DENDROCHRONOLOGY OF ARAUCARIA ANGUSTIFOLIA IN SOUTHERN BRASIL: PRELIMINARY RESULTS.

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RESUMO

Com o intuito de realizar estudos dendrocronológicos em Araucária angustifolia *foram analisadas 10 árvores da Estação Experimental de São João do Triunfo, da UFPR. Para a obtenção dos dados foram tomadas seções transversais (discos) dos troncos à altura de 2 m. Em cada disco foram marcados oito raios, com intervalos de 45°, sobre os quais foram medidas as larguras dos anéis anuais de crescimento com um micrometro de leitura ótica de alta precisão. O cálculo da série de índices dos anéis de crescimento para cada raio envolveu a remoção de tendência através da média flutuante de 13 pontos com pesos iguais. Posteriormente foi calculada uma série-índice média para cada árvore e para o povoamento. Os resultados preliminares indicam a existência de uma variação das séries-índice entre os raios de cada disco. O coeficiente de intra-correlação médio das larguras dos anéis entre os raios variou de 0.57 a 0.89. Uma correlação média de 0.60 foi encontrada para todos os pares de árvores, indicando a consistência das séries de índices entre as árvores. Isto possibilitou a construção de uma série de índices média para o povoamento como um todo.*

1. INTRODUCTION

The tree-ring studies in South America have lagged behind those in Northern Hemisphere. For the genus **Araucaria**, only one species, i.é. **A. araucana** (Mol.) Koch. growing in the Andean region, has ben subject to tree ring studies (La Marche et al. 1979a, b).

Araucaria angustifolia (Bert.) O. Ktze. is the most important native coniferous species in Southern America. It covers an area of app. 300.000 km² at the altitude between 400 and 1400 meters above sea level mainly in Southern Brasil. However, no attempts to analyze its dendrochronology or climate diameter growth relationship are known. These studies could be used to increase the understanding of the growth in a natural forest, providing also knowledge for the management of both natural and man-made forests.

The purpose of this paper is to study within tree and between tree variation in the tree rings of **Araucaria angustifolia** in Southern Brasil. The work is aimed especially towards detecting problems in determing the sample size and in construction of an average index series for the site.

2. MATERIAL AND METHODS

The study area is located at the Forest Research Station of São João do Triunfo of the University of Paraná (25° 34' S, 50° 05 W; 780 m a.s.l.) (Fig. 1). The stand forms a part of a natural forest, dominated by **Araucaria** associated with a understorey of broadleaved species. The tree age varied between 55 to 90 years. The stand mean diameter (DBH) was 30.1 cm (var=12.7) and the dominant height 19 m.

Ten trees of the dominating crown class were selected and felled. The mean age of the felled trees was 65 yr.) at 2 meters), the mean diameter (DBH) 45 cm, and the mean height 19 m. After felling, cross-sections were taken at the height of 2 meters. The sections were dried and prepared by smoothing one surface with a sand paper until it was polished. The sections allowed the identification of single cells, giving the best condition for the identification and measurement of the rings. Therefore no staining was necessary.

On each cross-section, 8 radii were marked beginning with the greatest, the next turning clockwise 45° and so on. From each radius the width of each

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annual ring was then measured with a digital positiometer to an accuracy of 0.01 mm. In the case of missing rings, their position was determined by eye in comparison with the adjacent radii.

The consistency of the tree ring sequence of a tree was studied by means of the estimated correlation coefficient between the widths of annual rings of individual radii. The mean value for all pairs of radii in each tree was also computed.

The tree rings series can be considered as time series with certain frequency domain properties. This domain is composed of four different kinds of signals that are recognizable. Let R(t) be the measured ring width in year t, then

$$R(t) = C(t) + B(t) + D(t) + a(t), \quad (1)$$

where C(t) is the macroclimatic signal common to all trees at a site, B(t) is the biological growth curve as a function of increasing tree age, D(t) is the tree disturbance signal, i.e. due to individual random effects or due to common effects, such as fire, which affected the whole site, and a(t) is the white noise (error) term (c.f. Graybill 1982).

In order to maximize the detection of C(t), it is necessary to remove the others. In our data, the growth trend was subtracted by a 13-point moving average of equal weights (Kendall 1976). Thus.

$$\text{Index}(t) = R(t)/Y(t), \quad (2)$$

where Y(t) is the expected annual growth determined from the moving average. First, the ring series of each radius was detrended and an index computed. Then the mean indices for the tree and for the stand were computed.

For between tree analysis, the correlation of the index series for all pairs of trees was calculated using the data from the years 1929 to 1982. In addition, an overall mean correlation was also computed.

3. RESULTS AND DISCUSSION

The calculated correlation coefficients of the ring width series between the radii of individual trees revealed that the within tree variation may be large in some cases (Table 1). This was especially the case with tree N.° 805 due to difficulties in the definition of missing rings. This led to the omitment of that tree from further calculations. For the trees N.°s 910 and 913, only 5 and 7 radii, respectively, could be identified due to wood defects.

The mean intra-correlation coefficient calculated for each tree varied between 0.577 and 0.891 (tree N.° 805 not included). Altough there are trees with high intra-correlation (e.g. tree 914; r = 0.891), others show low values (e.g. tree 802; r = 0.577) as a consequence of even lower values between the paired radii (e.g. radii 1 x 6, r = 0.173; radii 4 x 6, r = 0.365). For visual comparison, Fig. 2 shows the index series of eight radii for the trees N.°s 802 and 914.

The index series of individual trees showed similarity in the between tree variation. However, differences in the sensitivity of the ring indices were observed, e.g. tree N.° 910 showed pronounced variation (coefficient of variation = 0.43) in comparison with other trees or the stand mean (coefficient of variation = 0.20).

The correlation coefficient of the index series between trees varied between 0.323 and 0.809 (tree N.° 805 not included) (Table 2). The mean correlation for all pairs of trees was 0.596 indicating consistency in the variation between the trees (Fig. 3a). This made it possible to construct and average index series for the stand (Fig. 3b).

TABLE 1: Correlation coefficients of the widths of annual rings between the radii of the sample trees.

Radii	Tree									
	801	802	805	905	909	910	911	912	913	914
1 x 2	.740	.475	.204	.768	.742	.341	.900	.565	.576	.892
1 x 3	.734	.505	.359	.717	.621	.241	.891	.605	.574	.858
1 x 4	.731	.655	.110	.737	.652	.353	.792	.650	.428	.876
1 x 5	.646	.499	.273	.709	.604	.459	.770	.658	.438	.797
1 x 6	.726	.173	.520	.707	.359	—	.630	.458	.559	.806
1 x 7	.697	.542	.701	.674	.451	—	.847	.401	.582	.869
1 x 8	.872	.707	.447	.800	.690	—	.862	.668	—	.927
2 x 3	.677	.642	.303	.842	.786	.648	.927	.773	.870	.920
2 x 4	.727	.488	.405	.821	.644	.678	.678	.546	.721	.917
2 x 5	.609	.529	.100	.744	.690	.778	.695	.678	.696	.907
2 x 6	.666	.666	.204	.773	.540	—	.812	.813	.670	.880
2 x 7	.640	.597	.171	.763	.588	—	.899	.669	.588	.921
2 x 8	.648	.491	.414	.771	.583	—	.850	.521	—	.861
3 x 4	.712	.684	.367	.894	.749	.944	.775	.784	.866	.936
3 x 5	.609	.584	.200	.818	.696	.891	.776	.655	.833	.888
3 x 6	.693	.554	.136	.876	.499	—	.838	.727	.799	.860
3 x 7	.719	.750	.342	.755	.664	—	.907	.628	.674	.914
3 x 8	.722	.735	.345	.695	.665	—	.885	.673	—	.883
4 x 5	.721	.722	.227	.890	.882	.957	.941	.771	.906	.932
4 x 6	.696	.365	.075	.905	.512	—	.821	.542	.806	.900
4 x 7	.709	.580	.176	.808	.577	—	.747	.491	.657	.917
4 x 8	.780	.742	.314	.755	.588	—	.838	.703	—	.901
5 x 6	.661	.575	.554	.863	.640	—	.897	.636	.865	.954
5 x 7	.730	.496	.328	.685	.582	—	.790	.476	.768	.915
5 x 8	.694	.651	.049	.738	.556	—	.828	.551	—	.836
6 x 7	.749	.620	.650	.771	.684	—	.913	.704	.868	.947
6 x 8	.700	.397	.283	.723	.357	—	.851	.576	—	.833
7 x 8	.718	.740	.329	.716	.453	—	.910	.515	—	.896
Mean	.704	.577	.307	.776	.609	.629	.836	.623	.711	.891

TABLE 2: Correlation coefficients between the tree index series for period 1929-1982.

	801	802	805	905	909	910	911	912	913
802	.594								
805	.348	.353							
905	.711	.742	.373						
909	.605	.691	.291	.809					
910	.611	.526	.353	.655	.687				
911	.476	.534	.433	.552	.646	.706			
912	.453	.531	.088	.617	.629	.693	.695		
913	.323	.445	.028	.427	.519	.417	.419	.554	
914	.475	.856	.207	.667	.659	.652	.602	.777	.556

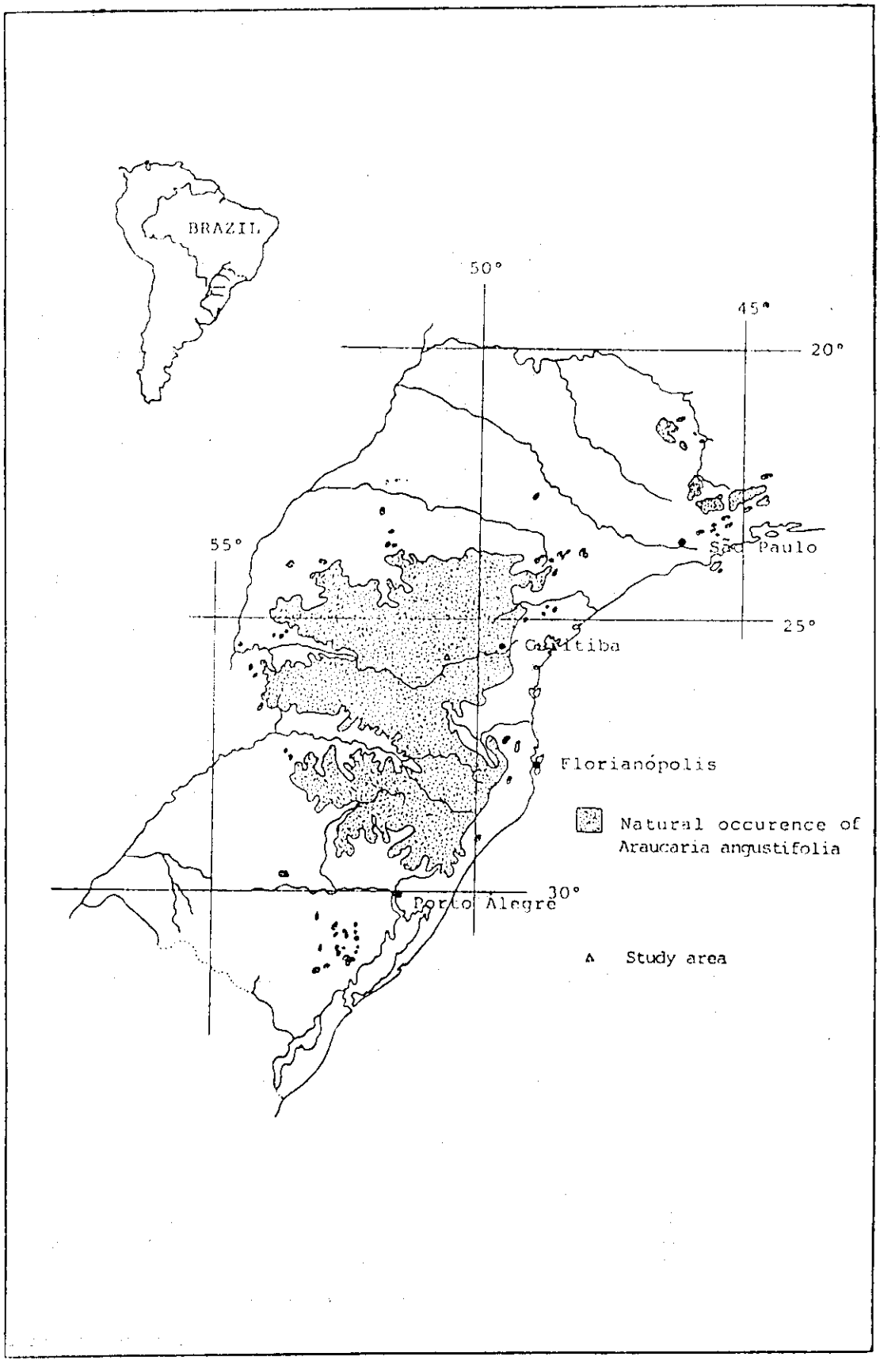

FIGURE 1: Natural occurrence of Araucaria agustifolia and location of the study area. (HUECK, 1952).

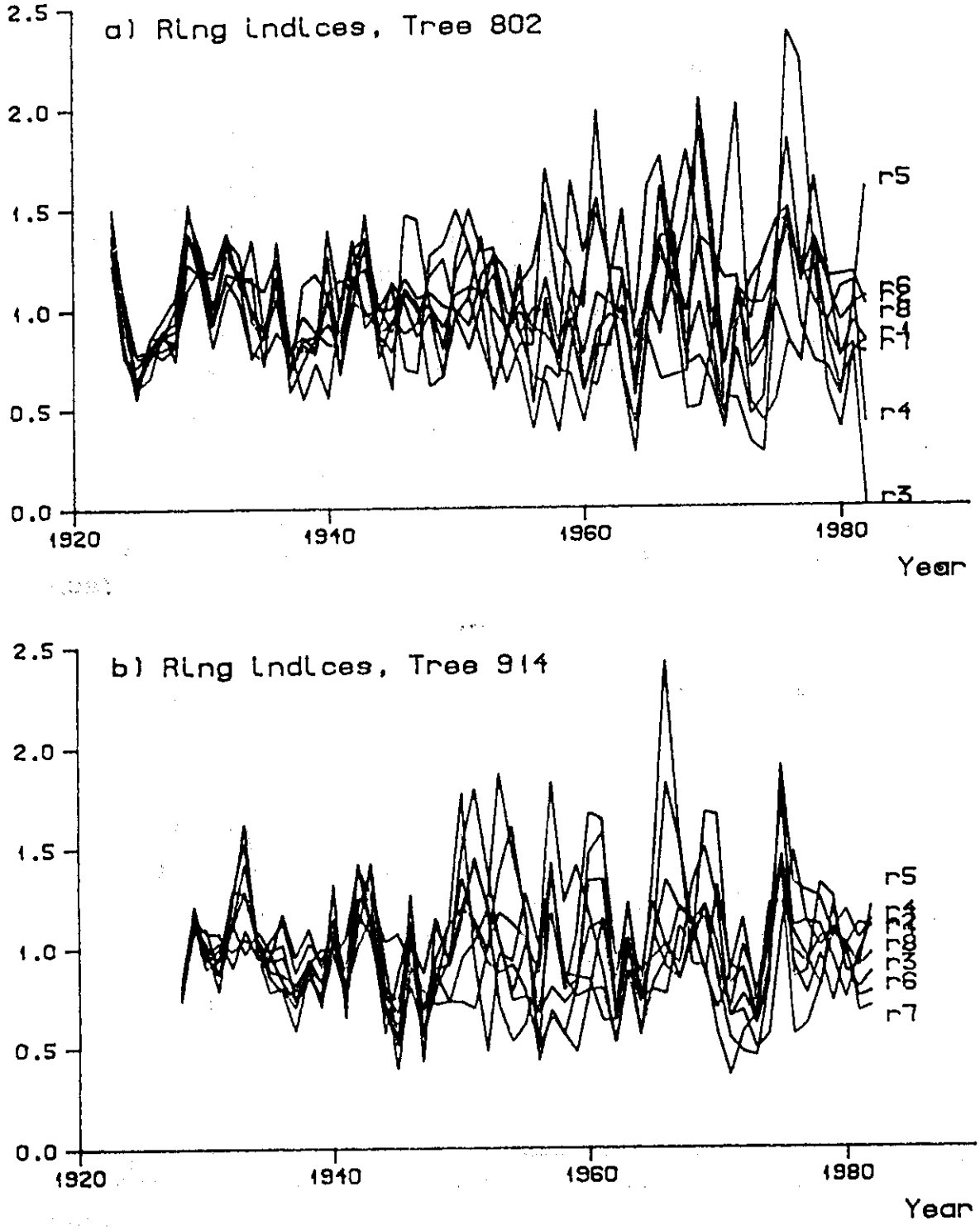

FIGURE 2: Ring indices of the eight radii (r1 -r8) for the trees a) 802, and b) 914.

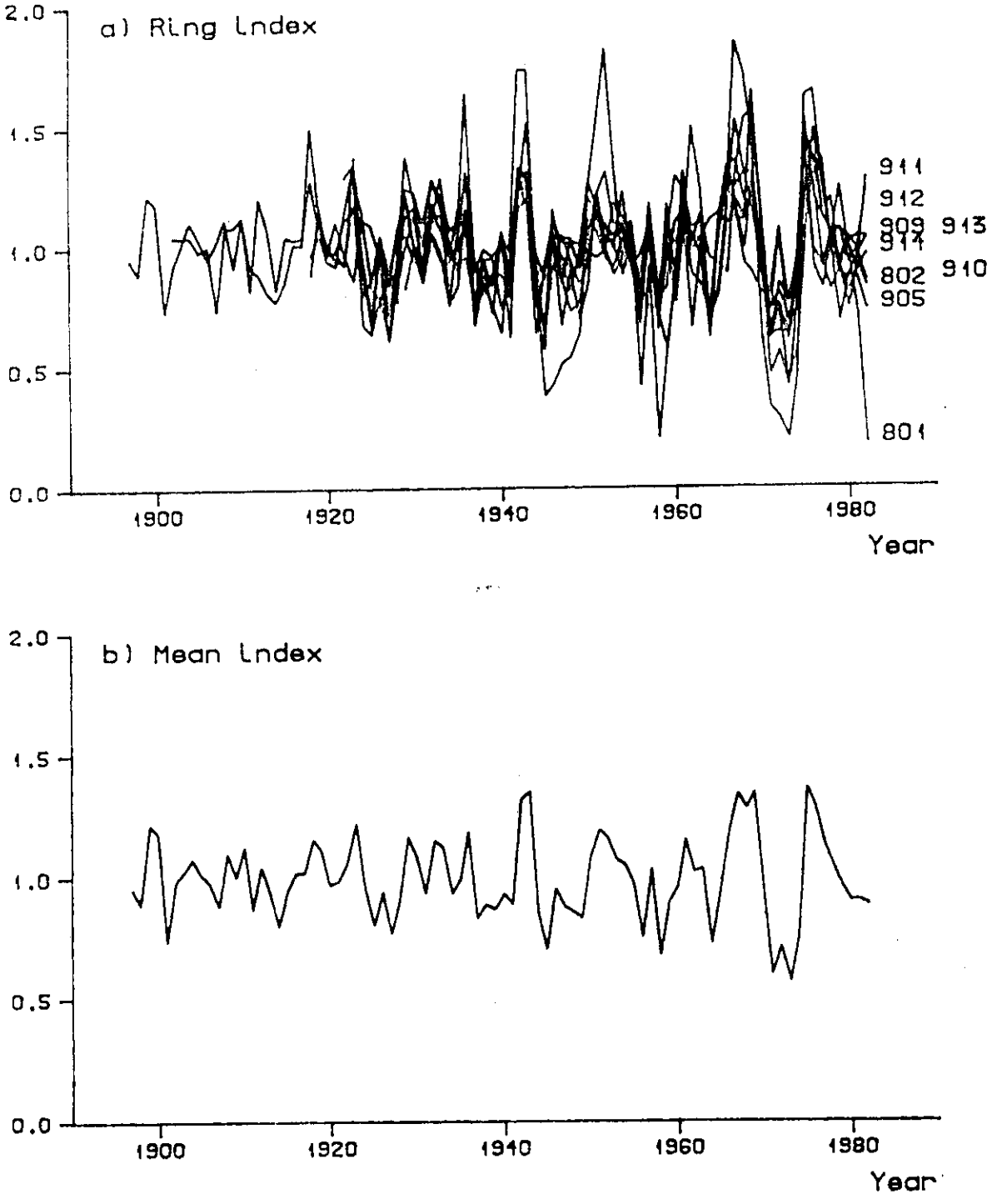

FIGURE 3: Mean ring indices a) for individual trees, and b) for the study stand.

4. SUMMARY

Tree ring analysis of **Araucaria angustifolia** trees grown at the forest research station São João do Triunfo of the University of Paraná has been carried out. The work is a part of the scientific cooperation between the University of Paraná and the Finnish Forest Research Institute.

The tree ring data consisted of cross-sections discs) taken from 10 trees at the height of 2 m. On each disc, eight radii were defined, from where the width of annual rings was measured with a digital positiometer.

The calculation of the tree ring index for each radius involved the removal of trend by 13-point moving averages of equal weights. After that, tree average and stand average indices were computed.

The preliminary results indicate that there exits within tree variation in the ring series. The mean intra-correlation coefficient for the ring widths between the radii varied between 0.57 and 0.89.

Mean correlation of 0,60 for all pairs of trees was obtained indicating consistency in the index series between the trees. This made it possible to construct an average tree ring index for the stand.

5. REFERENCES

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