

## (SS41) Ecological insights from palynological and macrofossil analysis

**Date:** August 27

**Place:** Room 5235 (oral), Room 6318 (poster)

**Organizers:** Simon Brewer & Thomas Giesecke

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**Purpose:** Palaeoecology offers the long time-perspective to ecological processes. However, ecological theory continues to be seldom addressed with palaeoecological data. While experiments are difficult to design as we reconstruct processes that have already occurred, hypothesis can be tested for example by using multiproxy datasets, comparing several datasets of the same proxy or selecting a site in a specific location with a known history of environmental change. The need to evaluate the impact of global change scenarios on the natural environment requires an understanding of processes and changes occurring over long time periods and palaeoecology is in a unique position to provide a long-term perspective of how ecosystems respond to environmental shifts. Palaeoecological data can and have demonstrated the introduction and spread of alien species, the postglacial recolonisation of previously glaciated terrain. They show examples for non-linear responses to environmental change past rates of ecosystem change as well as ecosystem stability in the face of well-documented environmental changes. Also the concepts of ecosystem resilience, alternative stable states and tipping points are equally relevant to palaeoecological data. Thus we invite contributions where palaeoecological data is used to test or explore ecological theory. This may include meta-analysis as well as single site studies as well as reviews and theoretical contributions.

### Oral Presentation

Aug. 27 [AM1] Room: 5235

9:00-9:20 **[Introduction to the Symposium] Ecological insights from palynological and macrofossil analysis SS41-O01**

Simon Brewer, Thomas Giesecke

Chair: Thomas Giesecke

9:20-9:40 **Spatial dynamics of Holocene vegetation and land cover at Haanja, SE Estonia: comparison of pollen, plant macrofossil and charcoal records from forest hollows [SS41-O02 \(245\)](#)**

Tiiu Koff, Seila Kastein, Triin Toming, Mihkel Kangur, Shinya Sugita

9:40-10:00 **Reconstruction of local ecosystem changes using Holocene multiproxy palaeorecords from forest hollow at Haanja Heights, SE Estonia [SS41-O03 \(421\)](#)**

Liisa Puusepp, Seila Kastein, Liisa Umbleja, Triin Toming, Geoffrey Lemdahl, Shinya Sugita

10:00-10:20 **Spatial dynamics of Holocene vegetation and land cover at Haanja Heights in SE Estonia: palaeoecological insights into factors and mechanisms affecting the landscape mosaic [SS41-O04 \(501\)](#)**

Shinya Sugita, Mihkel Kangur, Tiiu Koff, Seila Kastein, Triin Toming, Liisa Puusepp, Egert Vandel, Marko Vainu, Ben Smith, Geoffrey Lemdahl, Marie-José Gaillard, Erik Kjellström, Bent vad Odgaard

Aug. 27 [AM2] Room: 5235

Chair: Simon Brewer

10:50-11:10 **A data-model analysis for the identification of potential drivers of European fire activity over the last 9000 years** [SS41-O05 \(342\)](#)

Chiara Molinari, Veiko Lehsten, Richard H.W. Bradshaw, Mitchell J. Power, Almut Arneith, Jed Kaplan, Boris Vanni re, Martin T. Sykes

11:10-11:30 **Pollen accumulation in lake sediments during historic spruce beetle disturbances and implications for Holocene non-fire disturbance reconstructions** [SS41-O06 \(350\)](#)

Jesse Morris, Andrea Brunelle

11:30-11:50 **Understanding postglacial vegetation thresholds in western Tierra del Fuego** [SS41-O07 \(130\)](#)

Sonia L. Fontana, Keith D. Bennett

11:50-12:10 **High-resolution palynology, climate change, and human impact on a Late Holocene peat bog on Haida Gwaii, British Columbia, Canada** [SS41-O08 \(316\)](#)

Rolf W. Mathewes, Matthew J.W. Huntley

Aug. 27 [PM2] Room: 5235

Chair: Thomas Giesecke

14:30-14:50 **A North European pollen–climate calibration set: new tools for analysing the spatial structure of biological proxy data** [SS41-O09 \(461\)](#)

Heikki Sepp , H. John B. Birks, Miska Luoto, J. Sakari Salonen

14:50-15:10 **Migration of *Pinus* in Northern China during the Holocene** [SS41-O10 \(168\)](#)

Qian Hao, Hong-Yan Liu, Yi Yin

Chair: Simon Brewer

15:10-15:30 **Forest line dynamics under abrupt climatic changes: An example from the NW-European Late Glacial** [SS41-O11 \(534\)](#) (Cancelled)

Falko Turner, Richard Pott

Poster Presentation

Aug. 27 [PM1] Room: 6318

13:30-14:30 **Postglacial appearance of spruce and alder on the northwestern Russia according to pollen data** [SS41-P01 \(453\)](#)

Larisa Savelyeva

**Holocene changes in trophic states of shallow lakes from the Pampa plain of Argentina** [SS41-P02 \(499\)](#)

Silvina Stutz, C. Marcela Borel, Sonia L. Fontana, Marcela S. Tonello

**Long-term boreal forest dynamics at the modern western range limit of the Siberian larch (*Larix sibirica*), new insights from stomata and pollen records** [SS41-P03 \(259\)](#)

Niina Kuosmanen, Heikki Sepp , Richard Bradshaw, Jennifer Clear, Oleg Kuznetsov,

Ludmila Filimonova

**Reconstructing Holocene vegetation and fire history at Lake Wilks, Tasmania, Australia** [SS41-P04 \(72\)](#)

Hahjung Chin, Simon Haberle

**Features of Holocene broad leaved flora development in Amur River basin** [SS41-P05 \(22\)](#)

Valentina Bazarova, Lyudmila Mokhova

**Record of climatic and environmental changes in the Middle Pleistocene sediments from Łuków (E Poland) on basis of palaeobotanical studies** [SS41-P06 \(494\)](#)

Renata Stachowicz-Rybka, Irena Agnieszka Pidek

**Environmental history of the extinct lake Šúr (Western Carpathians, Slovakia) during the Late-glacial and Holocene: a multi-proxi approach** [SS41-P07 \(601\)](#)

Pavla Žáčková, Libor Petr, Eva Jamrichová

**Vegetation stability and disturbance regimes – a long-term perspective from the Portuguese coast** [SS41-P08 \(12\)](#)

João Araújo, Sandra Gomes, Simon Connor, Tomasz Boski

**Pollen spectra of Tohoku Tsunami sediments in Shikotan Island (Southern Kuril Islands, NW Pacific Ocean)** [SS41-P09 \(302\)](#)

Marina S. Lyashchevskaya

SS41-O02 (245)

**Spatial dynamics of Holocene vegetation and land cover at Haanja, SE Estonia: comparison of pollen, plant macrofossil and charcoal records from forest hollows**

Tiiu Koff, Seila Kastein, Triin Toming, Mihkel Kangur, Shinya Sugita

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Forest hollows provide fossil records suitable for reconstructing past stand-scale changes in vegetation and land cover. Pollen, plant macrofossil and charcoal records from three hollows are used to discuss the Holocene spatial dynamics of vegetation and land cover at the Haanja Natural Park, SE Estonia, as a part of the DYLAN (DYnamic Landscape ANalysis) project. The park is characterized by a mosaic of *Picea-Pinus-Betula* forest communities and cultivated fields. Studied hollows are situated within a 5 x 2 km area. Organic-rich sediments in the hollows vary from 130 to 210 cm in depth, covering the entire Holocene. Site-to-site variations of pollen assemblages, particularly arboreal taxa, are relatively small among the sites. The beginning of Holocene is characterized by early successional taxa, such as *Betula* and *Salix*, indicating an open landscape with scattered forest patches. The macrofossil records, however, differ significantly among sites, demonstrating the variation in local vegetation development. At one site the co-existence of abundant macrofossils of *Betula*, *Picea*, *Pinus*, *Populus*, *Salix* suggests a mixed forest stand in mid-Holocene; the other two sites are characterized by the changes in characteristic taxa in different time periods, as *Betula* was dominant in the early Holocene and *Picea* over the last 7500 years. *Pinus* pollen is well-represented at all sites, but the small number of its macrofossils does not

indicate the local dominance of pine. Although pollen percentages of herbaceous taxa are generally low at all sites, the total number of pollen types identified is similar to that of plant species found in the macrofossil records. Most of the macro remains are identified to species level, thus providing more detailed information on local-scale vegetation composition and habitat conditions. The abundant micro and macro charcoal fragments in the upper part of the cores indicates the increase in regional and local fires during the last 2000 years, which may be associated with slash-and-burn agriculture locally and regionally. The appearance of cereal pollen after the increase in charcoal abundance at all sites supports this interpretation. In addition a sharp decline in arboreal pollen and increase in non-arboreal pollen in this period indicate a dramatic decrease in the forested areas in the region. The spatial dynamics of local vegetation patches and the associated changes in biodiversity are discussed in the light of climate change, variability of soil types, fire history, and human land-use.

SS41-O03 (421)

**Reconstruction of local ecosystem changes using Holocene multiproxy palaeorecords from forest hollow at Haanja Heights, SE Estonia**

Liisa Puusepp<sup>1</sup>, Seila Kastein<sup>1</sup>, Liisa Umbleja<sup>2</sup>, Triin Toming<sup>1</sup>, Geoffrey Lemdahl<sup>3</sup>, Shinya Sugita<sup>1</sup>

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Small forest hollows are ideal places for reconstruction of local-scale ecosystem changes. The present study is a part of the DYLAN (DYNAMIC Landscape ANALYSIS)-Estonia project, which uses palaeorecords from hollows and modeling approaches to elucidate factors and mechanisms that have affected the spatial dynamics of the Holocene vegetation at Haanja Heights in SE Estonia. Among the eighteen hollows selected and studied for the project the Peedo hollow is unique because of the availability of a variety of palaeorecords including pollen, diatoms, macro-remains of plants and insects, and charcoal. Those records indicate three stages of development of the local ecosystem and habitat conditions. During the period ca. 11000-9800 cal yr BP, remains of aquatic insects, plants, algae and moss, and diatoms suggest that the site was a small pond with at least half a meter of standing water. The co-occurrence of a cold-adapted chironomid species, *Corynocera ambigua*, and *Chara* oospores infers that water was rather cold and clear. Macro-remains of *Picea* and *Betula* in this period demonstrate the local establishment of those tree taxa in the area, which is often difficult to detect using fossil pollen alone. During the period ca. 9800-7600 cal yr BP, the site was likely a part of swamp that supported aquatic insects, plants and planktonic diatoms. Plant macro-remains of *Betula*, *Ulmus* and *Salix* characterize this period, suggesting that the local vegetation around the site differed significantly from the regional deciduous broadleaved forests inferred from fossil pollen from lakes in the area. Since 7600 cal yr BP, the site has changed from swamp to peat bog. At the beginning of this period, abundant macro-charcoal and charred *Picea* needles and in the sediment indicate local fires around the site. According to the plant macro-remains, *Betula* and *Picea* have characterized the local vegetation throughout the period. Although Poaceae and *Secale* pollen increases in the hollow sediment over the last 2000 years, the record likely represents the regional signal of human activities. The multiproxy palaeorecords from the Peedo hollow are invaluable to distinguish its local ecosystem development from the regional changes in vegetation and land cover, and thus provide additional information on the spatial dynamics of plant communities in Haanja Heights in the Holocene.

SS41-O04 (501)

**Spatial dynamics of Holocene vegetation and land cover at Haanja Heights in SE Estonia: palaeoecological insights into factors and mechanisms affecting the landscape mosaic**

Shinya Sugita<sup>1</sup>, Mihkel Kangur<sup>1</sup>, Tiiu Koff<sup>1</sup>, Seila Kastein<sup>1</sup>, Triin Toming<sup>1</sup>, Liisa Puusepp<sup>1</sup>, Egert Vandel<sup>1</sup>, Marko Vainu<sup>1</sup>, Ben Smith<sup>2</sup>, Geoffrey Lemdahl<sup>3</sup>, Marie-José Gaillard<sup>3</sup>, Erik Kjellström<sup>4</sup>, Bent vad Odgaard<sup>5</sup>

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A better understanding of the factors and mechanisms that have affected past changes in vegetation and land cover provides valuable insights into modern and future dynamics of biological communities and species diversity. Major objective of DYLAN-Estonia (DYnamic Landscape ANalysis in Estonia) – an Estonian Mobilias Programme project (2009-2014) – is to evaluate the extent to which the spatial patterns of soil and topography would have determined those of the Holocene vegetation and land-cover mosaic at the Haanja Heights, a ca. 60 km<sup>2</sup> nature reserve in southeastern Estonia. The project uses palaeorecords from small hollows to reconstruct local changes in ecosystem and environmental conditions, and quantifies the spatial dynamics of vegetation in the area using fossil pollen and the Landscape Reconstruction Algorithm (LRA) (Sugita 2007a,b; Sugita et al. 2010; Nielsen and Odgaard 2010). The Haanja Heights is ideal for the LRA application because of numerous small hollows and several medium-sized lakes scattered throughout the area. We collected sediment cores from 4 lakes ≈50-100 ha and 19 small hollows ≈0.01 ha in the study area in 2009-2011. The sediment cores from all the lakes and 15 out of 19 hollows cover most of the Holocene. Thus far pollen and spores, diatoms, macro-remains of plants, insects and charcoal, and LOI have been analyzed for selected hollows, and pollen and spores, charcoal and LOI for the lakes. The results show that the hollow records have clear site-to-site variations in fossil assemblages, indicating significant differences in local sedimentary conditions and biota, as well as the surrounding upland vegetation, and that the multiproxy records at individual hollows tend to complement each other the interpretation of environmental reconstruction. The preliminary LRA results, based on pollen records currently available from four lakes and eight hollows, depict a declining trend of the patch sizes of plant communities through time in the Holocene. Although more detailed pollen analysis and better chronological control are necessary, the LRA results would suggest additional factors and mechanisms, such as the increase in *Picea* abundance in the mid-Holocene and its impacts on local ecosystem changes, may have affected the spatial dynamics of vegetation mosaic in the past. We will apply a vegetation dynamics model (LPJ-GUESS; Smith et al. 2001; Wramneby et al. 2008) and regional climate model (RCA3; Kjellstrom et al. 2007) for evaluating potential causes and conditions that would be feasible to explain the LRA-based results at the Haanja Heights and its vicinity.

SS41-O05 (342)

**A data-model analysis for the identification of potential drivers of European fire activity over the last 9000 years**

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European fire activity over the Holocene was investigated based on 156 sedimentary charcoal records from lakes and peat bogs. The dynamic vegetation model LPJ-GUESS, forced with climate outputs from the MPI/UV complex earth system model, was used to simulate vegetation/fuel and fire indices over the last 9000 years. In order to explore the potential drivers of biomass burning, climate data, simulation results and two independent scenarios of past anthropogenic land-use were compared with fire dynamics by means of a statistical approach. The combined charcoal records suggest little fire activity during the early and the mid-Holocene with just some centennial-scale increases probably due to climate changes. A progressive rise starts around 3500 calendar years BP. Biomass burning suddenly increases since the 18<sup>th</sup> century, reaching its maximum during the Industrial-Era and then abruptly declines. Within the statistical analyses, a linear regression model was fitted by means of a forward selection between charcoal data and simulated parameters for different time-slices during the Holocene. Additionally the Bayesian Information Criterion (BIC) was applied to ensure that only variables increasing the model performance were added. A randomisation test was finally performed for the estimation of the statistical significance of each variable chosen by the model. Land-use, followed by the number of consecutive dry days during the year and mean fire-season precipitation values seem to best predict European fire dynamics during the Holocene for most of the selected sites. Statistical analyses performed for different time-slices indicate climate (precipitation and temperature in particular) as the main driver of fire activity in the early Holocene. Since 7500 cal yr BP onwards, land-use changes and fuel availability become increasingly important. An association between fire and precipitation exists during the post-Industrial period. The decline observed in biomass burning during the last century is probably due to the spread of intensive agriculture, changes in fuel availability and to active fire suppression policies. The hypothesis raised by this regional study will allow testing data-model comparisons based on individual high-resolution charcoal records and precise palaeoclimate reconstruction for more realistic estimates of future fire dynamics.

**Keywords:** charcoal data, Holocene, human-induced land-use changes, LPJ-GUESS, palaeoclimate dynamics.

SS41-O06 (350)

**Pollen accumulation in lake sediments during historic spruce beetle disturbances and implications for Holocene non-fire disturbance reconstructions**

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In high-altitude and high-latitude ecosystems where landscape-scale disturbances recur at time intervals that probably exceed most historical records, paleoecological reconstructions from sediments provide essential information about ecological dynamics and forest disturbance processes

in these regions. In recent decades, eruptive populations of bark beetles (*Dendroctonus* spp.) have rapidly and profoundly altered forest ecosystems across western North America at scales and severities unprecedented in the historic period. Currently, little long-term information is available about these outbreaks and in general, the information that exists, does not extend beyond the most recent few centuries. Our research investigates the sedimentary signature of recent beetle outbreaks with the goal of generating more temporally extensive disturbance reconstructions. We examine sedimentary pollen records from six subalpine basins affected by severe spruce beetle (*D. rufipennis*) epidemics during the 20th century in south-central Utah. Reciprocal exchanges in pollen abundance between host spruce (*Picea engelmannii*) and non-host subalpine fir (*Abies lasiocarpa*) are conspicuous during the historic outbreaks. Calculating simple ratios of host and non-host pollen accumulations offers a useful metric to visually identify spruce beetle outbreaks in these records. However, additional analyses are required to conclusively confirm or deny that severe bark beetle outbreaks occurred in the past. We explore a high-resolution Holocene pollen dataset from a lake with modern stand inventory data to assess how known forest conditions can assist in quantitatively defining forests conditions to help identify beetle disturbances that may have occurred prior to the historical era.

**Keywords:** non-fire disturbance, subalpine forests, bark beetles, vesiculate pollen, western North America.

SS41-O07 (130)

### Understanding postglacial vegetation thresholds in western Tierra del Fuego

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The development of plant communities in Southern Andes has been strongly influenced by large disturbance events such as volcanic eruptions, earthquakes and fire. Additionally, vegetation has changed through its own internal dynamics, including migration, competition and succession. However, changes in the palaeoecological record are more often associated with climate shifts than any other factor. The western archipelago of Tierra del Fuego remained treeless for most of the Lateglacial period. Major shifts in the composition of plant communities occurred during the Lateglacial-early Holocene transition, when the postglacial steppe and heath vegetation declined with the regional expansion of forest patches. Because of their non-linear responses to environmental changes, these ecosystems have often switched from one stable state to another. We present a record of changes in vegetation over the past 17,000 years from a lake in extreme southern Chile (Isla Santa Inés, Magallanes region, 53°38.97S; 72°25.24W), where human influence on vegetation is negligible, in order to contribute to the understanding of ecological processes controlling vegetation composition. We aim to (i) determine the different drivers responsible of ecological thresholds, and (ii) identify variables of ecosystem resilience within any particular state in time. During the Lateglacial period vegetation shifted from a mosaic of cold-wet herbaceous plants to an ericaceous heath / grassland mosaic, as climate warmed. Changes in the composition and structure of plant communities are traced by changes in species abundance and immigration of new taxa, leading to competitive interaction between the new and the resident species. During the early Holocene *Nothofagus* woodland-dominated vegetation shifted to a *Nothofagus*-moorland mosaic. The partial replacement of newly establish woodland by cushion bog communities may have been caused by a negative effect of the cushion plants on woody seedlings. At 5200 cal. yr BP drastic and rapid

vegetation changes occurred when the Mt Burney 2 eruption produced a significant impact on the regional vegetation. The vegetation recovered within 700 years, at least in terms of species composition and density. However the new vegetation structure differed from that before the eruption. Although these changes in vegetation composition might have been to some extent triggered by a shift in the climate regime, it is likely that the disturbances caused by volcanic fallout on the former system facilitated the establishment and/or expansion of newly arrived species, leading to a new stable system with changed species composition.

**Keywords:** Magellanic moorland, *Nothofagus*, postglacial vegetation thresholds, Tierra del Fuego.

SS41-O08 (316)

**High-resolution palynology, climate change, and human impact on a Late Holocene peat bog on Haida Gwaii, British Columbia, Canada**

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Haida Gwaii (formerly Queen Charlotte Islands) is an archipelago located on the outer central coast of British Columbia. Drizzle Bog on Graham Island is a *Sphagnum*-dominated peatland selected for a detailed multi-proxy paleoecological analysis using pollen, spores, and other microfossils to see if climatic changes such as the Medieval Climate Anomaly (MCA), Little Ice Age (LIA) and post-LIA warming period could be detected in this hypermaritime region. A 90-cm long Wardenaar peat core was sliced into 1cm thick subsamples and dated using Pb-210 back to 1892, and 4 AMS radiocarbon dates back to 1800 cal yr BP. The major change in peat types from a sedge-moss type below 40 cm to raw *Sphagnum* above coincides with abundance changes in most taxa, defining a major shift in pollen and non-pollen microfossil zones. At 34 cm (~ 1875 AD) the total pollen and spore accumulation rate increases dramatically, coinciding with the end of the LIA based on evidence from glacier recession in the Coast Mountains of BC. We suggest that the increased pollen production is a likely reflection of climatic warming and associated increased vegetation productivity during the Industrial Period. *Sphagnum* accumulation rates increase continually up to 12 cm depth (~ 1958) when they decline, beginning with a period of road building across the western edge of the wetland. It appears that construction of the road lowered the water table, since copepod spermatophores almost disappear, suggesting a decline in open water pools on the bog surface. Conversely, a change in the rhizopod community follows, with a decline in *Arcella artocrea* and dramatic increases in *Assulina* species and total rhizopods in the uppermost 7 cm of peat. Evidence for a classical Medieval Climate Anomaly prior to the LIA is unclear, although very high pollen concentrations between 51-53 cm depth (~ 1350-1450 AD) occur at the start of the peat transition from humified sedge-moss peat to *Sphagnum* peat. High pollen concentrations may be due to peat humification and low accumulation rates, concentrating microfossils and non-organic residues and decreasing bulk density. Warm and dry conditions would favour such a change, although at Drizzle bog it occurs after the classical MCA.

**Keywords:** Little Ice Age, industrial age warming, Queen Charlotte Islands, *Sphagnum*, rhizopoda.

SS41-O09 (461)

**A North European pollen–climate calibration set: new tools for analysing the spatial structure of biological proxy data**

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The North European pollen-climate calibration set is based on 583 modern pollen samples from small-to-medium-sized lakes, collected, prepared and analyzed with harmonized procedures. This dataset has been widely used for investigating the spatial abundance patterns and climatic response types of individual pollen types and the spatial structure of the pollen assemblages. The dataset has also been the basis for constructing transfer functions for quantitative climate reconstructions and for testing their statistical performances. Canonical correspondence analysis has been usually used to assess the relative influences of different environmental factors on the spatial patterns of the pollen data, while the transfer functions have been generated using regression-based techniques, such as the weighted averaging partial least squares regression and calibration. Recently, novel regression tree methods have emerged as a potential new approach to analyse the effect of climate variables on the spatial structure of the pollen data. Multivariate regression trees are a promising technique to analyse the variation in pollen assemblages in the modern climate space, while boosted regression trees can be used to analyse the relative influence of different climatic parameters on each taxon. The results obtained using these techniques show that the taxon responses are highly individualistic – while most pollen types (65%) in northern Europe are most responsive to summer temperature, other parameters are either primary determinants or significant secondary determinants for many taxa. Such an individualistic climatic response of the pollen types is a factor that must be taken into account in all qualitative and quantitative climatic interpretation of fossil pollen data. At assemblage level, significant variation is found in assemblages from similar summer temperature regimes, with distinct assemblage clusters identified along the continentality gradient. Potential future lines of development in constructing and applying the pollen-climate calibration sets are discussed.

**Keywords:** modern pollen samples, pollen types, boosted regression trees, individualistic responses.

SS41-O10 (168)

### **Migration of *Pinus* in Northern China during the Holocene**

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Natural forests in northern China are dominated by conifer species such as *Pinus*, with *Pinus tabulaeformis* widely distributed. As a pioneer species, *P. tabulaeformis* has strong resistance to adverse environments, and it is therefore commonly used for afforestation in this region. Whether and how artificial pine forests can adapt the estimated future climate warming remain unclear. The study of the pine migration will put light into vegetation recovery in semi-arid and arid regions. In this paper, we for the first time systematically reconstructed the development of pine forests in this region and correlated its distribution with monsoon evolution as well as soil development. Our study area extended from 400 mm rainfall isopleth to both arid and humid regions. According to annual precipitation, this area was divided into four subregions: arid, semi-arid, semi-humid, and humid. Through meta-analysis of the pollen percentage of *Pinus* from 53 sediment sections in this area, the range shifting of *Pinus* since 12 ka BP was reconstructed. We found that: (1) Percentage of *Pinus* pollen was more than 10% which is a threshold for pine forest distribution during most of the Holocene in semi-arid, semi-humid and humid subregions, while no pine forests were suggested to have existed in the arid subregion; (2) During the Holocene, the distribution range of *Pinus* increased

significantly at 9 ka BP, reaching the peak during 7 ka ~ 4 ka in the semi-arid subregion. After that, there was a small shrinkage, following a significant decrease at 2 ka BP; (3) Through the analysis of Angulinao Lake granularity, winter monsoon was found to increase gradually from 7.5ka BP onward and reached the maximum 4ka BP. This strength maintained until 1ka BP. Expansion of pine forests were suggested to be driven by summer monsoon strengthening during the early Holocene. As winter monsoon strengthened, *Pinus* remained in a wider range, which is accounted for by good water conservation of sandy soil under winter monsoon-dominated climate regime. We concluded that climate aridity may lead to the withdrawal of *P. tabulaeformis*, but the sandy soil could buffer this effect. To alleviate the problem of desertification and sandstorms, sandy soil in the semi-arid region could be potential afforestation area and *P. tabulaeformis* could serve as an important tree species for afforestation. Water loss due to climate warming can be buffered to a certain degree by sandy soil in the future, which needs to be quantifying in future studies.

**Keywords:** pollen analysis, vegetation recovery, semi-arid area, East Asian summer monsoon, winter monsoon.

SS41-O11 (534)

**Forest line dynamics under abrupt climatic changes: An example from the NW-European Late Glacial**

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Being almost completely deforested and partly covered by glaciers during the Last Glacial Maximum, NW-Europe was covered within several hundred years after abrupt Late Glacial warming (Greenland ice cores: GS-2/GI-1 transition) by forests and tall shrub formations – with *Juniperus*, *Hippophae*, *Salix*, *Betula* and *Pinus* as main taxa. Reconstructing forest line dynamics during the afforestation process here is used to test classical concepts of ecosystem change and stability. Pollen records from the northern Alpine foreland to northern Great Britain are correlated using independent climatic proxies ( $\delta^{18}\text{O}$ /chironomids/beetles), which reveal similar temperature oscillations across the region. Correlations indicate the parallel formation of juniper shrub vegetation from the Alpine foreland to the NW European plain to be in time with climate warming, but detect a centennial-scale time lag before the expansion of *Juniperus* on the British Isles. The assumption of a migrational gap is corroborated by genetic evidence, as analyses of genetic diversity suggest glacial survival of *Juniperus communis* in Germany, but colonization via three separate routes in Britain. Distribution of birch forests during the early Late Glacial – with the north-western forest line in northern Germany – is also interpreted as result of migrational processes, although other explanations are not excluded entirely. However, forest development was hampered by three centennial-scale climatic setbacks afterwards. While further southern forests remained rather stable, northernmost birch stands were affected by these short-time climatic fluctuations strongly, as shown by increased percentages of heliophilic shrubs and herbs in pollen records. These examples show that migrational time lags even exist for adaptive species with high ability for long distance dispersal like *Juniperus communis*. Further, the principle is confirmed, that ecosystems – here birch forests – are most vulnerable to climatic change at their distributional limits, but more resilient in distributional centres.

**Keywords:** GS-2/GI-1 warming, afforestation, migrational time-lags, short-time climatic fluctuations, vegetational responses.

SS41-P01 (453)

**Postglacial appearance of spruce and alder on the northwestern Russia according to pollen data**

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Up to now the pollen and radiocarbon dates of Holocene peat and lake sediments of the northwestern Russia has collected enough. But until now there is no consensus concerning the Lateglacial centers, time and place of appearance as well as the ways of distribution during the postglacial times such tree species as spruce and alder. That's why we tried to reconstruct the history of their spread based on both our and published data. The investigated area is located between 55° and 70° N, 28° and 41° E. The sections of peat and lake sediments which accumulated continuously throughout the Holocene were selected for investigations. We determined the time of the spruce and alder appearance applying the 14-C-dates of empirical boundaries of *Picea* and *Alnus* pollen on the pollen diagrams. Thus, the spruce distribution started from the eastern and south eastern borders of this region about 10 000 yr BP. The highest rate of spruce distribution from the east to the west has obtained at the beginning of early Holocene (about 70 km per 100 yr). This migration flow was the strongest for the whole Holocene. Such high rates may indicate the proximity of refugia, one of which could be located within the Severnye Uvaly upland. It is possible that *Picea obovata* was spread in the early postglacial, and *Picea abies* appeared only in the middle Holocene. But this hypothesis is proved only a single finding of *Picea obovata* cones in central Russia (Sukachev, 1959). Besides, this is confirmed by the resistance of *Picea obovata* to low temperatures and permafrost than *Picea abies*. The spruce also spread in the northwest and southwest directions but rates fell sharply and ranged from 3 km to 8 km per 100 yr. Spruce reached the Peipsi Lake about 9000 yr BP and appeared in the north of the Kola Peninsula about 2500-3000 yr BP. The clear assignment of the empirical boundaries of *Alnus* pollen age has not been obtained. However, it may be noted a tendency to ages rejuvenation from the south to the north in the region. This could be evidence of the possible alder pathways in the same direction. Alder appeared in the south-west of the region (the upper reaches of Zapadnaya Dvina river) about 8000-10000 yr BP and about 6500-7000 yr BP it appeared in the north of the Kola Peninsula. The study was supported by the Grant of the Government of Russian Federation No. 11.G34.31.0025.

**Keywords:** pollen and radiocarbon data, peat and lake deposits, empirical boundary, rate of distribution.

SS41-P02 (499)

**Holocene changes in trophic states of shallow lakes from the Pampa plain of Argentina**

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Changes in trophic status of shallow lakes from the south-eastern Pampa plain of Argentina are evaluated based on the relative presence of submerged macrophytes and phytoplankton algae. The evolution of lake Lonkoy is reconstructed for the last 5000 years, using pollen, non-pollen

palynomorphs (NPPs) and macro fossil remain analyses, revealing three main lake stages. A macrophyte dominated clear lake prevailed until 670 cal yr BP. Afterwards, the lake changed to a turbid phytoplankton dominated state. Recently, the lake has turned to an inorganic-turbid phase, with suspended inorganic material. These results are compared with two other paleolimnological records from the region, lakes Hinojales and Nahuel Rucá revealing a similar late Holocene evolution, with a shift from a macrophyte to phytoplankton dominated lake, occurring at broadly the same time. The shift of states could be attributed to a shift in climate after 1000 cal yr BP towards wetter conditions during the Medieval Climate Anomaly.

**Keywords:** shallow lakes, alternative stable states, late Holocene, Pampa plain, Southern South America.

SS41-P03 (259)

**Long-term boreal forest dynamics at the modern western range limit of the Siberian larch (*Larix sibirica*), new insights from stomata and pollen records**

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The fossil stomata can be the key proxy to investigate the Holocene history of Siberian larch (*Larix sibirica*) at its western range limit in Europe. The Holocene history of the western distribution of Siberian larch is practically unknown, because the larch is palynologically a notoriously silent species. However, fossil larch stomata are more abundant and identifiable and, when analyzed from small hollows within the modern larch stands, can produce more reliable evidence for past occurrence of the species. To investigate the western range limit of Siberian larch in Europe, we analysed conifer stomata, pollen and charcoal from small forest hollow sites from Eastern Russian Karelia, east from Lake Onega. We present new data which suggests that Siberian larch has been present in its modern western range throughout the Holocene. Results from the first two small hollow records indicate that the boreal trees have been present near the sites already from the early Holocene. Larch stomata are abundant and show that larch has been present at this site since ca. 9100 cal yr BP, suggesting that western range limit of Siberian larch in Europe has remained constant since the early Holocene. Spruce stomata were also found throughout both cores. The charcoal records from the two cores are markedly different although both show decreasing fire frequency during largest spruce population. The future aim of our research is to complement pollen, stomata, charcoal and macrofossil data from this area and obtain more detailed data about the occurrence and dynamics of the larch throughout the Holocene at its western range limit.

**Keywords:** small forest hollow, Holocene vegetation dynamics, charcoal.

SS41-P04 (72)

**Reconstructing Holocene vegetation and fire history at Lake Wilks, Tasmania, Australia**

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Fires have long played a significant role in shaping the Australian landscape. Tasmania in particular presents a unique example of a mosaic landscape consisting of fire-adapted sclerophyll and fire-sensitive rainforest plant communities. Largely based on the “ecological drift” theory by Jackson (1968), such landscape has been explained as products of cyclic succession of vegetation communities from moorland to rainforest. According to this theory, vegetation-altering fire events are the major driving factor behind the “resetting” of forested landscape into *Gymnoschoenus*-dominated moorland, which will eventually, given sufficient fire-free interval, develop back into forest. To test this hypothesis in the palaeoecological context, two sediment cores from Lake Wilks, western Tasmania, have been studied in detail. These records represent a complete Holocene sequence dating back to 10055±45 BP. By comparing results from charcoal and pollen analyses, the study will examine whether 1) major fire events are marked by large-scale changes to the vegetation composition, and 2) the site undergoes different stages of succession towards rainforest in between these fire events. Preliminary charcoal analysis has identified a series of charcoal peaks in the last ca. 4000 years, and detailed pollen study revealed the significance of these events for vegetation dynamics in Tasmania.

**Keywords:** palaeoecology, palynology, charcoal analysis, ecological drift.

SS41-P05 (22)

### **Features of Holocene broad leaved flora development in Amur River basin**

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In coastal area of the basin the first broad leaved species appeared 9,5-10 ka BP in composition of mixed small leaved-coniferous forests. Maximum development of broad leaved species in the basin had during Holocene climatic optimum (6-7 ka BP). In this time eastern boundary of the Far-Eastern areal removed up to the Amur River mouth zone. In the west it reached the southern-eastern piedmonts of the Yablonovyi Ridge. In the Transbaikalia area insignificant quantity of the *Quercus mongolica* and *Ulmus* appeared in composition of birch-pine and pine-cedar forests. In this time boundary of the European areal of broad leaved species (*Quercus* and *Tilia*) reached the Leno-Angarskoe Plateau. Thus, in Holocene optimum some broad leaved species penetrated into territory of southern part of the Siberia both from west and east. The first appearance of the *Quercus mongolica* and *Ulmus* in early Holocene in the coastal area and in middle Holocene in the intracontinental area come from refuges. In the coastal part of the basin they were located relatively evenly along the Amur River valley. In the intracontinental area a quantity of refuges was less. They were distributed only in small river valleys and on southern slopes of some ridges. In these places microclimatic conditions were favorable for their preservation. Available pollen data testify about absence of the *Quercus mongolica* and *Ulmus* refuges on western and eastern coast of the Baikal Lake. Probably, bioecological features of the *Quercus mongolica* and *Ulmus* distribution and also compound orographical system around the Baikal Lake did not allow joining of the Far-Eastern and European areal of broad leaved flora in the Siberia. In present time there are small refuges of the *Quercus mongolica* on southern slopes of the northern Sikhote-Alin' Ridge. In the whole Siberia the single refuge of the *Quercus mongolica* preserved. This is Budyumkanskaya oak forest which locates in the Eastern Transbaikalia.

**Keywords:** Holocene climatic optimum, broad leaved species, *Quercus mongolica*, *Ulmus*, refuge.

SS41-P06 (494)

**Record of climatic and environmental changes in the Middle Pleistocene sediments from Łuków (E Poland) on basis of palaeobotanical studies**

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The site of Łuków comprises sediments of the Ferdynandovian bi-partite sequence, conformable with interglacials III and IV of the Cromerian Complex in Western Europe. According to palynological studies, section Łuków-3A bears a record of two warm periods (interglacials) and an intervening cooling, corresponding to the climatostratigraphical units of Ferdynandovian 1 and 2 separated by a cooling/glaciation (Ferdynandovian 1/2). Results of palynological correlated with plant macroremain analyses enabled a detailed reconstruction of vegetation overgrowing the lake and its surroundings. Pollen spectra of the Ferdynandovian 1 interglacial indicate the occurrence of open birch and pine-birch boreal forests in the protocratic phase. Climatic optimum is represented by pollen of trees with higher temperature requirements and likely to form multispecies deciduous forests. Different indicators of warm, humid climate are present. The optimum is followed by spruce and fir encroachment, while abundant Chlorophytes communities developed in the lake. Vast areas of sedge-moss mires covered the area. Presence of *Zannichellia palustris*, *Najas marina* and *N. minor* suggests an intensive water eutrophication, particularly during the younger phase of the optimum. Appearance of *Larix* and *Betula nana* t. in pollen spectra of the terminocratic stage of the Ferdynandovian 1 indicates climate cooling resulting in withdrawal of thermophilous trees and in the succession of boreal elements. Within the Ferdynandovian 1/2 cooling, increased frequencies of *Betula nana* t., *Juniperus*, *Salix* undiff. and *Sphagnum* suggest an expansion of vegetation typical of open communities: tundra, steppe-tundra and peat bogs. Increasing amounts of *Pediastrum kawraiskyi* may result from mineral material supply, while of Musci spores – from the development of peat bogs. The second warm period, the Ferdynandovian 2 interglacial, was initiated with the reexpansion of boreal birch forests, followed by the entrance of thermophilous deciduous taxa: *Quercus*, *Ulmus* and *Corylus*. Climatic optimum is represented mostly by the significant dominance of *Carpinus*. Multispecies deciduous forests – oak-hornbeam forests abundant in hazel, with an admixture of lime and maple – spread. The most thermophilous aquatic communities included *Brasenia borysthenica* and *Aldrowanda borysthenica*. A noticeable increase in NAP and pollen curves of *Pinus* and *Picea* indicates a subsequent cooling. During the terminocratic phase, thermophilous trees withdraw and were replaced by pine forests. At more humid sites communities with spruce occurred. Wet habitats from swamp peripheries were dominated by *Menyanthes trifoliata* and numerous *Carex* species. Aquatic communities comprised frequent *Potamogeton* species: *Potamogeton prelongus*, *P. gramineus*, *P. pectinatus*, and *P. crispus*, as well as *Myriophyllum spicatum* and *M. verticillatum*.

**Keywords:** palynology, macroremains of plants, Middle Pleistocene, Cromerian Complex, Central Europe.

SS41-P07 (601)

## **Environmental history of the extinct lake Šúr (Western Carpathians, Slovakia) during the Late-glacial and Holocene: a multi-proxy approach**

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This project is aimed at a paleo-environmental reconstruction of local vegetation and landscape character of the Nature Reserve Šúr (Western Carpathians, Slovakia) covering the past 13 000 years. Development and origin of the lake and changes of the surrounding vegetation in time and space are reconstructed by using a multi-proxy approach: pollen, macrofossil, diatom analysis. These data are supported by radiocarbon dating, detailed sediment stratigraphy and micromorphology of samples taken from three sections in this area. The sedimentary record of the lake Šúr was chosen due to its exceptional position within the area of contact between the Pannonian basin and Western Carpathians. We test the hypothesis if this type of environment is able to reflect climatic changes during transition of Pleistocene/Holocene, detect refugia of temperate trees in Late-glacial and to trace pollen indicators of agriculture in the middle Holocene. First results show that the Šúr section covers the period from the Late-glacial to the upper Holocene which is climatically very unstable and characterized by extensive vegetation and sedimentological changes. The macrofossil record gives detailed evidence of the existence of the shallow brackish lake. The pollen record reflects trees refugia very close to this area. The sedimentological record reflects also a weak fluvial activity during the Holocene.

**Keywords:** Late-glacial and Holocene transition, macrofossil analysis, pollen analysis, long-term vegetation succession, refugia of temperate trees.

SS41-P08 (12)

## **Vegetation stability and disturbance regimes – a long-term perspective from the Portuguese coast**

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Thermo-Mediterranean vegetation in Southern Portugal is characterized by high species diversity, spatial heterogeneity and structural complexity. Palaeoecological data can contribute a long-term perspective on the factors that influence these characteristics, thereby helping to inform ecological theory and conservation strategies. We used pollen data from a small wetland in the Santo André dunefields on the west coast of Portugal's Alentejo region to study the response of coastal vegetation to past disturbances. The small size of the wetland, and its close proximity to the sea, limit the pollen source-area to a scale comparable to that of a vegetation stand. Over the last 7000 years, the vegetation of the area has exhibited a high degree of stability. The gradual replacement of local pine populations by heathlands appears to be related to shifts in solar forcing, the influence of salt spray and podzolisation. Recent establishment of pine plantations demonstrates that pines grow successfully in the area today, so these environmental factors cannot fully explain pines' mid-Holocene decline. Grazing, fire and other disturbances appear to have been very important in the long-term development of heathland and in promoting vegetation stability. Our data demonstrate

that successional shifts, such as the transition from woodland to heathland, may take thousands of years to occur in response to a suite of factors operating on various spatial and temporal scales.

**Keywords:** Mediterranean, Atlantic, coastal vegetation, stability, ecological succession.

SS41-P09 (302)

**Pollen spectra of Tohoku Tsunami sediments in Shikotan Island (Southern Kuril Islands, NW Pacific Ocean)**

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Pollen spectra study of modern tsunami deposits is of great importance to clarify the characteristics of spectra formation, to estimate the pollen transport features. It is important to determine the environmental effects of sea floodings on vegetation. Earlier such works were carried out by Japanese researchers (Nanayama et al. 2007; Minoura et al. 1996). In Shikotan Island in Malaya Cerkovnaya, Snezhkova, Crabovaya and Otradnaya Bays sediments of Tohoku tsunami (11 March, 2011) were studied by palynological analysis. The sampling was performed immediately after tsunami from ice and in the growing season end (August - September 2011) on transects from sea edge to inland. The pollen spectra of Tohoku tsunami sediments include: 1) pollen of Shikotan Island vegetation (sparse dark coniferous taiga of *Abies sachalinensis*, *Picea jezoensis*, *Juniperus sargentii* thickets on mountain slopes and *Sasa* marshes); 2) transported pollen (*Cryptomeria japonica*, *Quercus* sp., *Carpinus cordata*, *Pinus pumila*, *Pinus parviflora*, *Corylus* sp.) are brought from the neighboring islands by wind and tsunami; 3) redeposited pollen from Late Holocene eroded deposits, especially in Crabovaya Bay. It was difficult to isolate the redeposited pollen because in the spectra all pollen grains were fossilized equally. When we compared our data with the results of subfossil pollen study (Mokhova, Gansey, 2007), they are similar. The main difference - the lot of transported tree and shrub pollen (23%) in Tohoku tsunami sediments, especially *Cryptomeria japonica* (7%), which forest areas are located in the southwest of Hokkaido and Honshu (Igarashi, 1979). Another difference is increased amount of pollen *Juniperus sargentii*, which may partly are redeposited from sediments that were eroded by tsunami. The maximum values of transported pollen were fixed in tsunami sediments in Malaya Cerkovnaya Bay (Pacific coast). It is possible that in Snezhkova Bay (Pacific coast) high content of Polypodiaceae spores in tsunami sediments pollen spectra is formed due to tsunami transport, the ferns are practically absent in surrounding vegetation. The same data were received for paleotsunami sediments of Shikotan Island and Kamchatka Peninsula (Lyashchevskaya, 2011). The study of modern sea sediments shows that the spores are transported by sea currents for longer distances better than by wind. The work was supported by RFBR (grant 11-05-00497) and FEB RAS (project 12-III-B-09-018).

**Keywords:** pollen spectra, tsunami sediments, Shikotan Island, transported pollen.