Source: Schleser G, Winiger M, Bräuning A, Gärtner H, Helle G, Jansma E, Neuwirth B, Treydte K (eds.) (2003) TRACE - Tree Rings in Archaeology, Climatology and Ecology, Vol. 1: Proceedings of the DENDROSYMPOSIUM 2002, April 11th - 13th 2002, Bonn / Jülich, Germany. Schriften des Forschungszentrums Jülich, Reihe Umwelt Vol. 33, p. 87 - 89.

Fluctuations in subalpine tree-ring records from sites located along a dendroecological transect in Northern Patagonia

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Introduction

Due to their great altitudinal range mountain systems display climatic regimes similar to those of widely separated latitudinal belts within short horizontal distances. Along such pronounced environmental gradients, the subalpine altitudinal belt, including tree- and timberline, inheres a key position in high mountain ecosystems by forming the highly climate-sensitive transition zone between the closed mountain forest and the periglacial (subnival) and nival belts. Thus, trees growing in these environments comprise excellent palaeoenvironmental records. The first studies on these topic were realized in the northern hemisphere, whereas the southern hemisphere has lagged greatly behind (Boninsegna and Villalba 1996). A substantial increase in the number of tree-ring chronologies from South America took place in the 1990s. More than 90 chronologies were recently developed from collections of *Nothofagus pumilio*, the dominant subalpine tree in the Andes of Chile and Argentina (c. 35°35' to 55°S) (Villalba et al. 2001). Nevertheless, fluctuations in radial growth in a dendroecological context, i.e. considering the entire ecological range of the distribution of the species from dry to moist environments have not been analysed yet. The present study is a first attempt to do so.

Material & methods

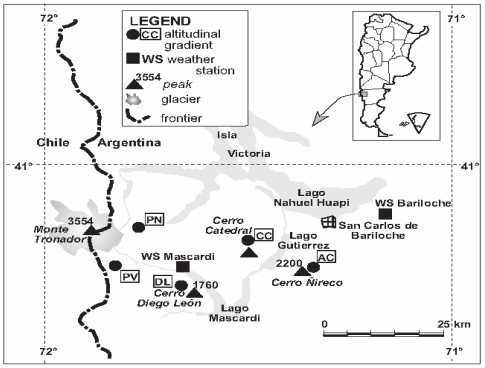
In the Northern Patagonian Andes, *Nothofagus pumilio* (lenga), is the dominant subalpine species, ranging from its lower distribution limit at elevations around 1100m asl up to the upper treeline in about 1800m asl.

In order to assess fluctuations in the radial growth along the steep precipitation gradient from the steppe in the east towards the Valdivian Rainforest in the west of the Andes, fourteen *N. pumilio* tree-ring chronologies have been developed (Figure 1), applying a strict sampling strategy across the northern Patagonian Andes at 41°S. It systematically followed

a) an E-W transect from dry to moist environments and
b) altitudinal gradients located along this transect.

The dendroecological network resulting from intensive sampling using increment borers encompasses fourteen sites located along five altitudinal gradients between the lower, xeric timber line in the east and the upper, humid tree line in the west. All samples were dried, mounted and surfaced. In a following step the tree rings were counted, crossdated and measured

Chronologies were built using standard methods commonly used in dendrochronology: COFECHA (Holmes 1983) and 'Gleichläufigkeit' (Huber 1952) provided quality control of crossdating, while ARSTAN (Cook 1985) was used for chronology construction. For frequency analysis of the dendroecological network, the power spectrum analysis PSA (Blackman & Tukey 1958) was applied to each site-chronology.



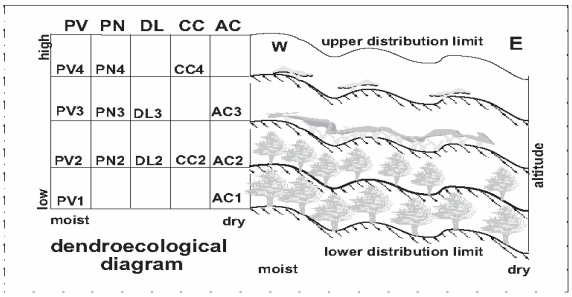


Figure 1: Location map and characteristics of N. pumilio sites sampled over a transect from the dry east to the moist west along five altitudinal gradients limited by the upper and lower distribution boundaries of this species. Sites are arranged in the dendro-ecological diagram according to their ecological characteristics.

Results

Analysis of the fluctuations in radial growth of *N. pumilio* along the entire ecological range of the species revealed the peaks of the Blackman-Tukey spectrum shown Table 1:

*Table 1: Significant peaks of the Blackman-Tukey spectrum for all sites of the transect. * significant at the 95%-level, ** at the 99%-level.*

site	period > 7yr	period < 7yr (high frequency)	altitudinal gradient
AC1	30.7* 11.4*	5.1* 3.0* 2.44** 2.40** 2.1*	
AC2	11.8* 10.6*	3.6** 3.5** 2.9*	dry
AC3	22.06*		
CC2	11.8*	3.5*	
CC4	29.6*	4.0* 3.7**	
DL2	24.9* 11.2*	5.7** 3.8* 3.7** 3.3* 2.4* 2.3**	
DL3		3.2*	
PN2	10.2*	2.7* 2.63** 2.58** 2.03* 2.0*	
PN3		3.1* 2.9* 2.0**	
PN4		3.4** 3.1** 2.5* 2.4*	
PV1	10.0* 7.7*		
PV2	10.1* 8.7* 8.1*	2.65* 2.60*	moist
PV3	13.4* 11.1*	2.4*	
PV4		4.9* 3.5*	

It is clearly shown that radial growth of *N. pumilio* shows different significant fluctuations along the dendroecological transect. Dry sites at low and intermediate elevations show the most consistent pattern in the appearance of a cycle around 11-yrs which may be attributed to the 11-yr sunspot cycle. Towards moist environments, this signal is no longer apparent in the tree-ring records. The appearance of short-term fluctuations is inhomogeneous along the transect and may reflect site-specific factors like fruiting cycles, etc.

Discussion

According to the results obtained in this study, *Nothofagus pumilio* records environmental fluctuations of different frequency depending on the site conditions. Thus, the complexity of the high mountain environment is reflected in its growth rings. Hence, care should be taken about site selection for developing chronologies which may be considered as representative for the whole region. Dry sites of low to intermediate elevations might be useful to record the 11-yr sunspot cycle.

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