Editorial

Russian Tree-Ring Research

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With approximately $809*10^6$ ha, Russian forests account for ~20% of the World's forested area (FAO Forestry Paper 163, 2010), which equals more than $650*10^9$ trees, i.e. ~21% of the Earth's total number of trees (Crowther et al., 2015). Russia thus provides ample opportunities for various aspects of modern tree-ring research, including wood anatomy.

The huge boreal forest zone with its relatively homogenous climate envelope, as well as an enormous variety of landscapes, including many different biogeographic and ecological conditions is a typical environmental feature of Russia. Tree-ring research therefore may range from the assessment of a single tree stand to studies of large-scale sub-continental networks (Shiyatov, 1986; Vaganov et al., 1996). The exceptional remoteness of vast territories, which are still difficult to access, promotes the long lasting conservation of unique natural ecosystems. Such undisturbed conditions also facilitate the development of composite chronologies from living and relict trees, which in turn allow climate variability to be reconstructed over past centuries to millennia (Büntgen et al., 2014, 2016). Moreover, the pristine mono-culture forests of large territories in Russia, and especially across Siberia, enable the investigation of tree growth and associated biogeochemical and ecophysiological processes of the same species along large environmental gradients, which may further act as surrogates for projected climate change (Vaganov et al., 1996).

N. Shvedov initiated the first dendrochronological attempts as early as 1892, at that time still in the Russian Empire. In his pioneering work, he compared the radial growth variability of Acacia with the summer drought frequency in Odessa (Shvedov, 1892). Since then, the quality and quantity of Russian tree-ring studies considerably increased. To date, several dendro-related laboratories and scientific centers are successfully operating in Barnaul, Ekaterinburg, Irkutsk, Kazan’, Krasnoyarsk, Moscow, Sankt-Petersburg, Tomsk, Vladivostok, Voronezh and Yakutsk, as well as in some smaller cities. After transformation of the Soviet Union, successful collaborations between Russian and western scientists were initiated in the early-1990s. For example, the circumpolar boreal expeditions under the joint leadership of F.H. Schweingruber, E.A. Vaganov and S.G. Shiyatov resulted in a high-latitudinal network of tree-ring width and density chronologies (e.g., Briffa et al., 1998, 2002a,b), which still describes a palaeoclimatic and ecological benchmark for the entire Northern Hemisphere.

The Russian-Swiss collaboration is still vitally on going, both at personal and laboratory levels as well as including many interests, such as dendroclimatology and dendroecology, qualitative wood anatomy, stable isotopes and tree physiology, stand dynamics and treeline shifts, as well as tracing the origin of Arctic driftwood. A recent workshop entitled “Current Status and the Potential of Tree-Ring Research in Russia” in Krasnoyarsk, January 20-21, 2015 (initiated and organized by A. Kirdyanov and U. Büntgen), gave new impetus to the Russian-Swiss tree-ring alliance. More than 40 participants, mostly young scientists and students, from seven Russian cities (from Moscow in the west to Yakutsk in the east) and two scientists from the Swiss Federal Institute for Forest, Snow and Landscape Research WSL (Birmensdorf, Switzerland) enjoyed lectures and presentations on various topics of Russian tree-ring research. In three key lectures, U. Büntgen presented “Frontiers in Tree-Ring Research”, whereas F.H. Schweingruber reported about the prospects on increment studies in dwarf-shrubs and herbs, and E.A. Vaganov connected dendrochronology, physiology and gene expression. Eighteen presentations from Russian scientists and students were devoted to dendroecology and dendroclimatology, as well as to the development and analysis of tree-ring chronologies, networks and teleconnections, with additional foci on the assessment of cell structures and the modeling of growth patterns. The final discussion was devoted to future research directions that will ideally be explored in close association between Russian scientists and their international partners. Most of these projects have already been successfully put into practice: scientific exchanges, visiting lectures, field expeditions, summer schools, and most importantly, joint publications. One direct outcome of the 2015 workshop is this Special Issue you are now either holding in your hands or enjoying online.

The first two papers are devoted to rather traditional aspects of dendro-sciences, including further development and analyses of a Eurasian tree-ring network. Hellman et al. (in this issue) update a Eurasian-wide network of 446 high-latitudinal ring width chronologies to assess its ability for Arctic driftwood provenancing. The authors found that boreal catchment areas do not always coincide with spatial patterns of climate-induced boreal growth coherency. Biogeographical criteria rather than catchment levels should therefore be considered for the provenancing of Arctic driftwood. Taynik et al. (in this issue) present a new network of 13 Siberian larch ring width chronologies from mid to high elevation sites along a nearly 1000 km west-to-east transect across the greater Altai-Sayan region. The highest agreement was found between chronologies ≥2200 m asl, whereas material from lower elevations reveals overall less synchronized interannual to longer-term growth variability. Depending on the chronologies' locations, variation in either summer temperature or hydroclimate can be reconstructed.

The next two papers introduce new tree ring-based reconstructions for regions that have not been previously covered by robust tree-ring proxies of climate. Dolgova (in this issue) develops the first minimum blue intensity (BI) chronology for the Caucasus, which demonstrates a high potential for reconstructing summer temperature variability over large regions in the Middle East and even Northern Africa. Panyushkina et al. (in this issue) compile a new set of Scots pine tree-ring records from burial timbers that were excavated at the historical center of Yaroslavl in western Russia. A $\delta^{13}C$ chronology from 1430-1600 AD reveals the timing, amplitude and duration of severe summer droughts in the upper Volga River basin. The new dendro-archeological record is confirmed by independent documentary evidence of crop failure and city fires.

Fonti and Babushkina (in this issue) analyze cell anatomical responses to environmental changes in conifers growing along local climatic gradients in the forest-steppe in Siberia (Russia). Their results suggest that increasing drought stress might hamper the formation of a functional xylem structure, which might be a possible trigger for miss-acclimation, as well as a subsequent long-term decline and higher exposure to hydraulic failure.

Two next papers deal with tree-ring growth modeling. Shishov et al. (in this issue) advocate a new visual approach for the parameterization of the process-based tree-ring growth model (Vaganov-Shashkin; Vaganov et al., 2006). This parameterization approach (VS-oscilloscope) was tested on two species in the central Siberian permafrost zone. Fine-tuning of the model enhanced the physiological understanding of ring formation. Churakova et al. (in this issue) combine different models that predict stem growth variation stable isotopic composition of larch trees in Yakutia. The author show that extending applications of different tree-ring parameters inferred from trees growing on permafrost to mechanistic eco-physiological models will improve our knowledge about interactions between permafrost thawing and tree productivity under global warming.

In a rather novel study for Russia, Matskovsky et al. (in this issue) compare dendrochronological and radiocarbon-based dating results of three medieval icons from the 15th–17th centuries, which originate from north-western Russia. Their results suggest that tree rings do indeed help in correcting art-historical dates and icon dating with subsequent implications for a new baseline of art history in the European part of Russia.

Although comprising only a small fraction of ongoing tree-ring endeavors in Russia, this Special Issue reveals an important insight into the potential of dendroecology, including dendroclimatology and wood anatomy across different parts of the World's largest country. The herein published work reflects a wide range of cross-disciplinary scientific tasks and opportunities. In this regard, it is obvious that tree-ring research offers ample pathways for highly beneficial collaborations between Russia and the international community.

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