispanica* (Frey) L. G. Sancho & A. Crespo). Net photosynthetic activity related to dry weight is also compared between the folious species (*L. hispanica*) and a fruticulous one (*Stereocaulon alpinum* Laur.). Moreover, we compare chlorophyll contents per surface unit and per dry weight in each case. All species are from Sistema Central (Spain), and were collected in localities above 2000 m. (Poster: Physiology and Ecophysiology: Friday in Nautilus)

SAXENA, D. K.* and **KAUR, HARINDER**

Department of Botany, Bareilly College, Bareilly-243 005 (U.P.)-India.

Active monitoring of aerial deposition of heavy metals in Kumaon Hills, India

Samples of widespread moss *Thuidium cymbifolium* were analyzed for heavy metals (viz., Pb, Cd, Zn and Cu) from famous tourist cities of Kumaon. Moss bags in triplicate were suspended for a period of four months during summer season for two successive years. Analysis of harvested moss samples exposed during summer season of each year clearly demonstrates a strong traffic related deposition of heavy metals. The highest lead levels were recorded in moss samples harvested from petrol pumps (3, 6) in Almora and Ranikhet hill resorts respectively. Similarly Zn, Cd and Cu too were mostly concentrated in areas of high traffic density. Besides this, Zn was also found exceptionally higher at site 4 which is located close to agricultural area. The results of the present study clearly revealed that high automotive traffic of tourists during summer season is an important source of these metals in Kumaon. Altogether the results of present study encourage the use of *T. cymbifolium* as active monitor to study the aerial deposition of heavy metals. (Poster: Ecological Monitoring, Friday in Triton)

SCHMULL, MICHAELA

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The lichen genus *Lecidea* s. lat. (sensu Zahlbruckner): How widely are species of this heterogeneous group distributed within the Lecanoromycetes?

The phylogeny of common and wide spread species of the genus *Lecidea* sensu lato (sensu Zahlbruckner) and species of allied genera was studied using parsimony, maximum likelihood, and Bayesian Markov Chain Monte Carlo analyses of combined mitochondrial small subunit and nuclear large subunit ribosomal DNA. The results of this study indicate that the majority of the taxa studied belong to the order Lecanorales. One of the species belongs to the Agyriales (Schaereriaceae). The results are discussed with respect to important morphological-anatomical characters, chemistry, and photobiont selectivity. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

SCHROETER, BURKHARD

Botanical Institute and Leibniz Institute for Science Education, Christian-Albrechts-University Kiel, D-24098 Kiel, Germany

Photosynthetic performance of lichens and mosses under natural conditions in the maritime Antarctic

In Antarctica lichens and mosses form the major element of terrestrial ecosystems. Cryptogams and especially lichens are adapted to extreme environmental conditions and often they are able to sustain long periods in a dry and inactive state. Due to the poikilohydric nature of lichens, thallus water content is largely unregulated. In their natural habitat lichens often change between metabolically active and inactive states depending on the water supply from their surroundings. Water relations in natural habitats often differ substantially on a small scale. Thalli which grow only a few metres apart may show very different activity patterns due to variations in water availability controlled by the microenvironment. Therefore, in many habitats water availability controls the productivity of these organisms. To analyse the water related metabolic activity of selected lichens and mosses *in situ* microclimatic conditions combined with chlorophyll *a* fluorescence patterns were investigated in a maritime Antarctic site in the austral summer season. The data presented here reveal microhabitat and species specific photosynthetic activity pattern in lichen and moss species and underline the dominant role of water availability in determining productivity under the extreme environmental conditions present in the maritime Antarctic. (*Symposium*: Lichens in Polar Ecosystems)

SCHULTZ, MATTHIAS

Biocenter Klein Flottbek and Botanical Garden of the University of Hamburg, Ohnhorststr. 18, D-22609 Hamburg, Germany

An Overview of Members of the Lichinaceae in Biological Soil Crusts

Many representatives of the cyanobacterial lichen familiy Lichinaceae have their main distribution areas in arid to semi-arid regions of the world and a number of them occurs in biological soil crusts. The talk will present an overview of those species of the Lichinaceae commonly observed in stabilized desert or semi-desert soils with focus on southern Arabia, Namibia and the American Southwest. Patterns of growth forms will be discussed as well as possible adaptive strategies. Furthermore, questions will be addressed dealing with the substrate choice of widely distributed species that occur in soil crust communities as well as on rocky substrata. Finally, the growth form variablity and distribution of soil crust species of the genus Peccania will be compared with those of their rock dwelling relatives based on a molecular phylogeny of the genus. (*Symposium*: The World under Your Feet: Biological Soil Crusts)

***SCHULTZ, MATTHIAS**[1] and **BUSCHBOM, JUTTA**[2]

[1]Biocenter Klein Flottbek and Botanical Garden of the University of Hamburg, Ohnhorststr. 18, D-22609 Hamburg, Germany; [2]Institute for Forest Genetics, vTI, Federal Research Institute for Rural Areas, Forestry and Fisheries, D-22927, Grosshansdorf, Germany

Ancestral Character Reconstructions in the Lichinales (Lichinomycetes), a Presumably Ancient Lineage of Lichen-forming Ascomyctetes

The Lichinales are isolated lichenized ascomycetes with cyanobacterial symbionts. Most Lichinaceae species possess simple thalli and thinwalled asci with usually 8, simple ascospores. Peltula has a layered thallus and polysporous, unitunicae-rostrate asci. Heppia and the Gloeoheppiaceae are intermediate. The position and sister-group relationship of the Lichinales have not been

clarified though the monophyly is strongly supported. The low number of species and overall simple structure pose the question whether these enigmatic lichens constitute one of the oldest living lineages of lichen-forming fungi with much of the diversity being lost and reductions in ascus structure and function. This question is addressed through Bayesian reconstructions of the ancestral character states of five morphological characters of reproductive and ecological importance using a ncSSU dataset representing evolutionary relationship. First results suggest that the ancestor to the Lichinales possessed an ontogeny, ascus type and eupolyspore asci similar to traits present in (basal) Lecanoromycetes. (*Symposium*: What's New about the Oldest Lichens and Bryophytes)

***SCHWARTZMAN, DAVID**

Howard University, Department of Biology, Washington, D.C. 20059, USA.

Was the origin of the lichen symbiosis triggered by declining atmospheric carbon dioxide levels?

Declining atmospheric carbon dioxide levels have been proposed as triggers of the emergence of cyanobacteria and leaves of vascular plants in the Archean and Devonian respectively. I propose that the lichen symbiosis likewise emerged as a result of the analogous episodic declines in the level of atmospheric carbon dioxide since the first emergence of fungi about one billion years ago. Fungal mats became plausible attractors to potential photobiont partners because of the higher in-situ respiration-derived pCO_2 level relative to the ambient atmosphere. This hypothesis rests on the apparent evidence for the recycling of respired carbon dioxide from the mycobiont to the photobiont in living lichens, especially when wetting of the thallus impedes carbon dioxide diffusion from the atmosphere. Analogous partial recycling of carbon occurs between heterotrophs and autotrophs in lakes and cyanobacterial mat communities. (*Symposium*: What's New about the Oldest Lichens and Bryophytes)

SELVA, STEVEN

University of Maine at Fort Kent, Division of Natural & Behavioral Sciences, 23 University Drive, Fort Kent, Maine 04743, U.S.A.

Calicioid lichens and fungi of the Acadian Forest Region of eastern North America

Extending from the Adirondack Mountains of northeastern New York, through northern New England and the Maritime Provinces of Canada, the Acadian Forest Region is an ecological transition zone between the eastern boreal forest and the temperate deciduous forest. As part of an ongoing effort to assess the ecological continuity of forested stands within this region, seventy-two species of calicioid lichens and fungi have been identified through vegetation sampling and investigations at regional herbaria. The habitat ecology and distribution of calicioid species within the Acadian Forest Region will be discussed, as will the roles they play in assessing ecological continuity. (Poster: Ecology, Thursday in Merrill Hall)

ŞENKARDEŞLER, AYHAN

Department of Biology, Faculty of Science, Ege University, 35100 Izmir, Turkey

The role of lichen anatomy on the ABA content variation after desiccation

Abscisic acid (ABA) is a signal responsible for slow growing and its level in lichens increases usually during rehydrations. However, in some cases, this increase falls out. In this study, 3 lichen species were rehydrated after a desiccation of 24 h and the changes of ABA content were analyzed. Then the results are compared with the anatomical observations. The ABA content of rehydrated *Ramalina farinacea* increases by 25.5%, whereas the ABA content of rehydrated *Pseudevernia furfuracea* increases only by 2.7% and *Evernia prunastri* decreases by 51.7%. The last two behaviors are unusual, whereas these are significant with the low phycobiont content. On the other hand, the thallus of *R. farinacea*, with dense algal content, shows the typical behavior in the ABA content variation. As a result, ABA levels could be changing with the algal density. This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK). (*Symposium*: Biochemistry and Physiology of Poikilohydry)

ŞENKARDEŞLER, AYHAN

Department of Biology, Faculty of Science, Ege University, 35100 Izmir, Turkey

Endemic *Aspicilia* species in SW Asia

The lichens of SW Asia have been intensively studied since the last two decades. However, early works of Steiner (1895, 1899, 1905, 1909, 1910, 1916, 1919 and 1921) are essential for the better knowledge. He described 64 species and 93 infraspecific taxa in his papers. Type specimens of these taxa are deposited in University of Vienna Herbarium (WU) and The Natural History Museum Vienna (W). Comparing these materials with other *Aspicilia* species and with the current floristical studies, some *Aspicilia* species seem to be endemic to SW Asia. Species like *A. albocincta* (J. Steiner) Şenkardeşler ined., *A. amylophora* (J. Steiner) Kondratyuk, *A. aschabadensis* (J. Steiner) Mereschk., *A. kjachtensis* (J. Steiner) Şenkardeşler ined. and *A. polychromoides* (J. Steiner) Hue represent these endemics. All of these taxa are 'forgotten' in lichenology, and they are waiting for rediscovering. Photos, types and descriptions of these *Aspicilia* species are presented here. This study was supported by SYNTHESYS and The Scientific and Technological Research Council of Turkey (TUBITAK). (*Symposium*: Endemics, especially in California and Poster: Biogeography and Floristics, Monday in Merrill Hall)

ŞENKARDEŞLER, AYHAN

Department of Biology, Faculty of Science, Ege University, 35100 Izmir, Turkey

Preliminary work of a Synopsis of the Genus *Usnea* in Turkey

Twenty-eight species belonging to the genus *Usnea* are reported from Turkey. However, suspicious species like *U. anatolica* Motyka, *U. bithynica* Motyka, *U. czeczottae* Motyka and *U. syriaca* Motyka are only known from four localities and they were given only in Motyka (1936-38), Czeczott (1938/39) and Verseghy (1980). In this study, distribution maps of twenty-eight species are given and the status of the critical four species is discussed. (Poster: Biogeography and Floristics, Monday in Merrill Hall)

ŞENKARDEŞLER, AYHAN

Department of Biology, Faculty of Science, Ege University, 35100 Izmir, Turkey

Lichen bioindication in the Karaburun Peninsula (Izmir, Turkey)

An air quality study using the IAP method has been carried out in the Karaburun Peninsula (Izmir, Turkey). The survey area was divided into 91 units, which were analysed for the frequency of epiphytic lichens on olive trees (*Olea europaea* L.). IAP values ranged between 0-40 and were classified into nine categories to produce an air quality map. The seashore was recognized as free of epiphytic lichens substantially because of the maritime effect. Availability of olives as phorophyte in bioindication studies was discussed. A reduced list of 16 indicator species has been suggested for the study area. (Poster: Environmental Monitoring, Friday in Triton)

***ŞENKARDEŞLER, AYHAN**[1] and **LŐKÖS, LÁSZLÓ**[2]

[1]Department of Biology, Faculty of Science, Ege University, 35100 Izmir, Turkey
[2]Botanical Department, Hungarian Natural History Museum, H–1087 Budapest, Könyves K. krt. 40, Hungary

Contributions of herbaria W, WU and BP to the lichen flora of Turkey

Exploration of the Turkish lichen flora is still not completed. Lichen records published by Steiner and Szatala up to the 1960s caused most of the difficulties. These lichens were collected by Andrasovszky, Bornmüller, Nabelek, Nemetz, Penther & Zederbauer, Selinka and von Handel-Mazzetti, and identified by Steiner and Szatala, but they were partly revised by others later, mainly in last 4 decades. A part of these revisions remained unpublished or the locality data lacking in some published revisions. To manage these problems and to find the requested information, approx. 400,000 specimens in The Natural History Museum Vienna (W), University of Vienna Herbarium (WU) and Hungarian Natural History Museum (BP) were carefully searched and checked for lichens from Turkey and 2263 specimens belonging to 547 species were found. This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK) and and partly by the Hungarian Scientific Research Fund (OTKA 047160). (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***ŞENKARDEŞLER, AYHAN**[1] and **LŐKÖS, LÁSZLÓ**[2]

[1]Department of Biology, Faculty of Science, Ege University, 35100 Izmir, Turkey
[2]Botanical Department, Hungarian Natural History Museum, H–1087 Budapest, Könyves K. krt. 40, Hungary

Some types of lichen taxa described by Steiner and Szatala

Most lichenologists believe that all the type specimens of Steiner are deposited in University of Vienna Herbarium (WU) and those of Szatala in the Hungarian Natural History Museum (BP). Furthermore, some lichenologists is thinking that Steiner was a Professor at WU, and Szatala was the lichen curator in BP for a long time. All of these predictions are not true at all. In fact, Steiner was a professor at the "käiserlich-königliche Staatsgymnasium", but he spent his free time mostly in WU. Moreover, he studied the collections in The Natural History Museum Vienna (W) as well, so his types are deposited both in W and WU. On the other hand, Szatala was working in BP officially only between 1953 and 1958. Before this, he had been working at the Royal Hungarian Experimental Station for Seed Testing, but he spent a lot of his time in BP. He studied, identified and revised the lichens not only in BP, but also in W, and some of his types are shared and deposited in both herbaria. Some critical types are discussed in this study, which was supported by SYNTHESYS and The Scientific and Technological Research Council of Turkey (TUBITAK). (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

SHUSTOV, MIKHAIL V.

Institute of Ecology of the Volga river basin of Russian Academy of Sc., Komzin st., 10, Togliatty, 445003, Russia.

The forecast spreading of the lichens within the Privolzhskaya upland (European Russia) by the middle of the XXI century

Basing on the research work made by E. G. Kolomyts (2003) it becomes possible to build a forecast of spreading the lichens within the Privolzhskaya upland by the middle of the XXI century. Modern location of some arid lichens corresponds to the existing floristic borders; the given species will survive in the region and the borders of their spreading will move to the north. The contemporary spreading of most lichens corresponds to the existing plant cover growing. We assume that by the middle of the XXI century the number of species mentioned below will have considerably decreased, namely: boreal, nemoral, hipoarctomontanous, montanous, arctoalpine besides many of them will have disappeared whereas the number of arid and multizonal lichens will have increased and prevailed throughout the lichens flora of the Privolzhskaya upland. Flora genesis processes are reflected in the modern location of the climate-related relicts of the Privolzhskaya upland lichens flora. Forest nemoral mesophytic relicts of the early-middle Miocene are likely to disappear on the territory of the upland, whereas arid relicts of the late Miocene and Eopleistocene are likely to survive. Many epilithic hipoarctomonteneous, montaneous, arctoalpine and other relict lichens of these groups may keep growing in the region on the top of the upland high plato. Forest epiphyte mesophytic boreal, hipoarctomontanous, montanous, arctoalpine and other relict lichens of these groups are likely to disappear on the greater part of the upland though in the northern part of the region there may have remainrd some isolated places of their growth. Further evolution of lichen biota of the Privolzhskaya upland will occur in the way of developing desert-steppe-xerophytic elements and decreasing forest mesophytic elements on the basis of its general degradation, impoverishing and simplification. (Poster: Biogeography and Floristics, Monday in Triton)

ŚLIWA, LUCYNA

Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46, PL-31-512 Krakow, Poland

Diversity of the *Lecanora dispersa* group in North America

The present treatment was initiated as a revision of the North American collections of the group in an effort to assess the species diversity of these lichens on that continent. Previously, only a few members of the complex had been reported from the USA and Canada. The *L. dispersa* group in North America was revised based on about 1900 specimens from 25 herbaria. The following 19 species are recognized in the study area: *Lecanora agardhiana*, *L. albescens*, *L. andrewii*, *L. crenulata*, *L. dispersa*, *L. flowersiana*, *L. fugiens*, *L. hagenii*, *L. invadens*, *L. juniperina*, *L. percrenata*, *L. perpruinosa*, *L. persimilis*, *L. salina*, *L. sambuci*, *L. semipallida*, *L. torrida*, *L. wetmorei*, and *L. zosterae*. Seven of the species are reported for the first time from the continent. The North American species have varied distribution patterns. The taxa differ also in frequency. (Poster: Biogeography and Floristics, Monday in Triton))

***SMIRNOV, IVAN** and **TRUSHINA, ELENA**

Lomonosov Moscow State University,GSP-2, Leninskie Gory, Moscow, 119992, Russian Federation

Influence of light intensity and ages of phorophytes on the growth of *Hypogymnia physodes* (L.) Nyl. on *Picea* spp.

The study was conducted in Russian Federation (Moscow region, republic of Karelia, Russian Far East) and USA (the Adirondack, New York). The object of the research was *H. physodes* on *P. abies, P. obovata, P. mariana, P. rubens* and *P. glauca*. On the lower accessible branches of trees about 200 microsites were chose. At each microsites age of branch, light intensity (by means lux meter), lichen biomass, thallium square and lichen cover etc. were measured (more than 4000 measurements were done). It is clear, that light intensity correlates with branch age: the young ones are more illuminated. The lichens are mostly abundant at the branches of the average age. Biomass, thallium square and cover of lichen grow together with branch age from 2-3 to 10-13 years, gradually decreasing after 14 years. However it is not a strict for all the species of *Picea* spp. *P. obovata*, demonstrating another crown shape, shows different light intensity and lichen biomass as well. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

SMITH, NICK, *MCNETT, KIMBERLEE J., CRABTREE, MATTHEW M., BRADY, DUKE G., LIEBMANN, MEGAN M. and FISCHER, DYLAN

The Evergreen State College, 2700 Evergreen Parkway NW, Olympia, WA 98505

Variation of Algal Layer Ratios in *Parmelia sulcata* (Parmeliaceae) along Gradients of Atmospheric Nitrogen Dioxide and Canopy Height

The algal layer ratios of pollution-tolerant lichens may serve as a hypersensitive indicator of air pollution. In this observational study we show that the ratio of algal layer width to total thallus thickness of the lichen species *Parmelia sulcata* responds positively to low-levels of anthropogenic nitrogen dioxide. The deviation of algal layer ratios on a local level represented a fraction of that which was detected on the low-level pollution gradient. Our findings suggest that variation along the pollution concentration gradient may be approximately 2× greater than the variation attributed to vertical position on a substrate. (Poster: Environmental Monitoring, Friday in Triton)

***SØCHTING, ULRIK[1]** and **SANCHO, LEO[2]**

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Polar biota – What can lichens tell us about their origin?

Studies on the origin of the polar biota must be based on organisms that are well represented in Arctic as well as Antarctic regions. Lichens, particularly from the family Teloschistaceae are well suited for the purpose. Teloschistaceae has about 50 and 35 species in the Arctic and the Antarctic, respectively. Recent studies based on molecular data have shown a very small degree of overlapping between the Teloschistaceae taxa from the two regions. Phylogeographic studies based on the ITS region of nuclear ribosomal DNA indicate that some bipolar species have been dispersed from the Antarctic to Antarctica, whereas others originate from the southern Hemisphere. Most Teloschistaceae species restricted to the Antarctic region belong to two different phylogenetic clades that at present appear to be rooted in South America. (*Symposium*: Lichens in Polar Ecosystems)

SØGAARD, MAJBRIT[1]; SØCHTING, ULRIK[1] and **SANCHO, LEO[2]**

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Maritime lichen zonation in Patagonia

Lichen communities on rocky sea shores in southern Patagonia were analyzed in order to find ecological parallels to the maritime zonations found in temperate zones of the northern hemisphere. The conspicuously colored zones of rocky sea shores have been thoroughly investigated in the northern hemisphere, but few similar studies have been made at southern latitudes. The maritime communities of 12 locations on the island of Navarino, Tierra del Fuego, Chile, were analyzed using a pin-point method. Locations were chosen to cover different aspects, distances from the sea and heights above sea level. Questions addressed: Are the zones composed of the same genera with the same or vicariating species as in the northern hemisphere? Do the maritime communities have a circumpolar distribution? Are maritime communities particularly rich in polar endemics due to special dispersal barriers and lack of refuges? (Poster: Ecology, Thursday in Merrill Hall)

SOHRABI, MOHAMMAD

Botanical Museum (Mycology), P. O. Box 7, FIN-00014 Helsinki University, Finland.

Comparative morphology among vagrant species of *Aspicilia* (Megasporaceae)

Taxonomy of terricolous *Aspicilia* is insufficiently known and mainly because of considerable variation in thallus morphology, the species concepts are unsettled. The emphasis of the present study is on the species occurring in the Iranian and central Asian steppes and deserts. Comparative morphology and anatomic details from 10 vagrant *Aspicilia* species are reported here. This include the cortex, position of pseudocyphellae, orientation of algal layer, medulla layer, apothecial characterisation, ascospore and conidium sizes, results from testing of chemical substances. The primary characterisation of this group confirmed that the chemical variation is insignificant, compared with the situation in *Aspicilia cinerea*. There are mainly two kinds of cortex structures occurring in this group. The main group has one cortex layer with paraplectenchymatous tissue (*Aspicilia esculenta, A. aspera, A. desertorum*). Two cortex layers are found in a small group (*A. fruticulosa*, *A. hispida,* and *A. transbaicalica*). Here, the outer part is paraplectenchymatous and the inner part prosoplectenchymatous. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

***SOHRABI, MOHAMMAD**[1] and **ALIABADI, FAEZEH**[2]

Botanical Museum, P.O.Box 7 (Unioninkatu 44), and Plant Biology (Biocenter 3), PO Box 65, FIN-00014 UNIV. HELSINKI, FINLAND; [2]Iranian Resaerch Institute of Plant Protection, Department of Botany, Tehran 19395-1454, IRAN.

Lichens of Arasbaran Forest, NW of Iran

Arasbaran Biosphere Reserve is a mountainous area in the northern part of East Azarbaijan province, and belongs to the Iranian part of the Caucasian highlands situated between the Caspian and the Black Sea. It extends between 38º33´and 39º09´ N latitude and between 46º09´ and 47º09´ E longitude. The knowledge of lichenized mycota in this area is so far insuficntly known. The results presented here are based on the material collected during the expedition to Arasbaran forests in November 2007 and May 2008. In this study lichens specimens were collected in Arasbaran forest originated from Asheglou and Aynalou, Tatar and Darana forests. Over 60 species are recorded for the area, and of these, numerous are reported new to E. Azerbaijan province, e.g. in the genera *Acarospor*a, *Arthonia Aspicilia, Bacidia, Caloplaca, Lecania, Lecanora, Lecidea, , Psorula, Peltigera, Pertusaria, Phaeophyscia, Physconia, Lobothallia, Placidium, Pyrenula, Ramalina, Rhizoplaca, Rinodina, Toninia, Tornabea* and *Umbilicaria.* (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***ŠOUN, JAROSLAV** and **VONDRÁK, JAN**

University of South Bohemia, Faculty of Science, Department of Botany, Branišovská 31, České Budějovice CZ-37005, Czech Republic.

Provisional data on phylogeny and taxonomy of the *Caloplaca cerina* group in Europe

From the taxonomical point of view, the *Caloplaca cerina* group has been little investigated so far. Results from phylogenetic analysis based on ITS sequences along with data on morphology are provided. The phylogenetic analysis revealed thirteen clades that are supported by morphological data and are considered species. These species/clades are well-defined by their ecology; there are three strictly saxicolous, six corticolous and about four species growing on moss, plant debris and herbal stems. *Caloplaca chlorina* is the only species that can be both saxicolous and corticolous. Two saxicolous species are being described now, *Caloplaca subalpina* from European mountains and *C. thracopontica* from the coast of the Black Sea. Regarding to other species/clades, additional material should be investigated before final assessment and type material of the existing names should predate eventual describing of new species. *Caloplaca aractina, C. haematites* and *C. squamuloisidiata* possessing "*Caloplaca cerina* morphology" belong to different, unrelated groups. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

***SPIELMANN, ADRIANO AFONSO** and **MARCELLI, MARCELO PINTO**

Instituto de Botânica, Seção de Micologia e Liquenologia, Av. Miguel Stéfano, 3687, Água Funda, São Paulo – SP, Brazil.

Type studies on pustulate and schizidiate parmotremoid lichens (Parmeliaceae, Ascomycota) with salazinic acid

Parmotremoid lichens (*Parmotrema* s.l.) are very abundant and diverse in the tropics and subtropics, and their morphology and specific limits are still poorly understood. Important features like maculation patterns, conidial length and rhizines types are

frequently overlooked, leading to a synonymization of several distinct taxa under a few widely used names, like *Parmotrema reticulatum* (Taylor) M. Choisy. Two schizidiate and six pustulate species are here discussed, based on the studied types. *Parmotrema austrocetratum* Elix & Johnston is set apart from *P. hawaiiense* (H. Magn.) Blanco, Crespo, Divakar, Elix & Lumbsch. A new combination is required for *Parmelia cetrata* f. *granularis* Asahina (*in prep.*), and a key is provided to accepted species. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

SPRIBILLE, TOBY[1], **THOR, GÖRAN**[2], **GOWARD, TREVOR,** and **BJÖRK, CURTIS**

[1]University of Göttingen, Untere Karspüle 2, D-37073 Göttingen, Germany; [2]Department of Ecology, Swedish University of Agricultural Sciences, P.O. Box 7044, SE 750 07 Uppsala, Sweden; [3]Edgewood Blue, Box 131, Clearwater, B.C. V0E 1N0, Canada; [4]Stillinger Herbarium, University of Idaho, Moscow, ID, 83843, U.S.A.

The epiphytic crustose lichen flora of the Pacific Northwest, held to its Fennoscandian mirror

The lichen flora of the Pacific Northwest has received intensified attention over the last 30 years. The early focus on macrolichens is beginning to shift to include the whole flora and the region is increasingly coming to be appreciated as a hotbed of crustose lichen diversity. Currently nearly 900 species of epiphytic lichens have been reported from the Pacific Northwest, a large number of these since 1995. This puts the Pacific Northwest almost exactly on par with Fennoscandia. We pooled epiphytic lichen floras of the two regions and examined species-substrate affinities for all 1271 species, assigning species to three 'guilds': obligate wood-dwelling, generalist, and obligate bark-dwelling. We found 1) about 40% of species are shared between the two floras, 2) there is a high percentage of overlap (59%) among wood-dwelling and generalist assemblages and 3) there is low overlap (28%) among corticoles in the two regions. The distinctness of the corticole floras has been attributed in the past to evolutionary isolation of the two floras. There is however no evidence to suggest that corticole floras have been isolated longer than generalist and lignicole floras, nor for the alternative hypothesis that lignicoles and generalists disproportionately consist of long distance dispersers. Instead, we propose that the present-day pattern reflects a different evolutionary landscape on bark versus wood, overlain with Pleistocene extinction events that have left the Pacific Northwest with a richer epiphytic lichen flora than northern Europe. (*Symposium*: Roots, trunks, branches and leaves: Systematics and Phylogenetics)

***STEWART, K** and **COXSON, D.**

University of Northern British Columbia, Canada, Natural Resources and Environmental Studies

Arctic nitrogen fixation: Nitrogen fixation by associative cyanobacteria varies across an Arctic tundra landscape over the growing season

Nitrogen is a key factor limiting plant productivity in cold northern environments. N-fixation by diazotrophic cyanobacteria is the main source of new N inputs in terrestrial arctic ecosystems. Cyanobacteria are not only common pioneer colonizers of newly exposed soils where they are often found in association with biological soil crust, but also colonize early successional plants, such as bryophytes. Our primary objective is to evaluate spatial and temporal variation in N-fixation by associative cyanobacteria in a northern environment. Acetylene reduction (AR) techniques that measure nitrogenase activity were used to assess the rates of N-fixation. Concurrent measurements of crust and moss operating environments, including moisture, light and temperature were taken to better determine the effects of abiotic factors on diurnal and seasonal variation. Preliminary results suggest that rates of N-fixation vary both between ecosystem units and over the growing season in an Arctic tundra landscape. (Poster: Physiology and Ecophysiology, Friday in Nautilus)

STOCKER-WÖRGÖTTER, ELFIE

University of Salzburg, Department of Organismic Biology, Hellbrunner Str. 34, A-5020 Salzburg, Austria/Österreich

Secondary chemistry, environmental and biological signaling, and PKS genes in lichens

Lichen-forming, ascomycetous fungi produce a broad spectrum of unique (depsides, depsidones, dibenzofurans) and common polyketides (anthraquinones, naphthaquinones, etc.). Lichen metabolites have been screened by TLC and HPLC analyses. One objective of our research was to localise PKS genes by studying under which environmental conditions, a particular class of polyketides is expressed in aposymbiotically cultured mycobionts. In extensive test series, it was shown that the compositions of nutrient media (specific carbohydrates together with ecological parameters and morphogenetic effects) influence and promote the expression of particular polyketides, compounds hitherto known only from intact lichens, in cultured mycobionts. For an anthraquinone-producing lichen (*Xanthoria elegans*) the PKS gene was successfully sequenced by using a new technology. We found a typical PKS 1 with a very interesting enzyme architecture. Progress in understanding the function of type I PKSs and

their control by PKS genes may revolutionise the use of lichens/lichen substances in future biotechnological approaches. (Poster: Symbiosis, Wednesday in Triton)

***STOCKER-WÖRGÖTTER, ELFIE[1], WERTH, SILKE[2] , PRINGLE, ANNE[3],** and **ELIX, JOHN A.[4]**

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Experimental Investigations on fungal and „symbiotic" networks as exemplified by *Ramalina menziesii* and *Cladia ferdinandii*: cultured bionts and morphogenetic dynamics to re-establish the symbiotic state

Ramalina menziesii, known as "lace lichen" in California shows a high variability of reticulate growth forms. In contrast to previous studies on naturally grown thalli, this investigation was mainly an experimental approach. By growing the lichen fungus and algae aposymbiotically, we tried to find out if this mycobiont differs from other mycobionts (clumpy structures), in that it probably would start its development as a more organized reticulate structure or if not, how it could be triggered to form a typical fungal network out of a undifferentiated hyphal mass. Another test series concentrated on *Cladia ferdinandii*. The *Cladia*-fungus builds a protective network around the algal layer that is located inside; the whole network thallus emerges as a coral-like superstructure. *Cladia ferdinandii* thalli are built from "pure networks" without any hyphal stabilisations inside. Considering the deviating ecological conditions, young thalli of *Cladia ferdinandii* were successfully re-established under artifical lab conditions. (*Symposium*: Together and Separate: The Lives of the Lichen Symbionts)

STOFER, SILVIA[1], WALTER SEIDLING[2], and **RICHARD FISCHER[3]**

[1]Swiss Federal Institute for Forest Snow and Landscape Research WSL, Zürcherstr. 111, CH-8903 Birmensdorf, Switzerland; [2]Johann Heinrich von Thünen-Institut, Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei, Institut für Waldökologie und Waldinventuren, Alfred-Möller-Straße 1, D-16225 Eberswalde, Germany; [3]Johann Heinrich von Thünen-Institute (vTI), Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute for World Forestry, Leuschnerstr. 91, D-21031 Hamburg, Germany

Background, main results and conclusions from a test phase for biodiversity assessments on intensive forest monitoring plots in Europe (ForestBIOTA project) – indicator epiphytic lichens

The aim of the ForestBIOTA project (www.forestbiota.org) was to develop and test standardized assessment methods to monitor different aspects of forest diversity on intensive monitoring plots at the European scale. The project took into account policy requirements stated by a number of political processes and institutions. Epiphytic lichens were monitored in 10 countries on 83 Level II plots of the European forest condition monitoring network in addition to forest type, stand structure, deadwood and ground vegetation. Frequency of epiphytic lichens was assessed on at least 12 trees per 2500m^2 plots. Sampled trees were selected following a randomized sampling approach with pre-stratification based on existing tree species information. The method for epiphytic lichen assessment was found to be feasible and efficient in all of the participating countries. Lichen data was evaluated in relation to biotic and abiotic parameters. Species richness of the epiphytic lichens correlated with the macroecological parameters latitude and altitude as well as with forest type, soil pH and deposition and turned out as an indicator for spatial tree distribution. (Poster: Environmental Monitoring, Friday in Triton)

STROTHER, PAUL K.

Department of Geology & Geophysics, Weston Observatory, Boston College, 381 Concord Road, Weston MA 02493 USA.

Fragments of Cambrian land plants

Fragmentary organic remains from strata of middle and late Cambrian age include: three kinds of cuticles associated with spore masses, masses of filaments with oblique cross walls, globlular and elongate membranous sacs (sporangia). Such features are more closely aligned with bryophytes than they are with any algae. In combination with spore data, these discoveries indicate that embryophytes may have evolved through the serial acquisition of adaptations to the subaerial landscape and that the upright, axial sporophyte, whose morphology is a direct outcome of embryonic development, was perhaps the last of such adaptations. Conceptually, this enables us to use the fossil record to explore in more detail the charophyte-embryophyte transition. It implies that a class of land plants existed before the embryophytes and suggests that two terms should no longer be regarded as synonymous. (Poster: Environmental Monitoring, Friday in Triton)

***STROTHER, PAUL K.**[1] and **TAYLOR, WILSON A.**[2]

[1]Department of Geology & Geophysics, Weston Observatory, Boston College, 381 Concord Road, Weston MA 02493 USA; [2]Department of Biology, University of Wisconsin – Eau Claire, 105 Garfield Avenue, P.O. Box 4004, Eau Claire, WI 54701-4004 USA.

Cryptospores and the evolution of sporogenesis in bryophytes

Axial plants are preceded in the geologic column by a 100 Myr record of cryptospore monads, dyads and tetrads. Cambrian dyads and tetrads are typically enclosed in a common synoecosporal wall comprised of one to three discrete laminae. Others possess multilaminate walls, similar to *Riccia*. Many Cambrian cryptospores are dispersed as dyads and dyad pairs; tetrahedrally-arranged meiospores do not appear in the fossil record until Middle Ordovician. The fossil record indicates that meiotic sporogensis evolved over time and was not a singular evolutionary event. This conclusion is supported by the work of Shimamura and others who noted in 2004 that the control of spindle formation (MTOCs) in bryophytes, varies from algal-like (centriolar) to higher-plant-like (diffuse). Embryophytes may have evolved from charophytes through the serial acquisition of structures (characters) associated with selection in subaerial habitats – a proposition that is also supported by recent discoveries of Cambrian fragmentary plant remains. (*Symposium*: What's New about the Oldest Lichens and Bryophytes)

SUIJA, AVE[1], **PÉREZ-ORTEGA, SERGIO**[2] and **CRESPO, ANA**[2]

[1]Botanical and Mycological Museum, Natural History Museum of the University of Tartu, 38 Lai St. Tartu EE-51005, Estonia; [2]Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense, Plaza de Ramón y Cajal s/n, Ciudad Universitaria, E-28040 Madrid, Spain

The first outline of the phylogeny of the lichenicolous genus *Abrothallus* (Ascomycota) based on nuITS

The genus *Abrothallus* described already in 1845 by De Notaris is a well-delimited genus of obligate lichen inhabiting fungi growing on various representatives of *Parmeliaceae*, *Peltigeraceae*, *Ramalinaceae*, *Cladoniaceae* and *Stereocaulaceae*. The adaptation of parasitic organisms to their habitat is usually accompanied by the reduction of taxonomically informative characters, leading to a difficult species delimitation based on morphological or anatomical traits. The genus *Abrothallus* is an example of this generalization being a well-delimited genus with controversial species definition. The host-specificity and sub-generic delimitation were investigated using nuITS rDNA sequences and analysed applying a Bayesian approach. Our results suggest that the phylogenetic host-parasite relationships are more complicate than previously thought. Species growing on *Peltigeraceae* show stronger specificity than those living on *Parmeliaceae*. The taxonomical importance of certain morphological characters is discussed. (*Symposium*: Lichenicolous Fungi: Taxonomy and Diversity)

SUTJARITTURAKAN, JUTARAT[1] and **BOONPRAGOB, KANSRI**[2]

[1]Department of biotechnology, King Mongkut's Institute of Technology Ladkrabang, Chumphon Campus, Patiew, Chumphon 86160, Thailand; [2]Department of Biology, Faculty of Science, Ramkhamhaeng University, Bankapi, Bangkok 10240, Thailand

The Graphidaceae at Khao Yai National Park, Thailand

Khao Yai National Park was established as the first NP of Thailand in 1962. More than 1100 specimens pertaining to the lichen family Graphidaceae were collected from seven different forest types and 70 tree species. The material was assigned to the following genera, comprising over 150 species: *Acanthothecis, Diorygma, Dyplolabia, Fissurina, Glyphis, Graphis, Hemithecium, Phaeographis, Sarcographa, Pallidogramme, Platygramme, Platythecium,* and *Thecaria.* The tropical rain forest and the secondary forests are favorable sites for the graphids, while the dry dipterocarp forests have a lower species diversity. *Glyphis cicatricosa* (46 collections in 5 forest types), *Dyplolabia afzelii* (15, 5), *Fissurina dumastoides* (22, 6), *G. rimulosa* (13, 7), *G. vermifera* (34, 6), *Phaeographis caesioradians* (30, 5), *Pallidogramme chlorocarpoides* (24, 7), *Sarcographa cinchonarum* (135, 6), and *Thecaria quassiicola* (23, 5) are the most common species. The greatest diversity of species was found on the bark of *Holarrheana antidysenterica* (37 species) and *Peltophorum pterocarpum* (27 species**).** (Poster: Biogeography and Floristics, Monday in Merrill Hall)

***SWEAT, KEN[1], NASH III, THOMAS H.[1], PRAPAIPONG, PANJAI[2], and GREMILLION, PAUL[3]**

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Geographic Patterns of trace Metal Deposition using the Lichen *Xanthoparmelia* in northern and central Arizona, USA

The epilithic lichen *Xanthoparmelia* spp. was used to assess atmospheric deposition of trace elements for areas in northern and central Arizona, USA. The northern, rural area consisted of 51 locations within or near Grand Canyon National Park; the central, urban area consisted of 27 locations in Maricopa County corresponding to a previous study (Zschau *et al.*, 2003). Temporal trends were also assessed using additional lichens collected from the region in 1970-1973, focusing on decreases in Cu and Pb from the closing of copper smelters and the phase out of leaded gasoline and increases in Zn from agriculture. Lichens were analyzed by both cold vapor technique for mercury (Hg) and wet digested in a high pressure microwave oven to have analyzed by high resolution ICP-MS for a suite of trace elemental concentrations. Initial research suggests higher levels of almost all metals (anthropogenic and geologic) in the urban area. (Poster: Environmental Monitoring, Friday in Triton)

TEHLER, ANDERS and **IRESTEDT, MARTIN**

Naturhistoriska riksmuseet, Stockholm, Sweden

Endemism in the lichen flora of California with examples from the Arthoniomycetidae

Endemism is prevalent in California. For the subclass Arthoniomecetidae and the order Arthoniales about one third of the genera contain endemic species in Alta and Baja California, for example Dendrographa, Dirina, Hubbsia, Lecanactis, Roccella, Schismatomma Schizopelte and Sigridea. Some of these genera, Dendrographa, Hubbsia and Schizopelte are confined to the Californian coast line. Evolution, dispersal patterns and possible migration routes as based on molecular evidence will be demonstrated and discussed for some of the most well known genera. (*Symposium*: Endemics, especially in California)

THELL, ARNE[1], HÖGNABBA, FILIP[2], ELIX, JOHN A.[3], FEUERER, TASSILO[4], KÄRNEFELT, INGVAR[1], MYLLYS, LEENA[2], RANDLANE, TIINA[5], STENROOS, SOILI[2], SAAG, ANDRES[5] and **AHTI, TEUVO[2]**

[1]The Biological Museums, Lund University, Östra Vallgatan 18-20, SE-223 61 Lund, Sweden; [2]Botanical Museum, Finnish Museum of Natural History, P.O. Box 7, FI-000 14 University of Helsinki, Finland; [3]Department of Chemistry, Building 33, Australian National University, Canberra, ACT 0200, Australia; [4]Hamburg Univesity, Biozentrum Klein Flottbek, Department of Botany and Botanical Garden, Ohnhorststrasse 18, D-22609 Germany; [5]Institute of Ecology and Earth Sciences, University of Tartu, Lai Street 38, 51005 Tartu, Estonia.

A new phylogeny of *Cetraria* s. l. based on five genes including rare species.

In a five-gene phylogenetic, cladistic analysis ninety species coming from all over the world proved to represent a single monophyletic clade of cetrarioid lichens s. str., presently divided in 13 genera: *Ahtiana, Allocetraria, Arctocetraria, Cetraria, Cetrariella, Cetreliopsis, Flavocetraria, Kaernefeltia, Masonhalea, Nephromopsis, Tuckermanella, Tuckermannopsis,* and *Vulpicida*. 71 samples representing 65 of those species and all the type species of the genera were included in a phylogenetic analysis based on the group I intron, ITS, beta-tubulin, GAPDH and mtSSU sequences. 12 of the species were phylogenetically analysed for the first time, and of the 170 sequences 66 are newly produced. Three representatives of the genera *Esslingeriana* and *Melanelia* s. lat. were selected as outgroups. About half of the species were gathered in a strongly supported clade composed of the genera *Allocetraria, Cetraria* s. str,, *Cetrariella* and *Vulpicida*. Spermatial shape is still the single non-molecular character showing a strong correlation with the DNA data. The chemistry of *Cetraria annae* was analyzed for the first time. (*Symposium*: Parmeliaceae: Development of a New Systematics)

TIMDAL, EINAR

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Recent literature on lichens: web services and further developments

Recent Literature on Lichens (RLL), which lists most of the international lichen literature published since 1950, and Mattick's Literature Index, which lists earlier lichen literature, (joint interface: http://nhm.uio.no/lichens/RLL), can return a search result as an xml file. This web service enables programmers to develop applications which read data from the databases and present the information in customized web pages. An example is seen in Aptroot & Sparrius' picture gallery of tropical lichens (http://www.tropicallichens.net). Other recent developments include the possibility to upload a link to a pdf file of a listed paper (or to a web page linking to a pdf file), or to upload the pdf file itself for storage at the RLL site. For some journals publishing free pdf files, RLL provides a link to the journal's download page. Currently, pdf files of more than 1000 papers are available through RLL. (*Symposium*: Integrated Data Networks in Lichenology)

***TIMSINA, BRINDA ADHIKARI** and **PIERCEY-NORMORE, MICHELE**

Department of Biological Sciences, University of Manitoba, Winnipeg, MB, Canada, R3T 2N2

Polyketide synthase genes in *Cladonia pyxidata*

Fungal Polyketide synthase genes (PKS) consist of cluster of genes containing a minimal set of three domains. PKS genes code for polyketides that exhibit a vast diversity of forms and functions. Studies of PKS genes in lichen fungi are still at the initial phase. The objectives of this study were to examine the evolutionary position of *Cladonia pyxidata* using ketosynthase (KS) domain, and to compare KS mutations with kinds of polyketides in some lichen fungi. Nucleotide sequences of the KS region of the PKS gene were used to determine the phylogenetic relationship of *Cladonia pyxidata* and Southern hybridization was used to detect variation. *Cladonia pyxidata* did not form a monophyletic group. Some species of lichen fungi showed evidence for paralogous PKS genes. Further investigation is required to show relationship between paralogues and kinds of polyketides. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

***TOMESCU, ALEXANDRU M.F.**

Humboldt State University, Department of Biological Sciences, Arcata, California 95521, USA.

Lichen and bryophyte signatures in 450-420 million year old biological soil crust-like fossil associations

Lichens and bryophytes have been associated with early stages of terrestrial colonization, yet pre-Devonian (> 415 Ma) macrofossils of these organisms have been elusive. Late Ordovician-Silurian (450-420 Ma) fossil associations from continental deposits in eastern North America are now starting to change this image. The associations represent biological soil crust-like communities of thalloid organisms. Morphology and internal structures of fossils indicate taxonomic diversity, but their preservation precludes direct identification. Co-occurring microfossils suggest bryophytes and fungi were present. Stable carbon isotopes of some of the thalloid fossils are consistent with liverwort affinities, and experiments simulating fossilization reveal structural similarities with algae, fungi, lichens, and bryophytes. These represent evidence for the nature of organisms and community structure during a long hypothesized yet previously unsubstantiated stage of terrestrial colonization that marked the transition between a cyanobacterial-algal biofilm phase (started in the Proterozoic), and modern, vascular plants dominated terrestrial communities (Early Devonian and younger). (*Symposium*: What's New about the Oldest Lichens and Bryophytes)

***TÕRRA, TIIU** and **RANDLANE, TIINA**

University of Tartu, Institute of Ecology and Earth Sciences, Lai Street 38-40, Tartu 51005, Estonia

Genus *Usnea* in Europe – diagnostic characters

About 30 *Usnea* species have been reliably reported in Europe recently. Taxa with abundant apothecia (*U. florida* and *U. intermedia*), coloured cortex (*U. rubicunda*) or medulla (*U. ceratina, U. flavocardia, U. mutabilis, U. subcornuta*) are rather easily recognized. Further taxa can be divided into two major groups – with pendulous and with shrubby thalli. The following characters are used as diagnostic: shape of branches in longitudinal and transverse sections (related to occurrence of foveolae and ridges), constriction of secondary branches, regular segmentation, occurrence and density of fibrils, presence and shape of soralia, presence of papillae and isidiomorphs, consistence of medulla, medullary chemistry etc. Diagnostic characters useful for the identification of European *Usnea* species are demonstrated in original colour images. Species in the heterogeneous aggregate of isidiate shrubby taxa (*U. diplotypus, U. glabrescens, U. praetervisa, U. silesiaca, U. subfloridana, U. subscabrosa, U. substerilis, U. wasmuthii*) are the most difficult to identify. (Poster: Biogeography and Floristics, Monday in Triton)

***TRETIACH, MAURO[1], FAVERO-LONGO, SERGIO E.[2], CRISAFULLI, PAOLA[1], GAZZANO, CLAUDIA[2], CARBONE, FRANCESCO[3], BAIOCCHI, CLAUDIO[3], GIOVINE, MARCO[4], MODENESI, PAOLO[5], RININO, SIMONA[5], CHIAPELLO, MARCO[2], SALVADORI, ORNELLA[6],** and **PIERVITTORI, ROSANNA[2]**

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How do endolithic lichens dissolve carbonates?

Calcicolous endolithic lichens actively dissolve carbonates by means of an unknown mechanism, purportedly related to the secretion of acids (e.g. oxalic acid), or the release of respiratory CO_2. Here we discuss the results of a multidisciplinary research, aimed at testing different factors which might modify the $CO_2/H_2CO_3/CaCO_3$ equilibria, notoriously at the base of carbonate dissolution. All endolithic lichens still immersed in the substratum, or freed from it, produce active forms of Carbonic Anhydrase (CA), which catalyzes the reversible hydration of CO_2, whereas they do not accumulate Ca oxalates. At least three species excrete chelating metabolites. Three low-mass compounds compatible with the siderophore hydroxamates are shown to scavenge Ca in apomycobiont cultures, and limestone dissolution increases upon 24 hrs incubation with the siderophore desferrioxamine. The possible co-operation mechanisms between CAs and Ca-chelants are thoroughly discussed in connections with further possible mechanisms of carbonate biodissolution. (*Symposium*: Functional Ecology)

***TRIEBEL, DAGMAR[1], WEISS, MARKUS[1], NEUBACHER, DIETER[1,2]** and **RAMBOLD, GERHARD[2]**

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Integrating biodiversity data in lichenology

In recent years, a number of integrated biodiversity data networks were established in the frame of international initiatives. Beside these general approaches more specialised networks integrating high-quality data on specific taxonomic groups exist. Exemplified with lichen data, some types of mechanisms for dataflow in distributed systems from information gathering to presentation and exchange, including first options of data analyses online are shown. In this context, the challenges include (a) the need of data repositories for sustainable storage of a wide range of biodiversity data types, (b) the growing demand for developing appropriate management tools on a concept-driven basis, and (c) the need for specialised network infrastructures with the programming of database clients and web services. The work of the IT centre of the Bavarian Natural History Collections including aspects of the Diversity Workbench initiative (www.diversityworkbench.net) are given as an example to elucidate the general tasks of a biodiversity informatics infrastructure. (*Symposium:* Integrated Data Networks in Lichenology)

***TRUONG, CAMILLE** and **CLERC, PHILIPPE**

Conservatoire et Jardin botaniques de la Ville de Genève, case postale 60, CH-1292 Chambésy, Switzerland

The diversity of the saxicolous species of the genus *Usnea* Adans. in the tropical Andes

The genus *Usnea* is widely represented in the neotropical mountains especially in habitats associated with the occurrence of fog and more than 150 names have been mentioned. However, because of their high phenotypic plasticity, modulated by various environmental conditions, the species are poorly known and a revision of their taxonomy is badly needed. In this study, saxicolous species occurring in the Andes of Colombia, Ecuador, Peru and Bolivia were studied using morphological, anatomical and chemical characters. About 30 species were identified, few being strictly saxicolous, whereas most of them are primarily corticolous. This suggests that in *Usnea* substrate specificity is low when environmental conditions are optimal (high levels of air humidity). The influence of the saxicolous habitat on morphology was investigated, as well as the occurrence of lichenicolous fungi. In *Usnea*, infraspecific chemical diversity seems to increase in the neotropics compared to temperate regions. (*Symposium*: Tropical Lichens and Bryophytes)

TÜRK, ROMAN

Department of Organismic Biology, University of Salzburg, Hellbrunnerstasse 34, 5020 Salzburg, Austria.

Diversity of lichens along a latitude gradient in continental East Antarctica in comparison with the lichen diversity in the nival zone of the eastern Alps

The extreme environmental conditions in the Continental East Antarctica and in the nival zone of the Eastern Alps permit the occurrence and surviving only well adapted lichen species. Along a latitude gradient in the continental Antarctica (Taylor Valley S 77° 37', Brown Hills N Darwin Glacier S 79° 50', Lake Wellman, S Darwin Glacier S 79° 55' and Mt. Kyffin 83° 45') the diversity is very different. Dependent on the age of ice free areas, the weathering conditions of the rocks and the availibility of liquid water the number of species is very different at the investigated sites. In the vicinity of the sea the species number of terricolous and saxicolous lichens is by far higher (up to ca. 40 species) than in the interior regions (down to 2 species). The total sopecies number in the inestigated areas is at about 45 species, only four of them occur in all studied sites. *Umbilicaria decussata*, *Pseudephebe pubescens* and some *Rhizocarpon* species exist as well in the Contiental Antarctica and in the nival zone of the Alps and show therefore a cosmopolitic distribution. (*Symposium*: Lichens in Polar Ecosystems)

UGUR, AYSEGUL and **OZTURK, SULE**

Uludag University, Faculty of Art and Sciences, Department of Biology, 16059, Gorukle-Bursa, Turkey

Investigation about the Effects of Some Terricolous Lichens (*Cladonia rangiformis, Peltigera neckerii, P. rufescens*) on Soil Bacteria' grown in Natural Conditions

In this paper, we aimed to investigate effect of terricolous lichens on soil bacteria' grown in natural conditions. We compared species of bacteria and numbers of colony on soil speciments which took from locations that 3 different terricolous lichen species growed on. Consequently, Peltigera rufescens that have not seconder metabolites, didnt show a ınhibition effect on soil bacteria. But, we detected that Peltigera neckerii effected on soil bacteria more than P. rufescens for having seconder metabolites. However, Cladonia rangiformis is the hightest inhibition effect on soil bacteria for having kinds of seconder metabolites. We suggested that in the future, we can investigate elaborately with soil analysis how bacteria inhibition on soil made by seconder metabolites of lichens have got an effect on soil mineralization (Poster: Ecology, Thursday in Merrill Hall)

UGUR, AYSEGUL and **OZTURK, SULE**

Uludag University, Faculty of Art and Sciences, Department of Biology, 16059, Gorukle-Bursa, Turkey

An investigation on changing lactase and tyrosinase activity in lichens following wounding or desiccation

In this paper, included phenoloxidase groups enzymes, Laccase and Tyrosinase activities that produced in lichen tallus related to different external stres in natural conditions, were measured in order Lecanorales and Peltigerales. We found that the presence of phenoloxidase activity in most of the epigeic lichens of the order Peltigerales is so much more than epiphytic lichens of the order Lecanorales. The aims of work presented here are to investigate to changes of laccase and tyrosinase activity in lichen thallus when they were wounded as external stres. Consequently, in this paper, we detected that laccase and tyrosinase activity in lichen increased with wounding. (*Symposium*: Biochemistry and Physiology of Poikilohydry)

***USUNIWA, YUSUKE, HARA, KOJIRO, KOMINE, MASASHI** and **YAMAMOTO, YOSHIKAZU**

Akita Prefectural University, Department of Biological Production, Shimoshinjo-nakano, Akita, Akita 010-0195, Japan

Production of secondary metabolites in cultured lichen mycobionts on malt-yeast extract medium with 20% sucrose and Lilly-Bernett medium

Lichens, which are symbiotic associations of fungal (mycobiont) and algal (phycobiont) partner, produce original secondary metabolites. However, cultured lichen mycobionts did not almost produce lichen compounds. We investigated the influence of different media conditions on the secondary metabolism. We selected 123 strains of mycobionts and they were cultured on malt–yeast extract medium (MY), MY medium with 20% sucrose (S20) and Lilly–Bernett medium (LB). After 3 or 6 months, the acetone extracts from mycobionts were analyzed by HPLC with a photodiode-array detector. By comparison of the UV–spectra and the retention times of peaks of the extracts with those of authentic compounds, 13 strains on S20 or LB medium were found to produce depsides. For example, gyrophoric acid was produced in the mycobiont of *Lasallia hispanica* on S20 medium and divaricatic acid was done in the mycobiont of *Sphaerophorus fragilis* on LB medium. (Poster: Symbiosis, Thursday in Triton)

VIEIRA, ANA RUTE[1] and ***BRANQUINHO, CRISTINA**[1]

[1]Universidade de Lisboa, Faculdade de Ciências, Centro de Biologia Ambiental, C2, 5º Piso; Sala 37, Campo Grande, 1749-016 Lisboa, Portugal; *Corresponding author: cmbranquinho@fc.ul.pt

Ammonium (NH_4^+) uptake and its effects on membrane integrity and chlorophyll fluorescence in aquatic moss *Fontinalis antipyretica*

Eutrophication is one of the main environmental problems in Mediterranean streams, specially in rural areas due to increasing livestock production. Aquatic bryophytes such as *Fontinalis antipyretica* have been widely used as biomonitors of stream water quality but with focus on metals. In this work we intend to study the pattern of intra and extracellular uptake of ammonium (NH_4^+) and its impact on moss physiology, in order to give a better insight into the use of these organisms as biomonitors of stream water eutrophication. For that, we submitted moss samples to increasing NH_4^+ concentrations and measured the ratio of variable fluorescence and maximal fluorescence (F_v/F_m) of chlorophyll α and the membrane integrity through loss of intracellular K concentration. The results obtained in controlled conditions were compared with results obtained in the field after exposing moss transplants in different streams with intensive agriculture activities. Both under field and lab conditions, we found a significant physiological impact when the percentage of ammonium content in cell wall was above 70%, that of the cell. This was observed through changes in membrane permeability and through lower efficiency of the Photosystem II. (Poster:)

VONDRÁK, JAN[1,5]**, ŘÍHA, PAVEL**[2]**, ARUP, ULF**[3] and **SØCHTING, ULRIK**[4]

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The taxonomy of the *Caloplaca citrina* group (*Teloschistaceae*) in the Black Sea region; with contributions to the cryptic species concept in lichenology

A new taxonomy of the *Caloplaca citrina* group in the Black Sea region is presented here. It is based on the nrDNA ITS molecular data, chemistry (anthraquinone contents) and 20 morphological charcters. Six known species were revealed in the region: *Caloplaca arcis*, *C. calcitrapa*, *C. dichroa*, *C. flavocitrina*, *C. geleverjae*, *C. limonia* and five species are new to science: *Caloplaca arcisproxima, C. austrocitrina*, *C. communis*, *C. confusa* and *C. nigromarina Caloplaca britannica, C. citrina*, *C. marina*, *C. maritima*, *C. microthallina*, *C. ora*, and *C. phlogina* are treated extensively. Some maritime species known from the Atlantic coast of Europe are absent from the region, and, surprisingly, *Caloplaca citrina* s. str. could not be confirmed from the region. Many convergences and some cryptic species were revealed by molecular data. A key to the species present in the region is provided, but morphological characters are of very limited value in this group. The variability and taxonomic importance of particular features is discussed. No significant differences in secondary chemistry were observed among the species. (Poster: Taxonomy and Systematics, Wednesday in Merrill Hall)

WANG, XIN YU, KOH, YOUNG JIN, and ***HUR , JAE-SEOUN**

Korean Lichen Research Institute, Sunchon National University, Sunchon 540-742, Korea

Effect of plant hormones on lichen-forming fungal growth

Several plant hormones were evaluated to stimulate growth and secondary metabolite production of lichen-forming fungi (LFF). Three lichen species of *Nephromopsis ornata* (fast growing LFF), *Myelochroa irrugans* (intermediate growing LFF) and *Usnea longissima* (slow growing LFF) were used in this study. In general, there was no noticeable effect of the hormones on the growth of the LFF during 2 month culture of malt-yeast extract liquid medium at 18 ^oC. However, 2,3,5-Triiodobenzoic acid and indole-3-butyric acid (IBA) had positive effect on fungal growth of *Nephromopsis ornata* at the concentration of 2μm/l. The hormones could also affect the production of secondary metabolites of the LFF. This study suggests that some plant hormones can be used as an inducer or stimulator for fungal growth and lichen substances of LFF in mass cultivation. (Poster: Ecology of Symbiosis, Thursday in Nautilus

***WEBER, BETTINA, DEUTSCHEWITZ, KIRSTIN, DOJANI, STEPHANIE** and **BÜDEL, BURKHARD**

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Biological soil crusts in southern Africa: Distribution, succession and classification methods

Biological Soil Crusts (BSCs) were studied along a 2000 km transect from the Namibian-Angolan border to the Cape Penisula. In six out of seven biomes, BSCs occurred in varying composition and coverage. Based on structural and taxonomic features, seven BSC types were distinguished. BSC potential for re-establishment after disturbances was studied experimentally. Early stages of BSCs developed already during the first rainy season (6 months), reaching the extent of BSCs in control plots. Eighteen months after disturbance biomass was still far below the original values and no lichens and bryophytes had established. A large-scale BSC classification methodology was developed on the basis of hyperspectral remote sensing data. Based on small and narrow spectral characteristics, the Continuum Removal Crust Identification Algorithm (CRCIA) was established, and classification of Succulent Karroo-BSCs was accomplished at high accuracy (Kappa = 0.831). (*Symposium*: The World under Your Feet: Biological Soil Crusts)

WERTH, SILKE[1,2,] SCHEIDEGGER, CHRISTOPH[1], and **SORK, VICTORIA L.[2]**

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Population genetics of epiphytic lichen-forming fungi at two different spatio-temporal scales

The genetic variability of populations is a crucial aspect defining a species' evolutionary potential. The genetic structure of epiphytic lichen-forming fungi is particularly interesting because they have different reproductive strategies, form an obligate mutualism with a photobiont, and are associated with different host species. We studied the local genetic structure of *Lobaria pulmonaria* in a Swiss pasture-woodland landscape, and found gene flow, mainly mitigated by vegetative propagules. The studied population showed strong genetic structure. In contrast, no local genetic structure was found in *Ramalina menziesii* in an oak savanna of Southern California. The studied population was mainly sexual, with frequent relichenizations. When we studied the phylogeography, however, populations of *R. menziesii* were differentiated, and we found a marked split between populations from desert sites of Baja California vs. all others. Populations North of California showed traces of range expansion. We discuss the future potential of population-genetic studies in lichen-forming fungi. (*Symposium*: Between Individuals and Species: The Genetics of Populations)

***WIDHELM, TODD, EGAN, ROBERT** and **LIVSHULTZ, TATYANA**

University of Nebraska at Omaha, Department of Biology, Allwine Hall, 6001 Dodge Street, Omaha, Nebraska 68182-0040, USA

Testing species delimitations in the *Parmotrema perforatum* group in eastern North America

The current taxonomy of the *Parmotrema perforatum* group recognizes six closely related species divided into three species pairs, each with an apotheciate and a sorediate species. Each pair has a distinct combination of lichen acids. This species delimitation has been reexamined using 30 unique alleles of the *glyceraldehyde-3-phosphate dehydrogenase* locus from 53 individual thalli from eight populations in Texas, Louisiana and North Carolina. Population aggregation analysis of Texas and Louisiana populations suggests that the *Parmotrema perforatum* group is instead two phylogenetic species. One phylogenetic species is fixed for norstictic acid and polymorphic for stictic acid, and the other species is fixed for alectoronic acid. Both species are polymorphic for apothecia and soredia, suggesting that sorediate thalli are part of the same sexually reproducing population as apotheciate thalli. There is also evidence suggesting that the norstictic acid-containing strain of *P. subrigidum* is a hybrid between the two recognized phylogenetic species. (ABLS program Tuesday)

[+]WIDMER, IVO, [+]*P, FRANCESCO, CORNEJO, CAROLINA and **SCHEIDEGGER, CHRISTOPH**

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A new integrated approach for lichen population genetics: fungus- and alga-specific microsatellite markers for *Lobaria pulmonaria* (L.) Hoffm.

Lichens are symbiotic associations of a fungus (mycobiont) with an alga and/or a cyanobacterium (photobiont). So far, the lack of appropriate molecular tools did not permit to solve the main issues concerning mutual selectivity and evolutionary interactions

between symbionts at different spatial scales. We present here the first set of informative markers for both partners of a lichen symbiosis, namely eight fungus- and twelve alga-specific microsatellite loci for the lichen *Lobaria pulmonaria* (L.) Hoffm. Preliminary results show the effectivity of these markers in enhancing the resolution of analyses of genetic diversity and exchangeability between phyco- and mycobiont populations. Ongoing research on a) dispersal strategies, b) combined phylogeography, c) influence of habitat structure and disturbance types on genetic diversity and d) algal sharing among different lichen species and communities will finally shed more light on broader coevolutionary patterns and processes. (Poster: Symbiosis, Thursday in Triton)

WILK, KARINA

Polish Academy of Sciences, W. Szafer Institute of Botany, Lubicz 46, PL-31-512 Krakow, Poland

Calcicolous species of the genus *Caloplaca* in the Polish Western Carpathians

The genus *Caloplaca* is represented by 65 species in Poland. 53 species of *Caloplaca* are known from the Western Carpathians and ca. 32 are saxicolous-calcicolous. The purpose of the study is to analyze the taxonomic diversity and distribution of calcicolous species of the genus *Caloplaca* in the Polish Western Carpathians. The study is based on critical revision of material from national and foreign herbaria and the author field collections. Several species have been recognized as new to the country or the area during the study (e.g. *C. percrocata*, *C. vitellinaria*). The geographical distribution of many poorly known taxa has been completed (e.g. *C. alociza*, *C. aurea*, *C. chrysodeta*, *C. flavescens*, *C. polycarpa*, *C. xantholyta* and *C. xanthostigmoidea*). An interesting discovery was *C. xantholyta* parasitized by rare lichenicolous lichen *Diplotomma scheideggerianum*. The project will result in detailed descriptions of all recognized species with illustrations, maps of their distribution in the study area and modern key to species identification. (Poster: Biogeography and Floristics, Monday in Triton)

WILL-WOLF, SUSAN[1], TREST, MARIE T[1] and **NELSEN, MATTHEW P[2,3]**

[1]University of Wisconsin-Madison, Department of Botany, 132 Birge Hall, 430 Lincoln Drive, Madison, Wisconsin 53706-1381, USA; [2]University of Chicago, Committee on Evolutionary Biology, 1025 E. 57th St., Chicago, IL 60638, USA; [3]The Field Museum, Department of Botany, 1400 S. Lake Shore Drive, Chicago, IL 60605, USA

Composition of a southern Wisconsin (upper midwest USA) woodland bark lichen community varies with land use

We found, in a 3-decade study of oak woodlands near a 'clean' power plant in rural Wisconsin, that lichen community composition varied more with nearby land use than with power plant impact. An NMS ordination 'land use' axis became more important 1974-2003. In 2003, higher species richness plus abundance of *Cladonia*, larger foliose, and granular/ecorticate crust guilds occurred near more forest. Smaller foliose and corticate crust guilds were more abundant near less forest. Lichen tissue sulfur content (after accounting for the power plant) increased with lichen species richness, higher % forested, and lower % agriculture. *Quercus* (black oak) sample trees had slightly higher bark pH near more agriculture. Tissue nitrogen content showed no corresponding pattern and several neutrophile and/or nitrophile species were more abundant near more forest. Mechanisms driving these lichen patterns may thus relate more to mesoclimate or dispersal limitations than to direct effects of agricultural fertilizer. (*Symposium*: Community Structure and Dynamics)

***WOLSELEY, PAT[1], SUTTON, MARK[2], LEITH, IAN[2]** and **VAN DIJK, NETTY[2]**

[1]Natural History Museum, London SW7 5BD, UK; [2]Centre for Ecology & Hydrology Edinburgh, Bush Estate, Penicuik, Midlothian EH26 0QB, UK

Lichens as indicators of ammonia concentrations across the UK

Between 2003-6 we conducted field work in the UK recording lichens on twigs and trunks of trees. Sites were selected near ammonia monitoring stations in order to test the use of lichens as bioindicators of atmospheric NH_3. Results on a landscape scale indicate that loss of nitrophobic species occurs prior to the increase in nitrophiles and that this is observed earlier on twigs than on trunks. Further tests in the vicinity of poultry farms show that a combined index of nitrophobes and nitrophiles L_{AN} is highly correlated with bark pH and with NH_3 concentration . A national survey of macrolichen frequency on a range of tree species shows that L_{AN} is correlated with NH_3 concentrations on all tree species sampled. This research has resulted in the lowering of the UNECE critical level of NH_3 for lichens and bryophytes from 8 to 1 $\mu g\ m^{-3}$ in Europe. (*Symposium*: Air Pollution)

***YAMAMOTO, YOSHIKAZU, NARITA, AKEMI, HARA, KOJIRO** and **KOMINE, MASASHI**

Akita Prefectural University, Department of Biological Production, Shimoshinjo-nakano, Akita, Akita 010-0195, Japan

Screening for lichen cultured mycobionts having tolerances against freezing or heating

Lichens grow in extreme environments such as those of Polar Regions, hot deserts, seashores and high mountains; therefore they are thought to have unique tolerance mechanisms for extreme environments. About 500 strains of lichen cultured mycobionts were maintained in our laboratory. We investigate to screen and identify mycobionts having tolerances against freezing and heating. Aggregates of 45 strains of lichen cultured mycobionts were carried out in freezing or heating conditions. We used at -165^{o}C, -83^{o}C, -30^{o}C or 4^{o}C for 6 months and did at 40^{o}C for 2 or 4 weeks or at 60^{o}C for 1 week. They were cultured on malt-yeast extract medium (MY) in Petri dishes at 20^{o}C. After 3 months they were harvested and weighed. Their growth weights were calculated. We found *Graphis connectans* and *Trapeliopsis granulosa* as the tolerant mycobionts against freezing or heating, respectively. (Poster: Symbiosis, Thursday in Triton)

ZEDDA, LUCIANA[1,3], WEISS, MARKUS[2], NEUBACHER, DIETER[2], *TRIEBEL, DAGMAR[2] and **RAMBOLD, GERHARD[1]**

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[3]Rheinische Friedrich-Wilhelms-Universität, INRES, Karlrobert-Kreiten-Str. 13, 53115 Bonn, Germany

Gathering, maintenance and analysis of data on lichen diversity in southern Africa

Data on lichen diversity from Southern Africa have been collected in the framework of the BIOTA Africa project. The main objective is to assess lichen diversity and its shifts along climatic and land use gradients. Lichens are frequently disregarded in ecological studies. Therefore, it is essential to get information on their distribution and ecology in general and to create suitable identification tools. The relevant data domains are: 1) collection data; 2) descriptive data (as phenotypic characters); 3) vegetation data; 4) image data. Data are stored in PostgreSQL and MS SQL server database engines. The applications used are part of the Diversity Workbench framework (www.diversityworkbench.net). For remote data entry, maintenance, flexible data query and analysis, modularized Java- and .Net-based clients have been developed. The data are presented on the internet via various clients and web services. Lichen identification is optimized by using NaviKey and its recent updates programmed as part of the BIOTA project. (Poster: Biogeography and Floristics, Monday in Triton)

***ZHAO, ZUNTIAN, LEI, LV** and **QIANG, REN**

College of Life Sciences, Shandong Normal University, No.88 East Wenhua Road, Jinan, Shandong 250014, P. R. China

A Taxonomic study on the lichen genus *Lecanora* in Western China

Lecanora is one of the most striking and widespread crustose lichen genus. 67 species, 5 varieties and 2 forms have been reported in western China, but no one has yet come for the systemic study. The studies are performed according to the morphology, anatomy, chemistry and geography on the basis of investigation of the specimens from western China. Forty-five species are reported in this paper. Among them nineteen species are reported as new to China, they are *L. argentata*, *L. bruneri*, *L. cateilea*, *L. cinereocarnea*, *L. cinereofusca*, *L. dispersogranulata*, *L .flavidofusca*, *L. flowersiana*, *L. fuliginosa*, *L. garovaglii*, *L. horiza*, *L. insignis*, *L. japonica*, *L. nipponica*, *L. novaehollandiae*, *L. opiniconensis*, *L. perflexuosa*, *L. perplexa*, *L. subrugosa*, *L. symmicta*. The key of the genera *Lecanora* is presented in the paper. Anatomy, morphology and chemistry descriptions based on our materials and short comments for the new records are also given. (Poster: Biogeography and Floristics, Monday in Triton)

ZIMMERMAN, SHAWNA[1], *ROSENTRETER, ROGER[2], and **SERPE, MARCELO[1]**

[1]Department of Biology, Boise State University, Boise, ID 83725
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Effects of lichen-dominated biological soil crusts on seed water status and root penetration of two annual grasses and its ecological significance

Biological soil crusts can affect seed germination and initial seedling establishment. We have investigated the effect of biological soil crusts on seed water status as a potential mechanism affecting germination. The seed water potential of two annual grasses, *Bromus tectorum* and *Vulpia microstachys*, were analyzed after placing the seeds on bare soil, on a crust that contains a variety of lichens and mosses (mixed crust), or on a crust dominated by the crustose lichen *Diploschistes muscorum* (lichen crust). For the two grasses studied, seed water potential was significantly higher on the bare-soil and mixed-crust than on the lichen-crust. These differences in water content correlated with differences in germination, which was much lower on the lichen crust. The three seedbed surfaces received the same amount of water and initially all reached high water potentials. However, differences in water potential developed between watering events. Between waterings, the water potential of the soil and mixed crust remained above -0.5 MPa, while there was a marked decline in the water potential of the lichen surface to about to -4 MPa. To ascertain that water was the major factor limiting germination on the lichen crust, we conducted germination tests in an environment with 100% relative humidity. Under these conditions, germination on the lichen crust was similar to that on the bare soil. The seeds that germinated on the lichen crust did not penetrate, however, this surface and their root tips became necrotic. Our results indicate that the presence of crustose lichens can inhibit seedling establishment by two mechanisms, a reduction in seed water absorption and an inhibition of root penetration. The net effect of this may be an abatement of weedy annual plant growth in sagebrush steppe. (*Symposium*: The World under Your Feet: Biological Soil Crusts)