A Latest Rapid Non-destructive Tool to Measure Annual Rings of Living Camellias in Zhejiang Province China

Jiyuan Li[1*], Sui Ni[2], Hui Wu[1, 2], Deshou Pan[3]*

1. Research Institute of Subtropical Forestry, Chinese Academy of Forestry, Hangzhou, Zhejiang 311400, P. R. China
2. Ningbo University, Ningbo, Zhejiang 315211, P. R. China
3. Anji Conservation Center for Wild animals and Plants, Anji, Zhejiang 313300, P. R. China

Email for Corresponding Authors: jiyuan_li@126.com; 469934848@qq.com

Abstract

This paper introduces the latest, rapid and non-destructive tool to measure living ancient camellia trees. We also analyzed the relationship between growth ring width and temperature and precipitation.

Key Words: living camellia, annual ring, age, measurement, non-destructive

1. Introduction

Ancient and historic camellias are not only regarded as important germplasm resources, but also as local cultural heritage. They are usually planted in villages, temples, and public parks, and naturally distributed in conservation zones and remote mountainous area in China.

According to the recognition standard of China Ancient trees, an Ancient tree must be over 100 years old. However, it is not easy to estimate the age of a living old tree, especially if there is a lack of helpful literature records. Currently, the Increment borer is widely being used to measure age of living trees. Although the borer provides a tool to measure accurately the numbers of year rings in an easy operation, results are low work efficiency and heavy labor. Furthermore, the borer will cause injury to ancient trees to some extent by drilling the trucks in up to 10 mm wide hole. This kind of operation is usually not permitted to some important ancient and historic trees. On the other hand, if the diameter is wider (over 50cm), the borer is not easily operated.

Recently, the author found an instrument could be used to measure growth ring in an automatic record by drilling a very small hole (less than 3mm) and to easily operate. I used the tool to measure some big camellia trees in my institute and presented some results in the international meeting for ancient and historic camellias in October 2019.

2. Material and methods

Four living camellia species trees were planted in the National Camellia and Magnolia germplasm in the Research Institute of Subtropical Forestry, the Chinese Academy of

Forestry in the previous century. They are *Camellia semiserrata*, *C.gigantocarpa*, *C.polyodonta* and *Gordonia acuminata*, but there were no detailed records about their planting year and provenances.

Species	Diameter in South-North(cm)	Diameter in West-East (cm)	Circumference (cm)	Form
Camellia semiserrata	19.03	20.48	58.9	Single trunk
C.gigantocarpa	41.15	43.45	115.8	Branched
C.polyodonta	26.19	26.34	69.8	Single trunk
Gordonia acuminata	26.0	24.26	73.9	Single trunk

The instrument (IML-RESI PD1000) is manufactured by a German company, Instrumenta Mechanik Labor System GmbH (www.iml.de). The IML-RESI PD series of wood detectors can be used in any reliable and stable wood testing experiment. By measuring the drilling resistance of the probe in real time, different curves are presented to detect decay, cavity and insects inside the tree.

The instrument makes resistographs automatically, based on drilling resistance to wood. A peak is formed between early wood and late wood of an annual growth when drilling through a growth ring. In subtropical zone, where there is usually growth during a year period. If we analyze the growth rings, thus we will obtain the numbers of growth rings.

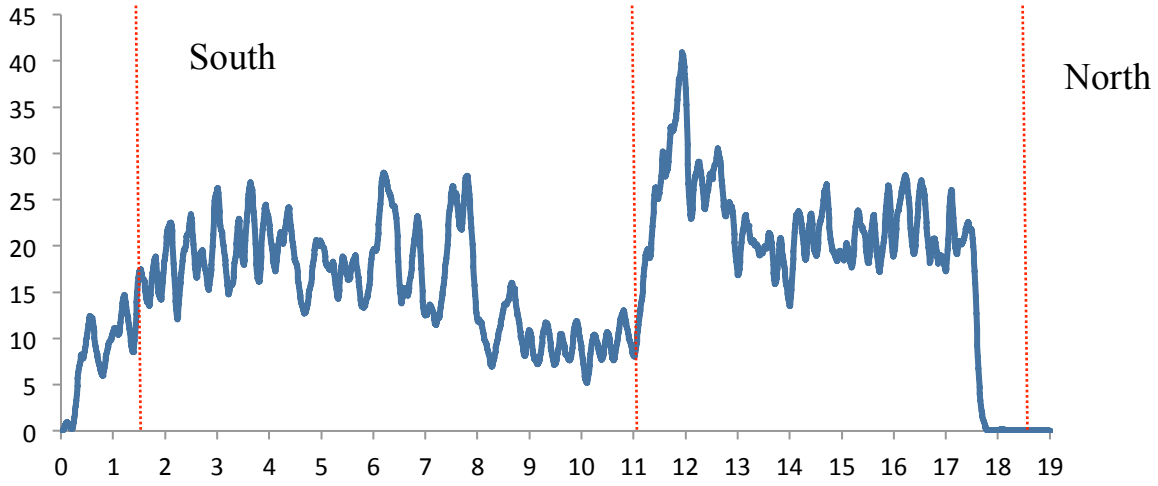
3. Result and analysis

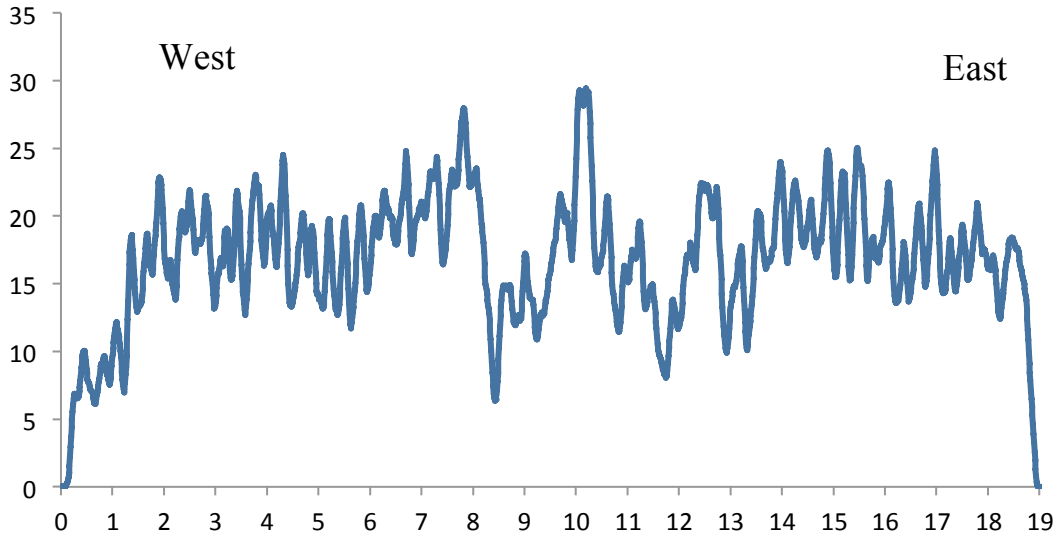
3.1 Analysis of growth rings

3.1.1 *Camellia semiserrata*

Camellia semiserrata naturally grows in Guangdong province of south China, and has been introduced into the national germplasm located in north Zhejiang Province. It blooms through January to March, and is used for ornamental and edible oil.

The resistograph shows that there are 66 growth rings in North-South direction and 67 growth rings in West-East direction. We determined 66 growth rings based on N-S measurement through the whole trunk, therefore the age of the could be 32 years.



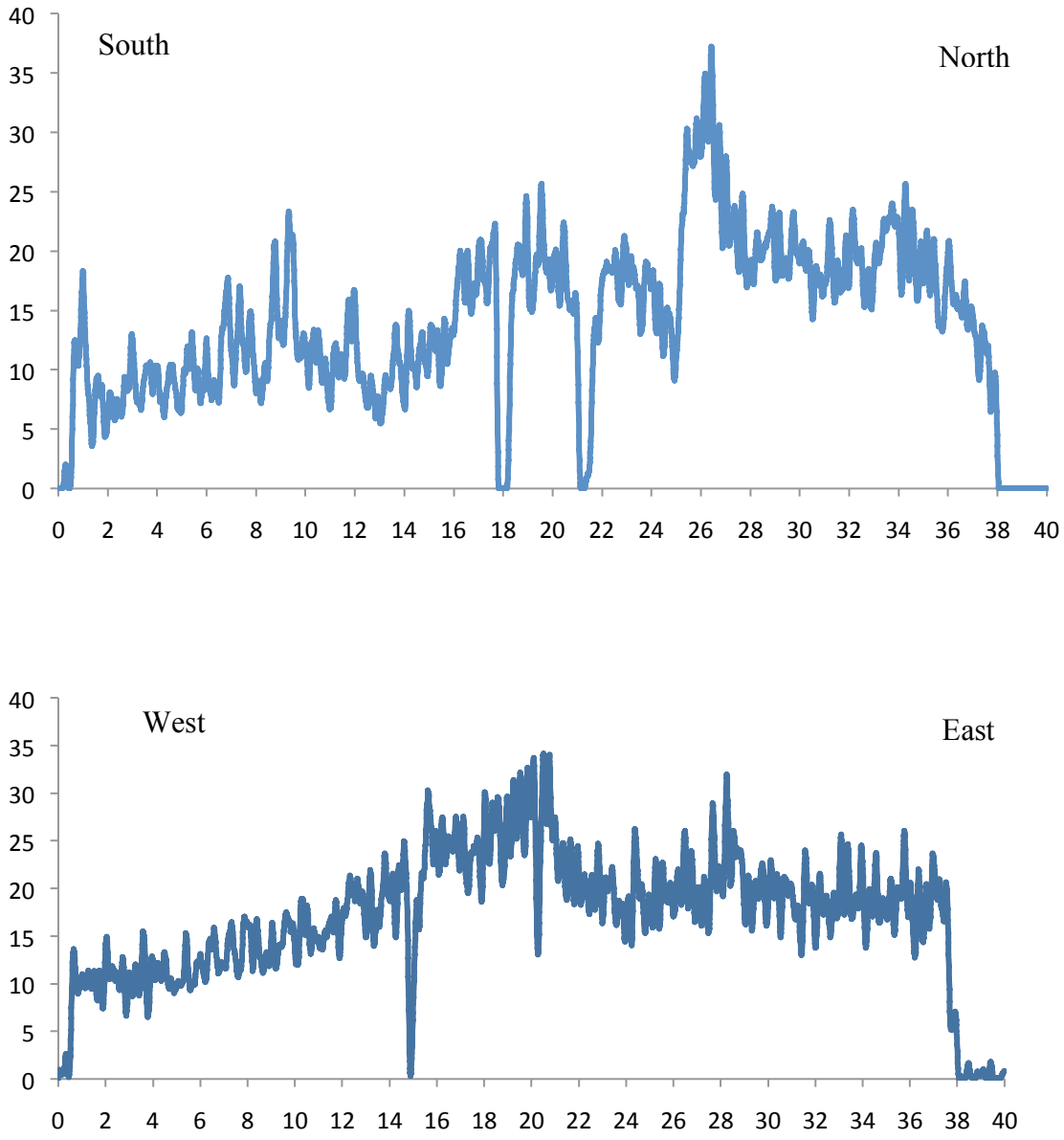


Feed curves for *Camellia semiserrata* Chi

3.1.2 *C.gigantocarpa*

C.gigantocarpa is also naturally distributed in southern Guangdong province of south China, and has been introduced into the national germplasm located in north Zhejiang Province. It blooms through October, and is mainly used for extracting edible oil.

The resistograph shows that there are 122 growth rings both in North-South direction and in West-East direction. We obtained 122 growth rings based on measurements through whole trunk, therefore the age could be 61 years.

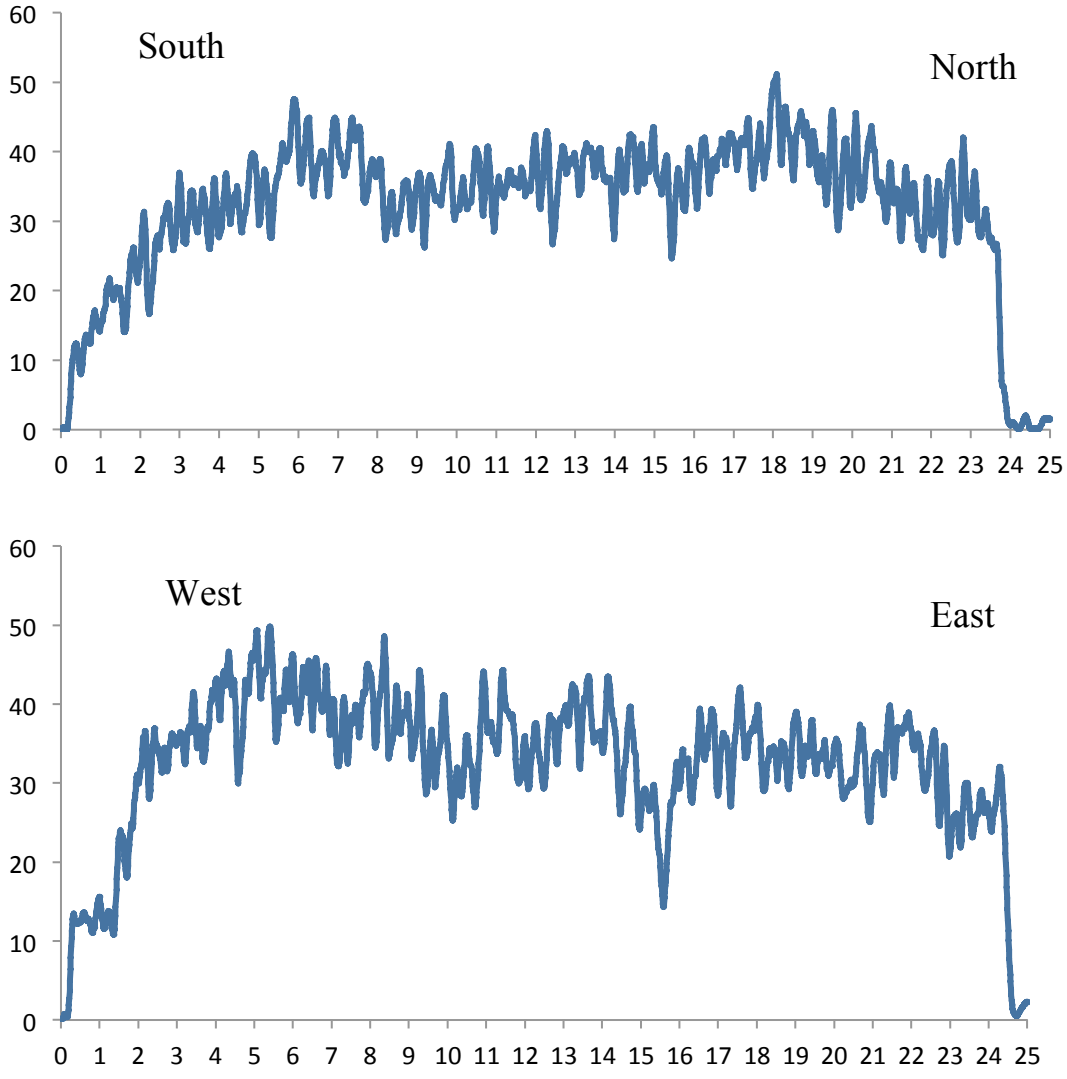


Feed curves for *Camellia gigantoarpa* He et T.C.Huang

3.1.3 *C.polyodonta*

C.polyodonta naturally occurs in Guangdong, Guangxi, and Hunan in south China, and has been introduced into the national germplasm located in north Zhejiang Province. It blooms in spring, and mainly used for ornamental purpose.

The resistograph shows that there are 79 growth rings in N-S direction and 89 rings in West-East direction. We generally used measurement from N-S direction through whole trunk, therefore the age could be 40 years.

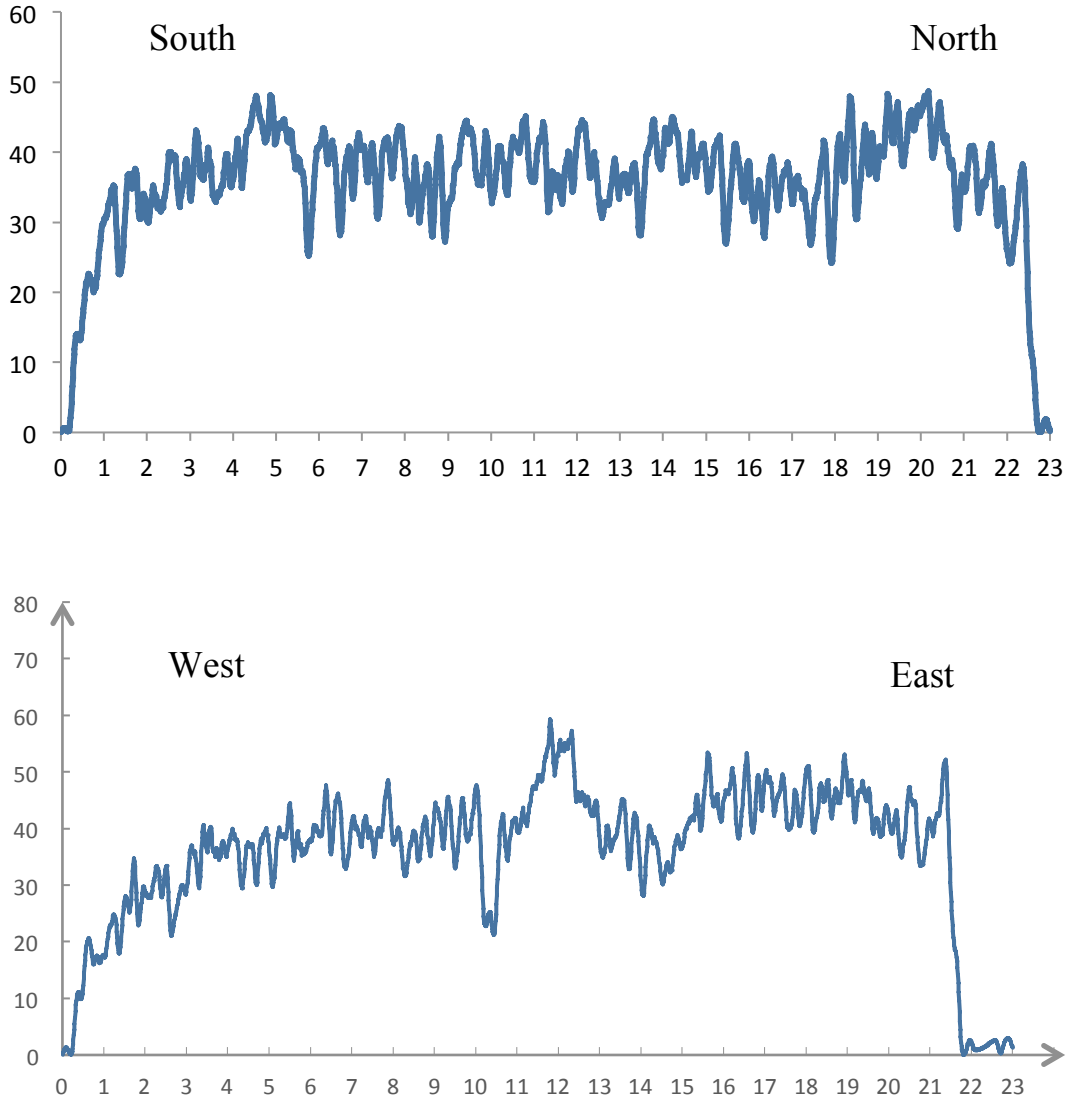


Feed curves for *C.polyodota* How et Hu

3.1.4 *Gordonia acuminata*

Gordonia acuminata naturally appears in Sichuan and Chongqing in Southwest China, and has been introduced into the national germplasm located in north Zhejiang Province. It blooms in September through October, and is mainly used for ornamental purpose and furniture production.

The resistograph shows that there are 100 growth rings both in N-S direction and in West-East direction. We easily determined 100 rings as whole trunk, therefore the age could be 50 years.



Feed curves for *Gordonia acuminata* Chang

3.2 Analysis of relationship between diameter growth and major climatic factors

In general, living trees are influenced by climatic factors, especially extreme climatic events, such as extreme temperature and extreme drought. We analyzed the relationship between growth width and three kinds of climatic factors -- average monthly temperature, average monthly coldest temperature, and average monthly precipitation -- using measurements collected from a tree of *Gordonia acuminata* Chang.

3.2.1 Average monthly temperature

The table shows that ring width was less influenced by average monthly temperature through whole growth period from year 1 to year 50. But, if we looked at different grow periods from early stage to mid stage, we obtained some interesting results. The average monthly temperate played a more important role on ring width in second half year. The ring width was much influenced by this kind of climatic factor after 16 years of age, and less in the first 10 years.

Correlation coefficient between average monthly temperature and ring width

Age period	Mar	Aug.	Oct.	Nov.	Dec.
1-50					
1-15		0.5838			
16-30	-0.5581		0.4891		
31-50					0.4846
1-20				-0.4358	
21-50			0.3909		0.3460
1-25	-0.4158	0.3960		-0.4079	
26-50					
5-25					

Note: the blue represents significant difference ($p<0.05$, same in below);
the blank for not significant difference (same in below).

3.2.2 Average monthly coldest temperature

The following table shows that ring width was great influenced by the average monthly coldest temperature in May both in the whole growth period and different growth stages. The higher the coldest temperature was in May, the faster this species grows. But it appears that the older camellia was much influenced by this factor ($p<0.01$, light brown color, same in below).

Age period	May
1-50	0.3026
1-15	0.5492
16-30	0.5166
31-50	
1-20	0.6555
21-50	
1-25	0.5354

26-50	
5-25	0.5444

3.2.3 Average monthly precipitation

Apparently, precipitation played a very important role on camellia diameter growth. There was a significant negative relationship between ring width and average monthly rainfall in Aug. during the whole growth period of 50 years ($p<0.05$). It appears that rainfall in autumn significantly positively influenced the ring width in the first 10 years, the first 20 years, and other different growth stages ($p<0.01$).

Age period	Apr.	May	Jun.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual total	Cumulative Prec. from Sept. to Dec.
1-50				-0.2927						
1-15					0.5569	0.7738			0.6111	
16-30			-0.4824		0.6843		0.5381		0.5927	-0.5119
31-50	0.5469				0.5679	0.4686		0.5392	0.5199	
1-20				-0.4681	0.5838	0.7804			0.7391	0.5130
21-50					0.5765		0.3565	0.4572	0.7299	0.5211
1-25		0.4100			0.5902	0.6518			0.7761	0.5090
26-50					0.5417		0.4001	0.5656	0.7695	0.5352
5-25					0.6250	0.6600			0.7137	0.4752

3. Conclusion

This instrument truly provides a rapid tool to measure annual ring and age of living ancient camellias with non-destructive array. In order to improve its accuracy, we suggest that users should know enough information regarding the diameter growth character of certain living ancient trees in local climatic and soil conditions. On the other hand, users will obtain better measurements to drill through the pith of a trunk both in N-S and W-E although this operation is not easily carried out.

4. Acknowledgements

This work was supported by the National key projects for international scientific and technological innovation cooperation among governments (2016YFE0126100) and the special funds for basic scientific research expenses of public welfare research institutes of the Chinese academy of forestry **(**CAFYBB2017ZF001**)**.