Call to complete the circumarctic juniper network – an environmental proxy

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Introduction

Arctic shrubs have become important proxy archive in the Arctic environment. They present detailed, abundant, and often long-lived environmental proxy. In recent decades they were used to reconstruct temperature (Buchwal et al. 2013), snow regimes (Schmidt et al. 2006), or ice-sheet melt (Buras et al. 2017). Although circumarctic studies exist (*e.g.* Myers-Smith et al. 2015) they lack common methodological background, often combine different species and thus cannot always address specific environmental issues accurately. Therefore, we are currently building the circumpolar wood anatomy juniper network to satisfy this need (Fig. 1). So far, seven locations – mainly along the Northern Atlantic coast – have been sampled. Nonetheless, field campaigns covering Asia and N. America are still missing. Here, we invite the polar scientific community to contribute to our juniper network with the benefits of co-authorship and network access for each data contributor. The aims of this contribution is as follow: 1) to introduce *Juniperus communis* and highlight its advantages compare to other species with respect to sensitivities, distribution, and life-span; 2) to present programmatic aspect of juniper sample collection to ease and accelerate data collection.

Methods and Materials

Visited juniper field campaigns are marked in the Fig. 1. The map in the top right of Fig. 1. presents the juniper circumarctic distribution. Such wide range of occurrence is one of the key motivation for juniper selection as a model species for Arctic environmental reconstructions. Among others, with the similar importance, we have identified i) relative abundance, ii) exceptional life-span, and iii) environmental sensitivity.

i) Although juniper is not among the most common Arctic species in the areas of its occurrence it is usually easy to find and sample. We are convinced this is due to relatively special ecological niche. Juniper tends to inhabit dryer, often elevated (ridges) or disturbed (stony slopes) microsites. Ridges are not suitable for species with higher moisture demand (*Salix sp., Alnus sp.*) which in other sites can overgrow juniper and limit its access to light. Similarly, disturbed stony slopes are another niche for juniper since rock fall is less stressful for prostrate life form which Arctic junipers often occur in. This combination gives to the juniper unique environment to inhabit the sites with very little interspecies competition and thus with less growth affection by non-climatic factors. Therefore, juniper is a good candidate for environmental reconstructions.

ii) Most Arctic shrub species used in dendrochronology live rarely longer than a century. Schweingruber et Poschlod (2005) as well as personal collections show limited life-span for frequently used species: *Betula nana* (average 60 – 80 ys, max 130 ys), *Salix sp.* (average 40 – 60 ys, max 110 ys), or *Alnus sp.* (average 30 – 60 ys, max 80 ys). *Juniperus communis* has proved to be an exception. Its average life-span reaches over one century, with the individuals living for more than 200 years and in special cases even over 600 years (Kola peninsula; authors archive). This presents another crucial reason for juniper environmental reconstructions suitability.

iii) Increasing number of studies have demonstrated significant environmental sensitivity of *Juniperus communis*. Species growth parameters (including cell anatomical parameters) were found to be sensitive towards summer temperature, SPEI (standardised precipitation evaporation index), or even ice-sheet melt (*e.g.* Lehejček et al. 2017, Buras et al. 2017).

We are strongly convinced that above mentioned is clear enough message from juniper community to polar scientific community that we should spent more effort to explore the potential of this fascinating species. Therefore, we outline bellow the sampling strategy and procedure to fill the geographical gaps in juniper circumarctic field campaigns.

For the purposes of circumarctic juniper network we suggest to sample between 25 – 30 individuals. This is a compromise between environment protection and sufficient sample depth since up to one third of the samples may not be adequate in quality for subsequent analysis. All samples are taken from similar microsite with respect to moisture availability, exposition (max. 90°), elevation range (within 150 altitude meters), and slope inclination (20º). Sites with open canopy with no light limitation for juniper individuals are preferred. To capture the full variety of plant ages and various sizes a systematic grid is established within existing juniper stand. Shrubs are than sampled from a random subsample of the respective grid-points. Root collar discs at the soil surface are taken by hand-saw from each plant to maximize the number of rings and obtain the oldest parts of the plant stems. Two additional samples along the stem are taken with preferred distance of 50 cm from each other to satisfy serial sectioning method if needed. This samples are labelled XY01/1, XY01/2, XY01/3; XY01/1 being the root collar disc. Packaging is preferred into paper bags to prevent moulding. Each sampled individual has its own standardised shrub sheet (will be send on request). It contains information on photograph number, sample ID (*e.g.* XY01), latitude, longitude, altitude, exposition, slope angle, microsite characterisation, surrounding vegetation, (co)-dominance, life-form, fitness, sex, fruit presence, diameter at base, stem length, distance between serial samples, amount of stems, damage, dead wood, and personal comments. Eventually, shipping the samples to the address of the corresponding author is required.

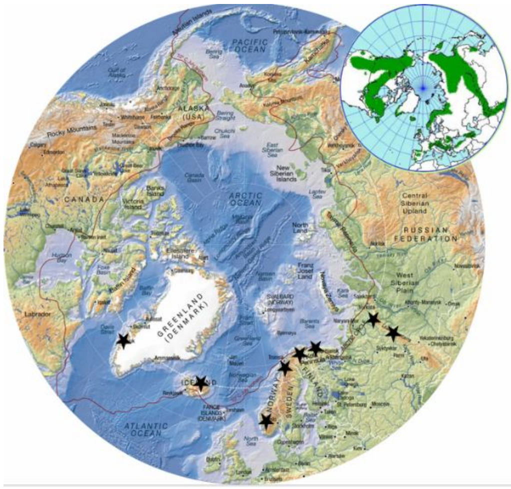

Fig. 1. *J. communis* circumpolar distribution (green area, small map) and location of visited field sites (black stars, main map). Field sites from west to east: Kobbefjord, Greenland; Hólasandur, Iceland (2018); Finse, Norway; Abisko, Sweden; Kevo, Finland; North Kola Peninsula, Norway; Polar Ural, Russia.

Conclusion

Due to spatial scarcity and lack of long instrumental climatic records as well as missing written sources from the Arctic, studies focusing on proxy archives and environmental reconstructions are important evidence of eco-climatic variations in (sub)-polar regions. Unfortunately, representative circumarctic network of environmentally sensitive, long-life, and abundant species is still missing. *Juniperus communis* presents superb option to address such issue. We therefore outlined in detail the sampling strategy and procedure to make sample collection possible for any field polar scientists. Field sampling should not exceed two man/days, only basic equipment is needed and samples are easy to transport. The revenues for each contributors are publication co-authorship and juniper network data access. In case of your interest, please contact the corresponding author.

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