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Climate factors control inter-annual variability of radial growth, while microsite conditions affect absolute growth and long-term growth trend in the multi-stemmed shrub *Alnus alnobetula* at the alpine treeline

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Green alder (*Alnus alnobetula* (Ehrh.) K. Koch = *Alnus viridis* (Chaix) DC), a tall multi-stemmed deciduous shrub, is widespread at high elevations in the Central European Alps especially within avalanche slide path, screes and steep, north-facing slopes with high water availability. The ascending growth of stems frequently leads to eccentric growth, discontinuous rings and elliptical shape of annual rings making development of representative ring-width time series, necessary to determine climate forcing of radial growth and long-term growth trends, a challenge. Therefore, the focus of this study was to assess growth variability among radii of one shoot (n=4 radii), among shoots belonging to one stock (n=20 shoots per stock) and among stocks exposed to different site conditions (n=3 sites). Stem discs were sampled within the treeline ecotone (*c*. 2150 m asl) on Mt. Patscherkofel (Tyrol, Austria), and annual increments were measured along 188 radii. Variability in inter-annual agreement among ring-width series was evaluated by applying dendrochronological techniques, i.e., the parameters (*i*) percentage of parallel variation ("Gleichläufigkeit", Glk) and (*ii*) the correlation coefficient *r*, adjusted for the amount of overlap (t_{BP}-score) were determined. Variation in intra-annual dynamics of radial growth among shoots belonging to different stocks was evaluated by mounting diameter dendrometers (n=6). Results revealed a high agreement in ring-width variation among radii of one shoot (Glk: $P<0.001$; t_{BP}-score>5), among shoots of one stock (Glk: $P<0.05$; t_{BP}-score>4) and among stocks from different sites (Glk: $P<0.05$; mean t_{BP} -score=4.5). Dendrometer records gathered from shoots belonging to different stocks also revealed a high agreement in intra-annual radial growth dynamics, which started in 2023 at the end of June and already terminated in early August. In contrast to this, a high variability in both absolute growth rates and long-term growth trends was found at selected study sites. We attribute our findings to the pronounced limitation of radial stem growth in *Alnus alnobetula* by climate factors (mainly summer temperature and winter precipitation) leading to a high agreement among ring width series developed from different radii, shoots and individuals. On the other hand, differences in compressive and tensile forces and variation in microsite conditions determine absolute growth rates and long-term growth trends.

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