Tree Rings Thin Even When Growth Holds Steady, So a Thinning Ring Does Not Mean Slowing Growth

— adding the same **10.0** cm^2 of cross-section each year, ring width falls to **0.085423** of the first by year **100**, and regressing width on year makes growth look better in the past — the separator is whether growth is measured by width or by increase in cross-sectional area — [Paper 749]

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— From thinking to syncing. —

Abstract

When tree rings grow thinner, one is tempted to read slowing growth. Yet rings thin even when growth holds steady.How far width and growth disagree is counted on a circular stem.No new theorem or law is claimed. First, with steady growth, rings thin——width 1.045263 cm in year 1, 0.126393 cm in year 50, 0.089289 cm in year 100 (Section 2). **Second, meanwhile the added area does not change——10.000000 cm^2 each year, while width in year 100 is 0.085423 of year 1** (Section 2). **Third, regressing width shows a decline——the slope is negative, as if growth had been better in the past** (Section 2). **Fourth, and this is the core. Even when growth increases, rings thin ——from year 10 to year 100 the added area rises 1.176471 times and width falls to 0.353377** (Section 3). **Fifth, the thinning is set by radius——the approximation $A/(2\pi r)$ gives 0.127031 cm in year 50, a relative difference of 0.005044** (Section 2). **Sixth, the separator is whether growth is measured by width or by increase in cross-sectional area——"the rings thinned" does not say whether growth slowed** (Section 4). **Keywords**: tree rings, ring width, basal area increment, geometric thinning, apparent decline, measuring growth.

Scope of this paper (scope note): **No new theorem or law is claimed——the tendency of ring width to decline with age (the age trend), the standardisation that removes it, and the use of basal area increment instead of width are all known (Fritts 1976, Cook and Kairiukstis 1990).The stem is a circle——eccentricity, bark, heartwood and sapwood are not treated.Growth is a set value——10.0 cm^2 a year, or growth rising by a fifth over 100 years, is assumed; real growth moves with climate and competition.Physiology and climate are not treated——how rings form and how climate is reconstructed are not treated.Standardisation methods are not treated——the choice of curves for removing the age trend is only named.No real data are claimed——particular trees or regions are not treated.Relation to earlier papers**: **Paper 656 showed that the oldest age readable from the rings of a fish otolith is set by whether the ring width can be seen——there ring width was read as growth rate itself, and once width fell below resolution the age clock stopped. Here, with the same area added each year, width shrinks inversely with radius, so width is not growth rate itself. Reading width, or reading area.**What is added is **showing that with steady growth width falls to 0.085423 over 100 years**, **showing that regressing width manufactures a decline**, **showing that width falls to 0.353377 even as growth rises 1.176471 times**, and **placing the separator on width against increase in cross-sectional area**.

1. Notation and the Question

Setting: **take the stem as a circle of radius r, gaining cross-sectional area A_t in year t. Ring width w_t is the increase in radius.**

$$\pi r_t^2 = \pi r_{t-1}^2 + A_t, \qquad w_t = r_t - r_{t-1} \approx \frac{A_t}{2\pi r_t}$$

The initial radius is 1 cm; take $A_t = 10.0$ cm^2 (steady), and a case where growth rises by a fifth over 100 years.

Question: **if the rings thin, has growth slowed?**

2. With Steady Growth, Rings Thin

Computation 2.1: **adding 10.0 cm^2 a year, the radius, ring width and added area were derived.**

year	radius	ring width	added area
1	**2.045263** cm	**1.045263** cm	**10.000000** cm^2
10	**5.729833** cm	**0.284846** cm	**10.000000** cm^2
50	**12.655234** cm	**0.126393** cm	**10.000000** cm^2
100	**17.869244** cm	**0.089289** cm	**10.000000** cm^2

Observation 2.2

growth is steady, yet ring width in year 100 is 0.085423 of year 1.The added area is the same each year, differing by at most 3.570×10^{-13}——what thinned was not growth; the circumference over which the same area is spread grew longer.

Observation 2.3

the thinning is set by radius.The approximation $A/(2\pi r)$ gives 0.127031 cm in year 50 against the actual 0.126393 cm, a relative difference of 0.005044——width goes roughly inversely with radius.

Observation 2.4

regressing width on year shows a decline.The slope is -3.015146×10^{-3} cm per year, negative——judged by width alone, growth looks better in the past.

3. Even When Growth Increases, Rings Thin

Computation 3.1: with growth rising by a fifth over 100 years, years 10 and 100 were set side by side.

year	ring width	added area
10	0.289075 cm	10.200000 cm^2
100	0.102152 cm	12.000000 cm^2

Observation 3.2

this is the core: even when growth increases, rings thin.From year 10 to year 100 the added area rose 1.176471 times while width fell to 0.353377——width and growth point in opposite directions.

4. The Separator

> **Observation 4.1**
>
> **the separator is whether growth is measured by width (a length along the radius) or by increase in cross-sectional area.Area increase copies growth directly; width copies growth divided by radius——“the rings thinned” does not say whether growth slowed.**

> **Observation 4.2**
>
> **beside Paper 656.Paper 656 read otolith ring width as growth rate and showed the age clock stopping once width fell below resolution——here, with the same area added, width shrinks inversely with radius, so width is not growth rate itself. Reading width, or reading area.**

> **Observation 4.3**
>
> **what is not said.The stem is a circle, growth is a set value, and physiology, climate and real data are not treated——what is shown is that width and growth can disagree even in direction.**

5. Roll Call and Closing

1. **width 1.045263 cm in year 1** (Computation 2.1): **the start.**
2. **0.126393 cm in year 50** (Computation 2.1): **thinning.**
3. **0.089289 cm in year 100** (Computation 2.1): **thinner still.**
4. **area 10.000000 cm^2** (Computation 2.1): **steady growth.**
5. **0.085423 of year 1** (Observation 2.2): **a longer circumference.**
6. **approximation 0.127031 cm** (Observation 2.3): **inverse to radius.**
7. **a negative slope** (Observation 2.4): **an apparent decline.**
8. **area 1.176471 times** (Computation 3.1): **growth rises.**
9. **width 0.353377** (Observation 3.2): **the core.**
10. **width or area increase** (Observation 4.1): **the separator; Paper 656.**

Closing: **Tree rings thin even when growth holds steady, so a thinning ring does not mean slowing growth.From a radius of 1 cm, adding 10.0 cm^2 of cross-section a year, ring width goes 1.045263 cm in year 1, 0.126393 cm in year 50 and 0.089289 cm in year 100, which is 0.085423 of the first——the area added stays 10.000000 cm^2; what thinned was the spreading of that area over a longer circumference.Regressing width on year gives a negative slope, as if growth had been better in the past.Even with growth rising by a fifth over 100 years, from year 10 to year 100 the added area grows 1.176471 times while width falls to 0.353377——width and growth point in opposite directions.The separator is whether growth is measured by width or by increase in cross-sectional area.Placed among the earlier papers——Paper 656 read ring width as growth rate and showed the limit of seeing it; this counts that width is not growth itself.To be honest——the stem is a circle, growth is a set value, and physiology, climate and real data are not treated.**

References

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