Wood Properties of Three Lesser-Used Species of Tropical Hardwood from Ghana

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Outline

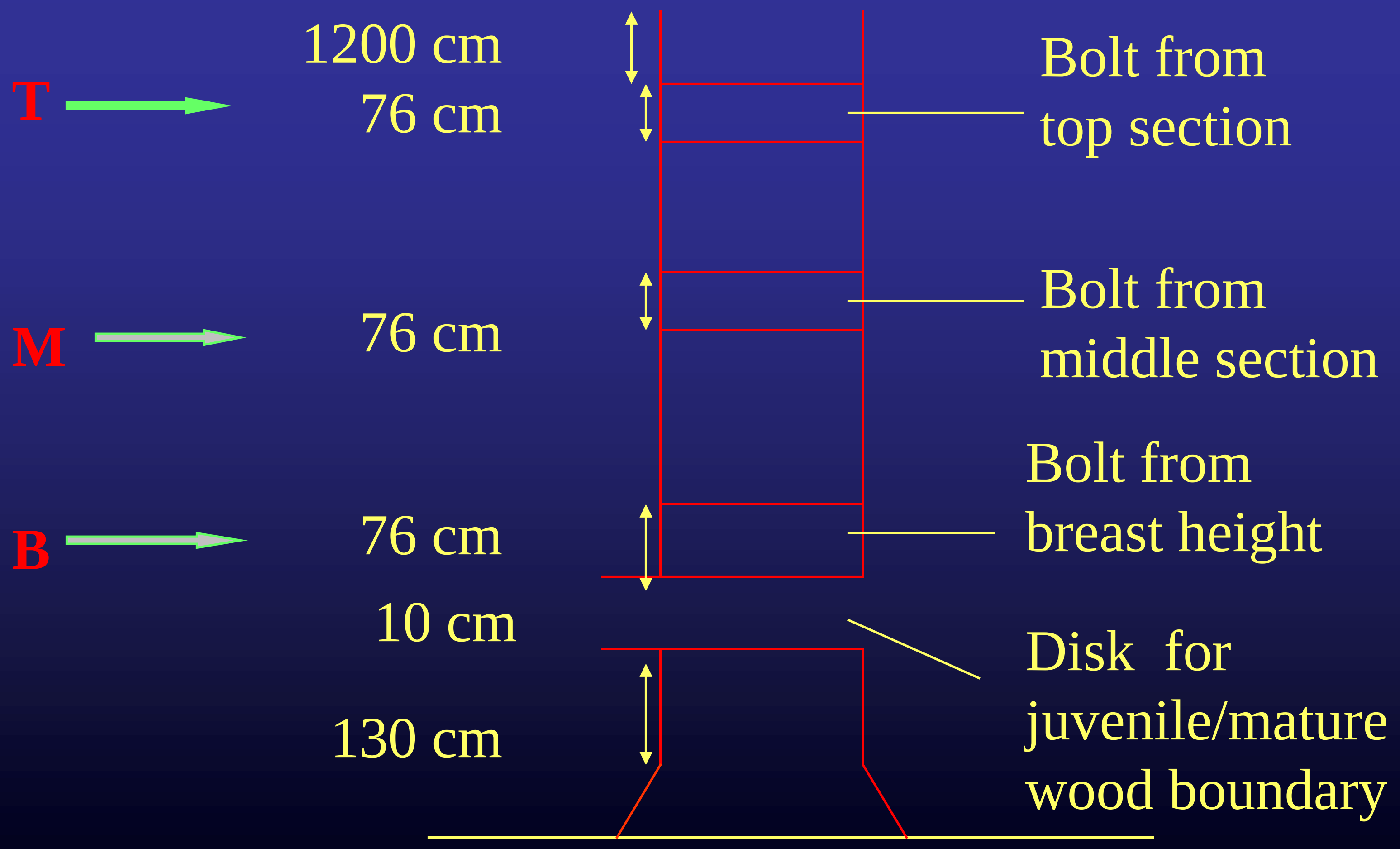
- Background
- Study objective
- Methodology
- Results
- Summary
- Next steps


AFRICA
ALGERIA
LIBYA
EGYPT
MALI
NIGER
CHAD
SUDAN
ETHIOPIA
ATLANTIC
OCEAN
INDIAN
OCEAN
MADAGASCAR
NORTHERN

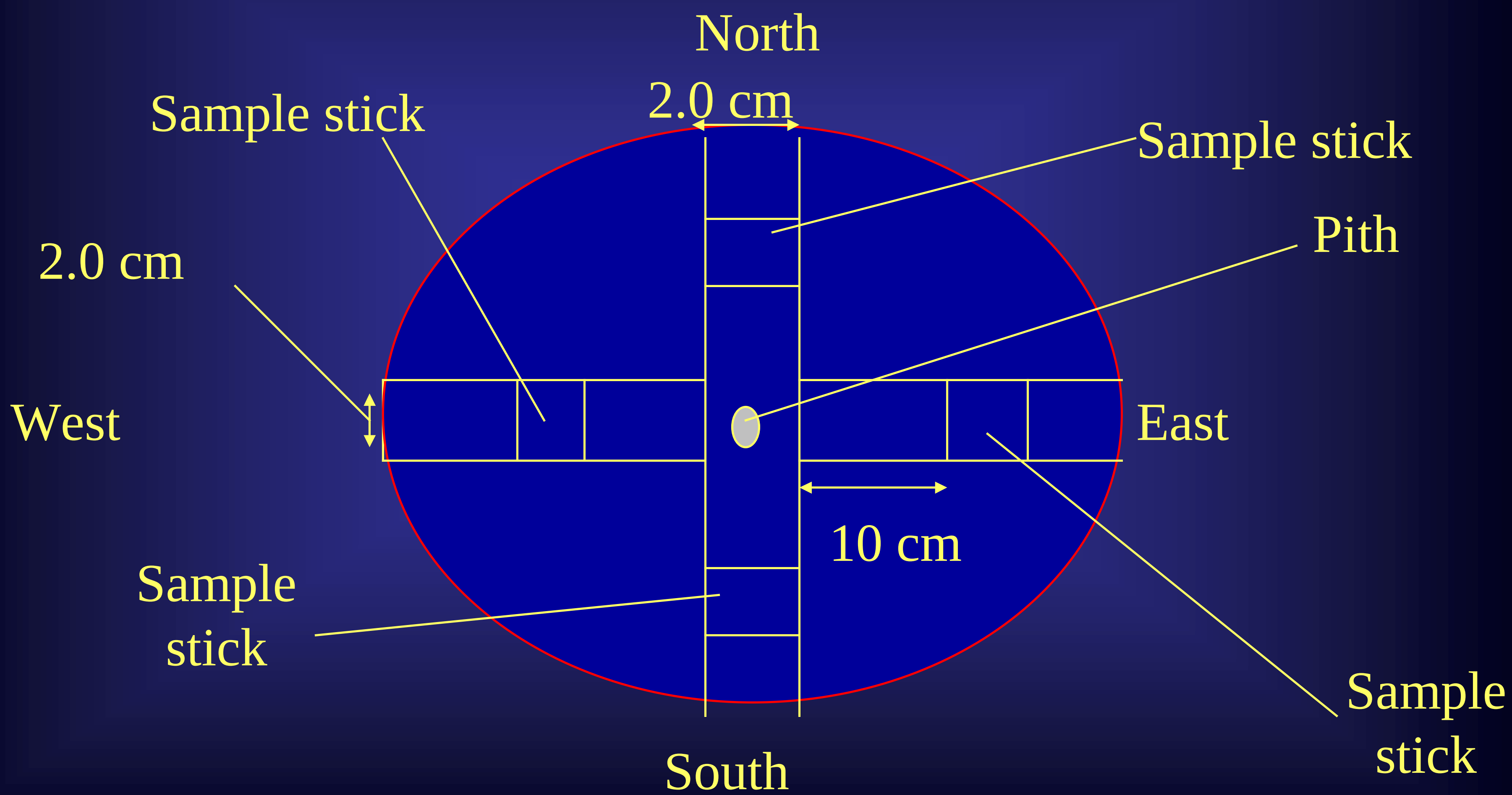
Research Objective

Examine the variation of physical and mechanical properties in the tree stem of three lesser-used species (LUS) from Ghana

Methodology



Cross-Section of Bolt Showing Method of Marking and Cutting Sample Sticks for Physical and Strength Tests



Wood Properties

- Juvenile/mature wood boundary -Fiber length
- Specific gravity
  - Oven dry weight/Vol. X density of H_2o
- Shrinkage
  - % shrinkage = $\frac{\text{decrease in dimension}}{\text{original dimension}} \times 100$

Wood Properties

- Maximum crushing strength
  - Maximum load/cross-sectional area
- Modulus of elasticity
  - Stress/strain

Linear Regression for Fiber Length and Growth Ring for Three LUS from Ghana

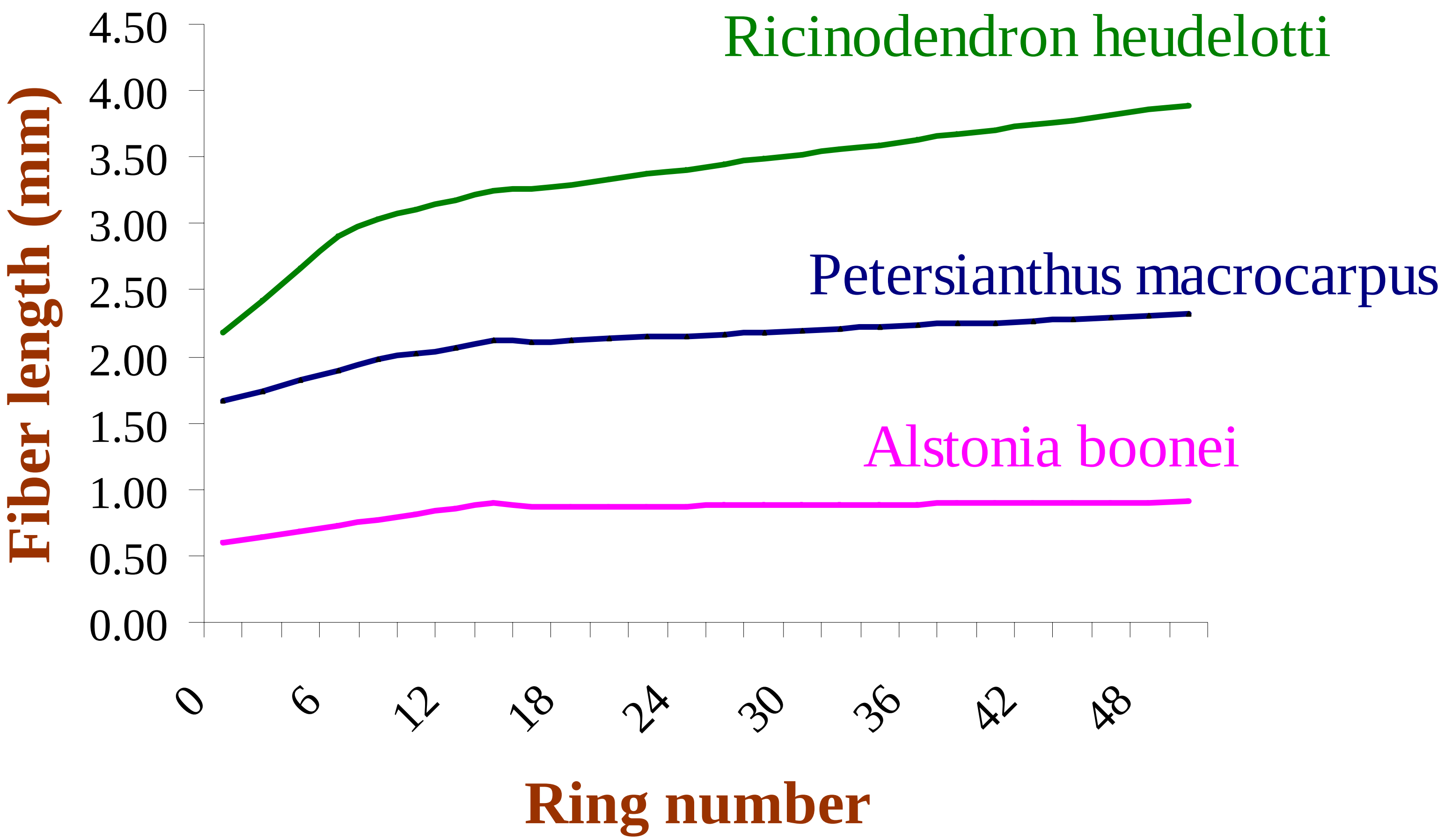
(J- juvenile wood; M- mature wood)

- *Alstonia boonei* J: $Y = 0.597 + 0.0212X$
  M: $Y = 0.846 + 0.0012X$
- *Petersianthus macrocarpus* J: $Y = 1.070 + 0.0175X$
  M: $Y = 1.158 + 0.0051X$
- *Ricinodendron heudelotti* J: $Y = 0.512 + 0.0825X$
  M: $Y = 0.957 + 0.0123X$

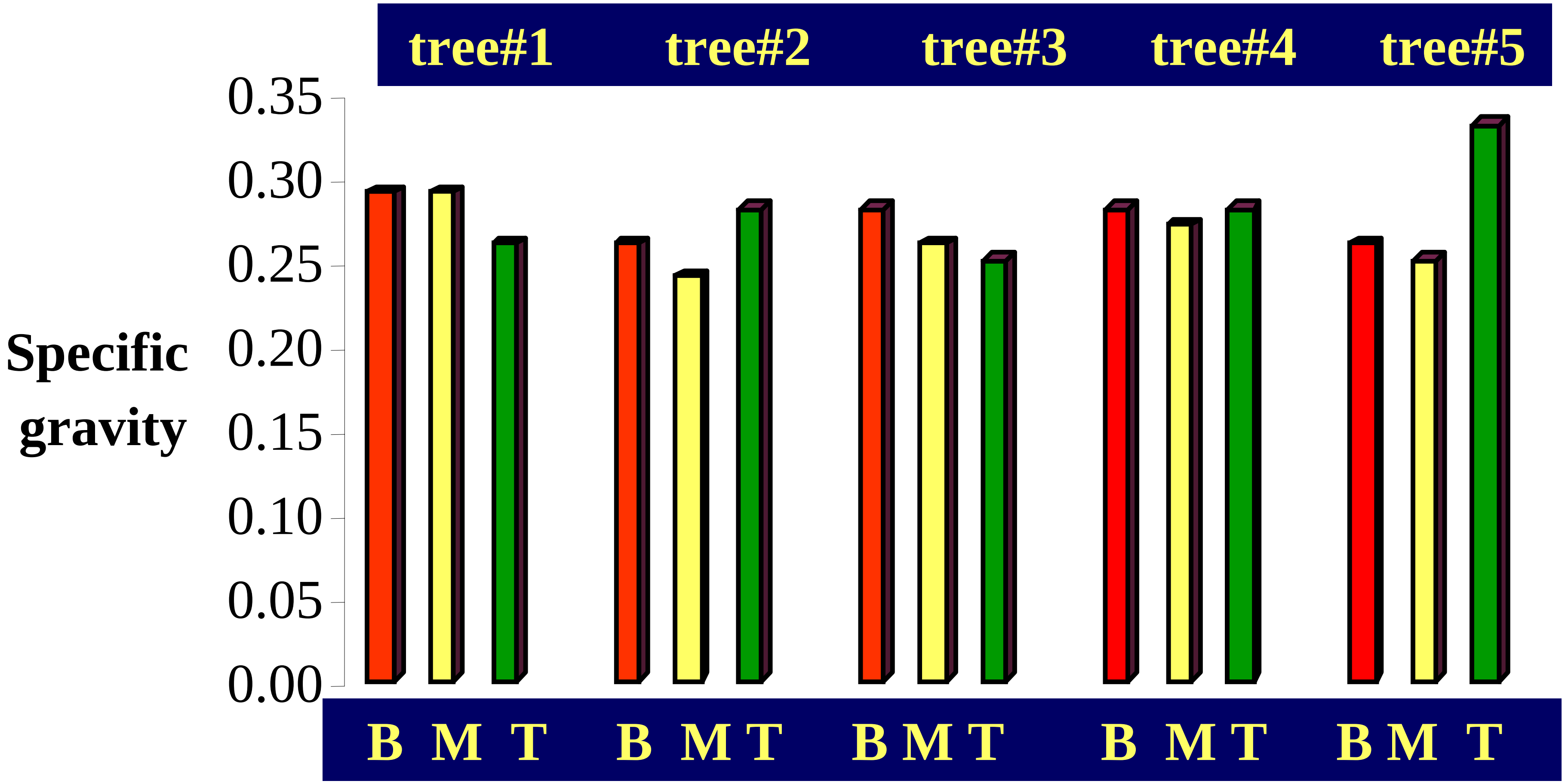
Juvenile -Mature Wood Boundary for Three LUS

Species	*Fiber Length at Boundary (mm)*	*Ring Number at Boundary*	*Boundary Distance from pith (cm)*
A. boonei	0.74	11	5
P. macrocarpus	1.14	6	6
R. heudelotti	0.86	8	5

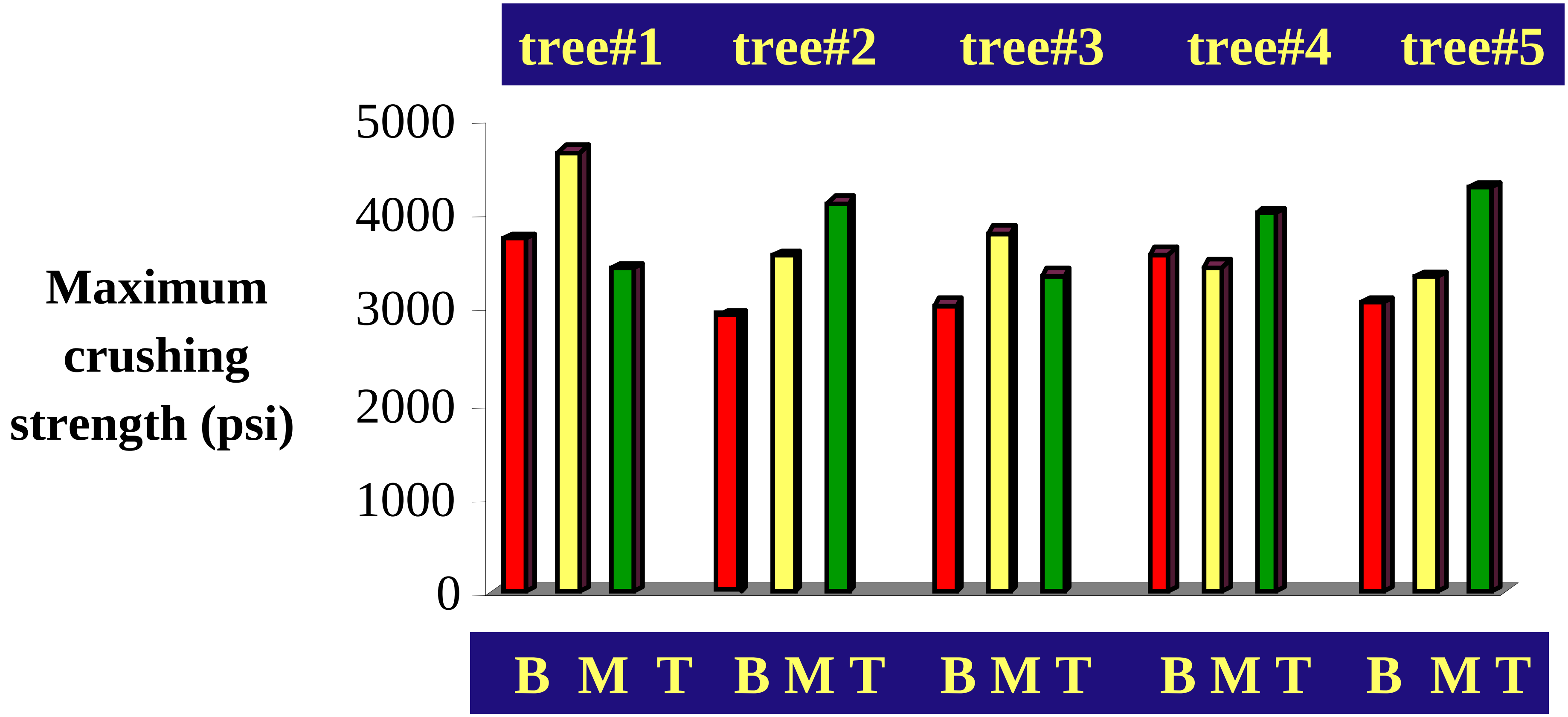
Radial Variation of Fiber Length with Ring Number for Three LUS from Ghana



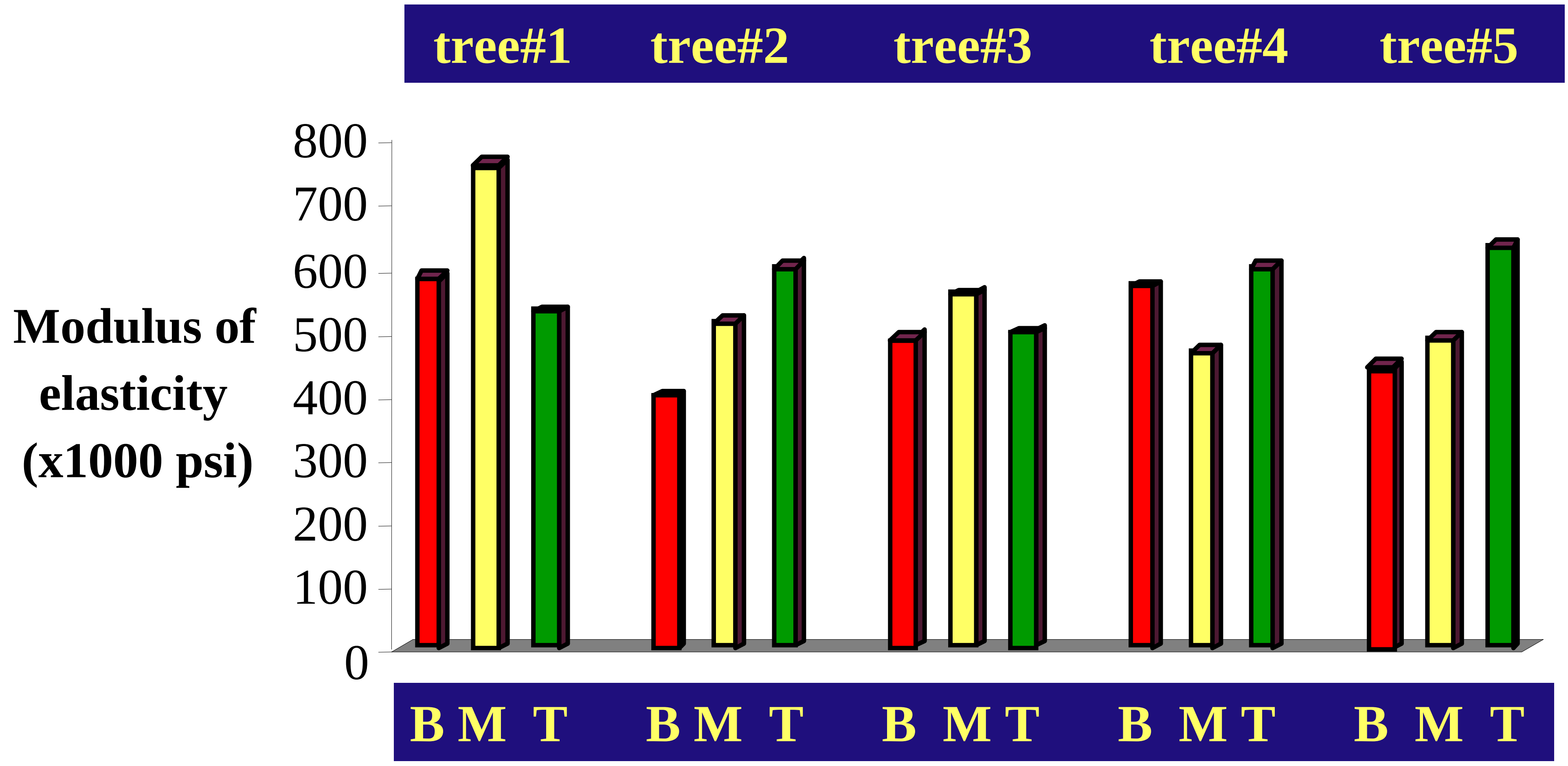
Variation of Specific Gravity within Trees of *R. heudelotti*



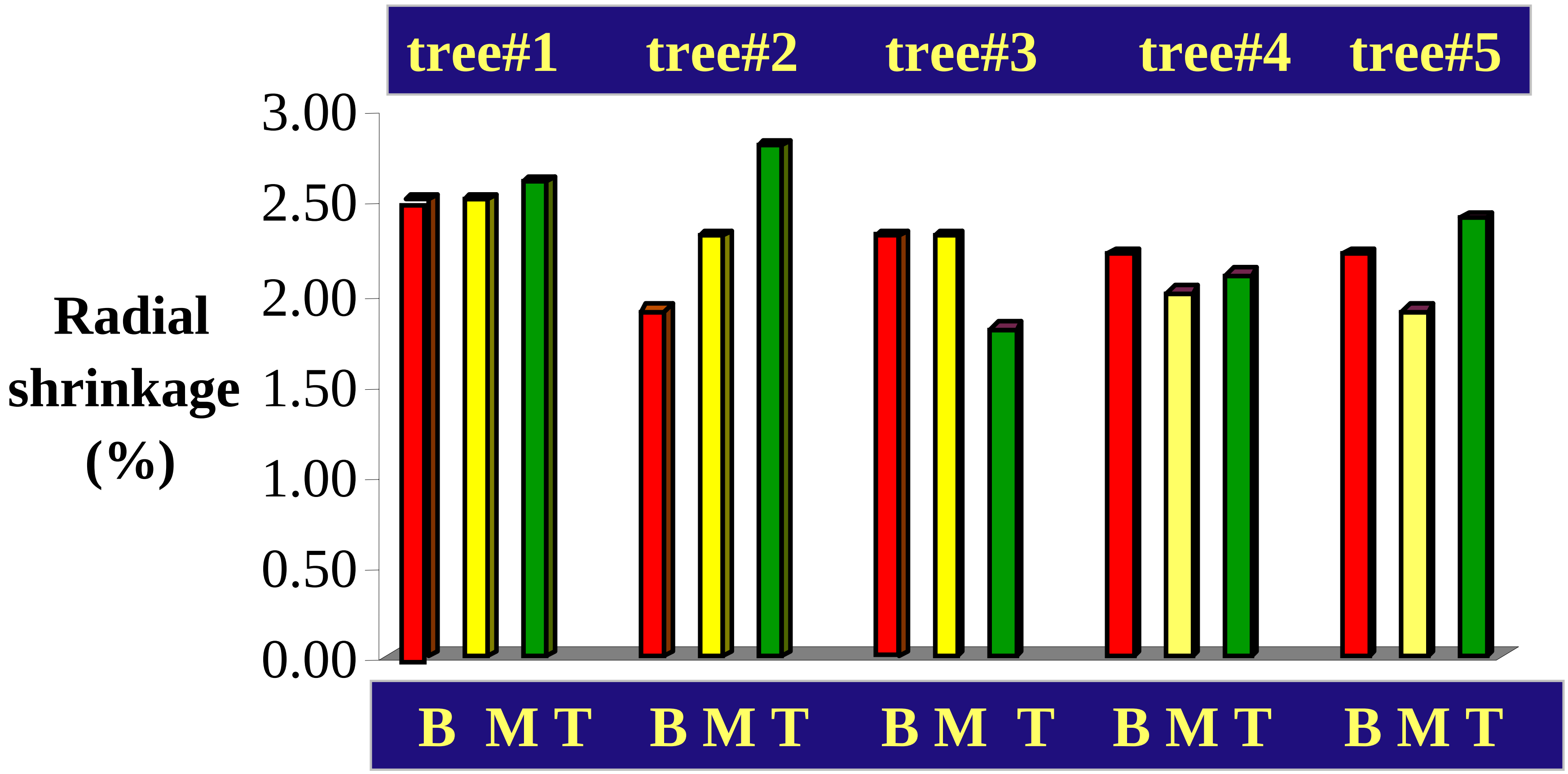
Variation of Maximum Crushing Strength within Trees of *R. heudelotti*



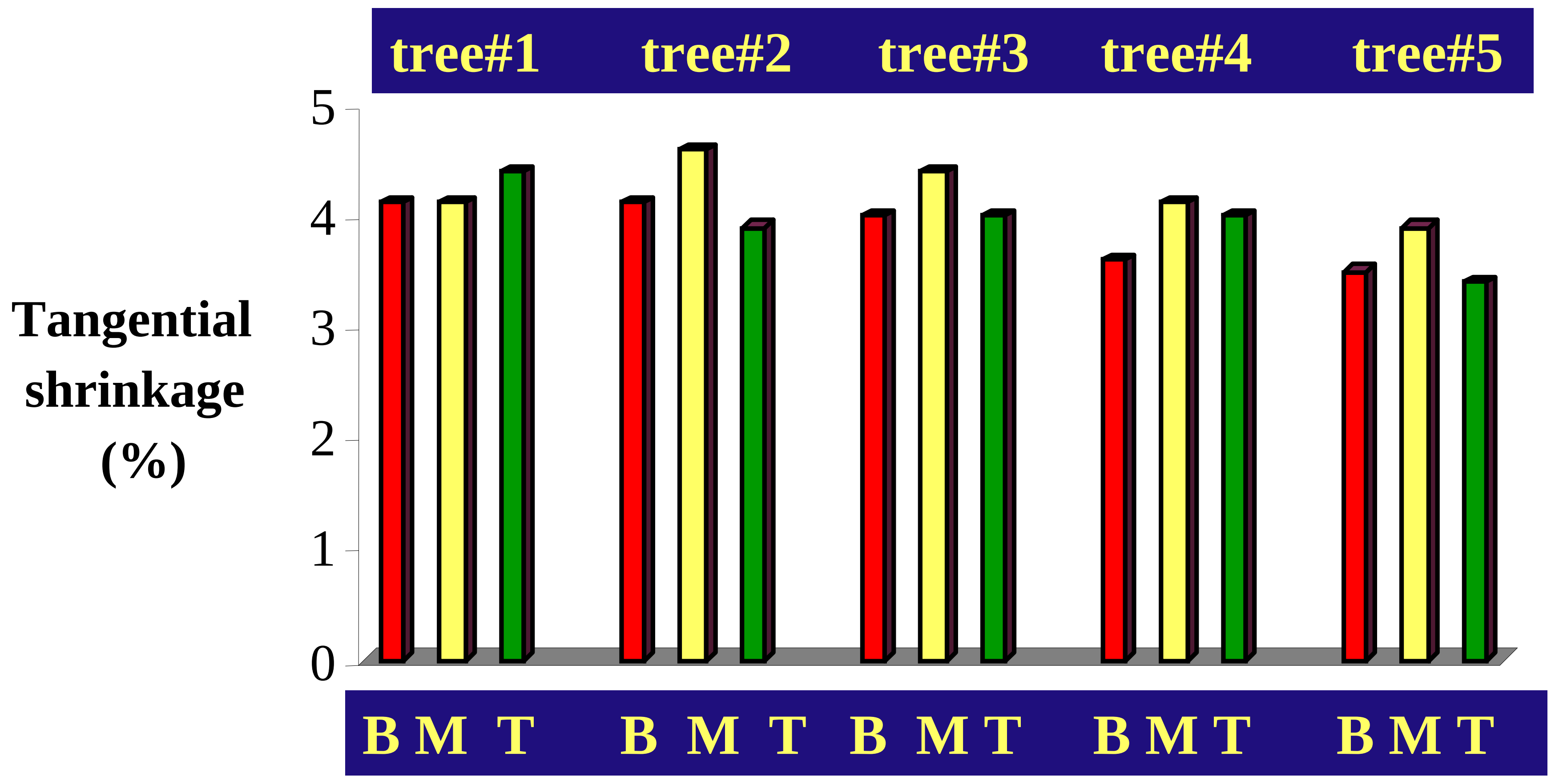
Variation of Modulus of Elasticity within Trees of *R. heudelotti*



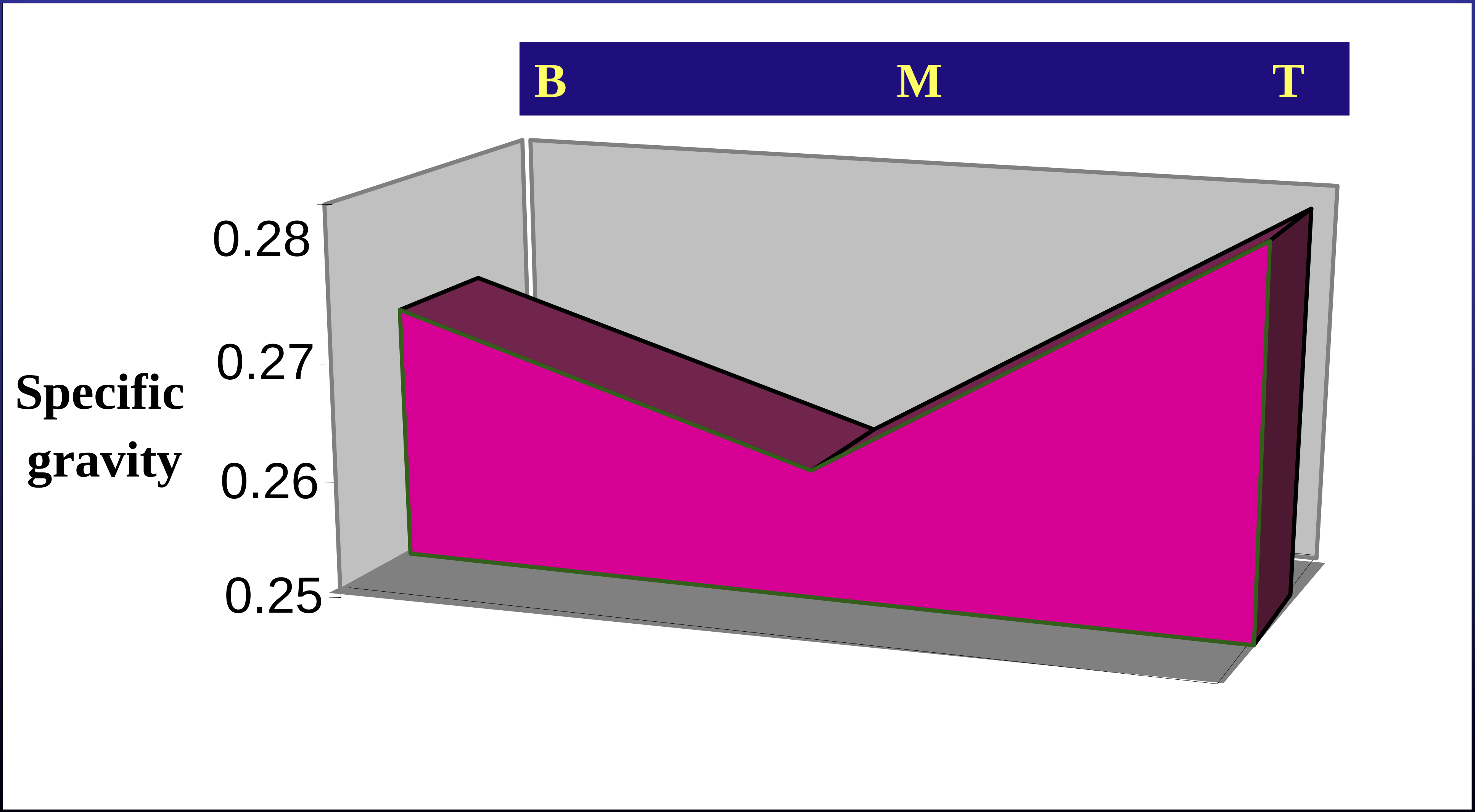
Variation of Radial Shrinkage within Trees of *R. heudelotti*



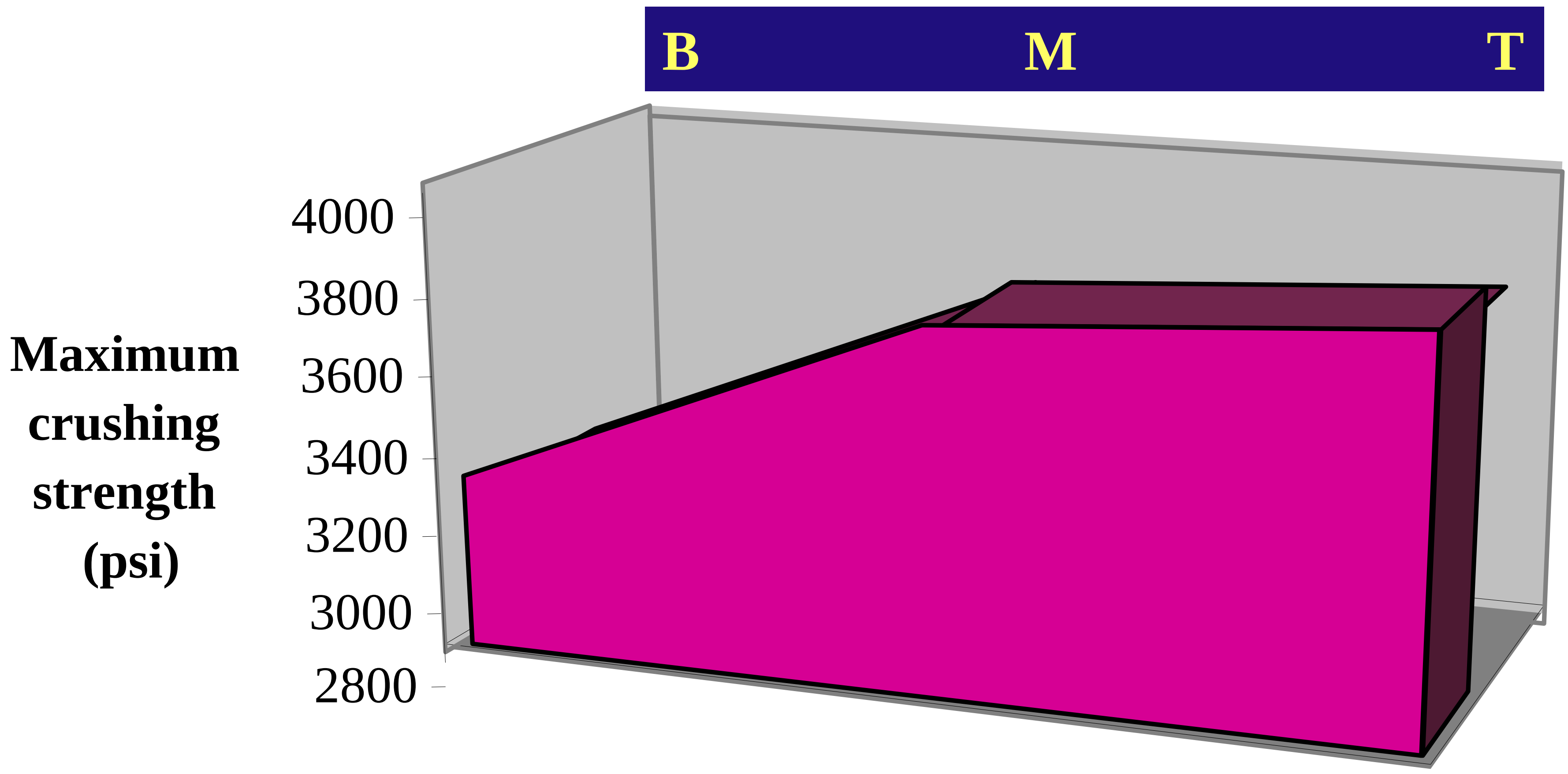
Variation of Tangential Shrinkage within Trees of *R. heudelotti*



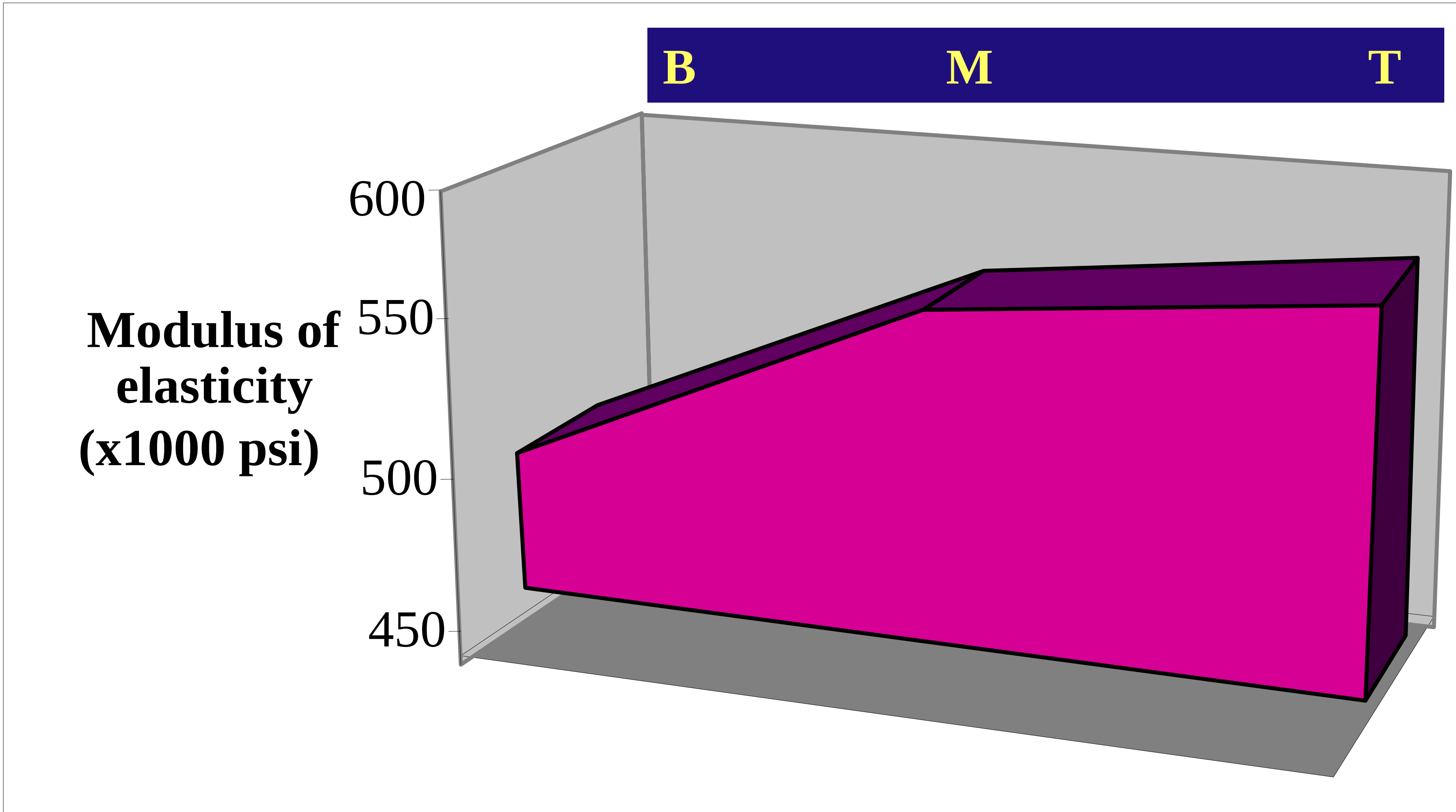
Specific Gravity between Tree Locations for *R. heudelotti* (mean of 5 trees)



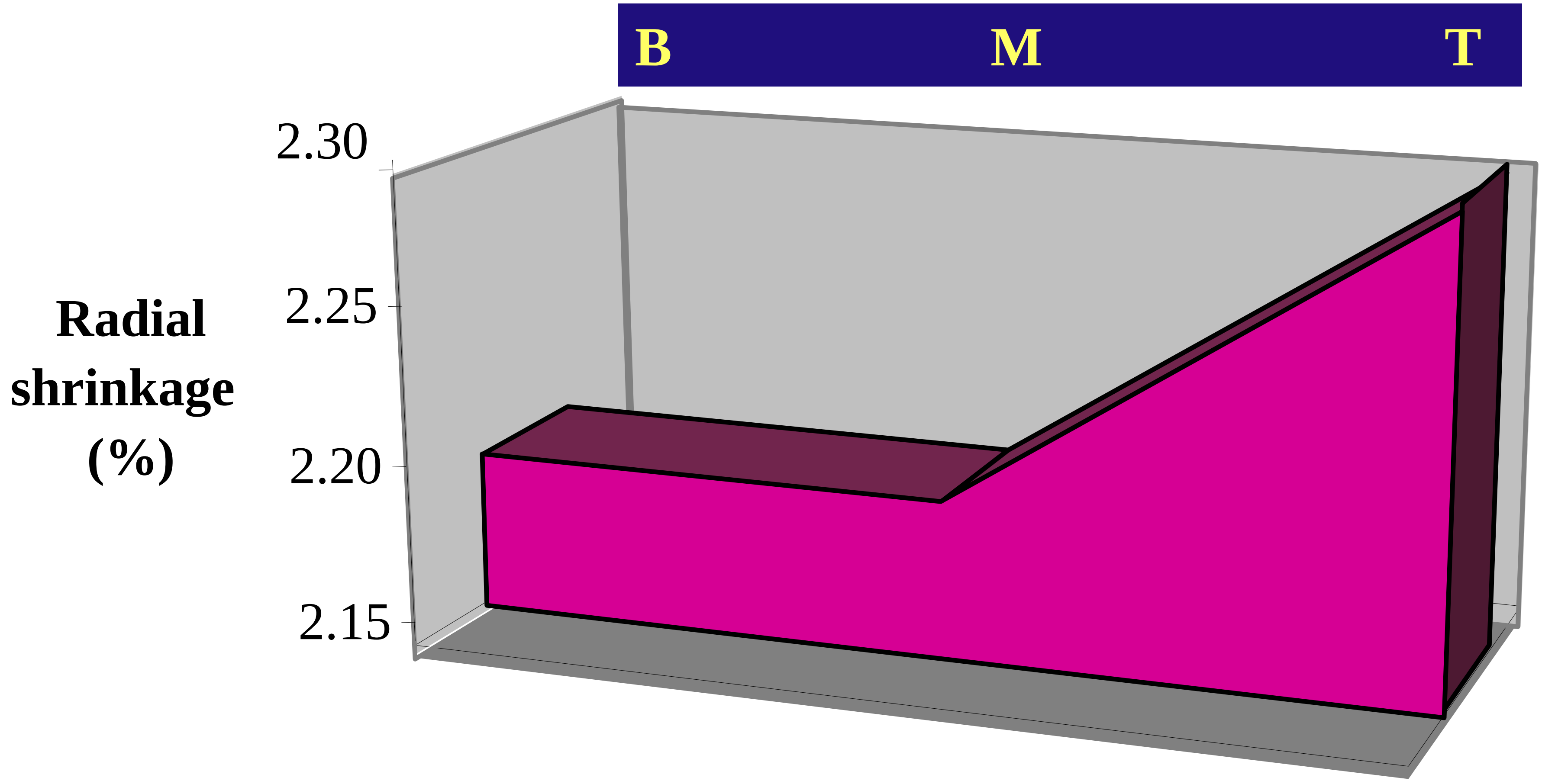
Maximum Crushing Strength between Tree Locations for *R. heudelotti* (mean of 5 trees)



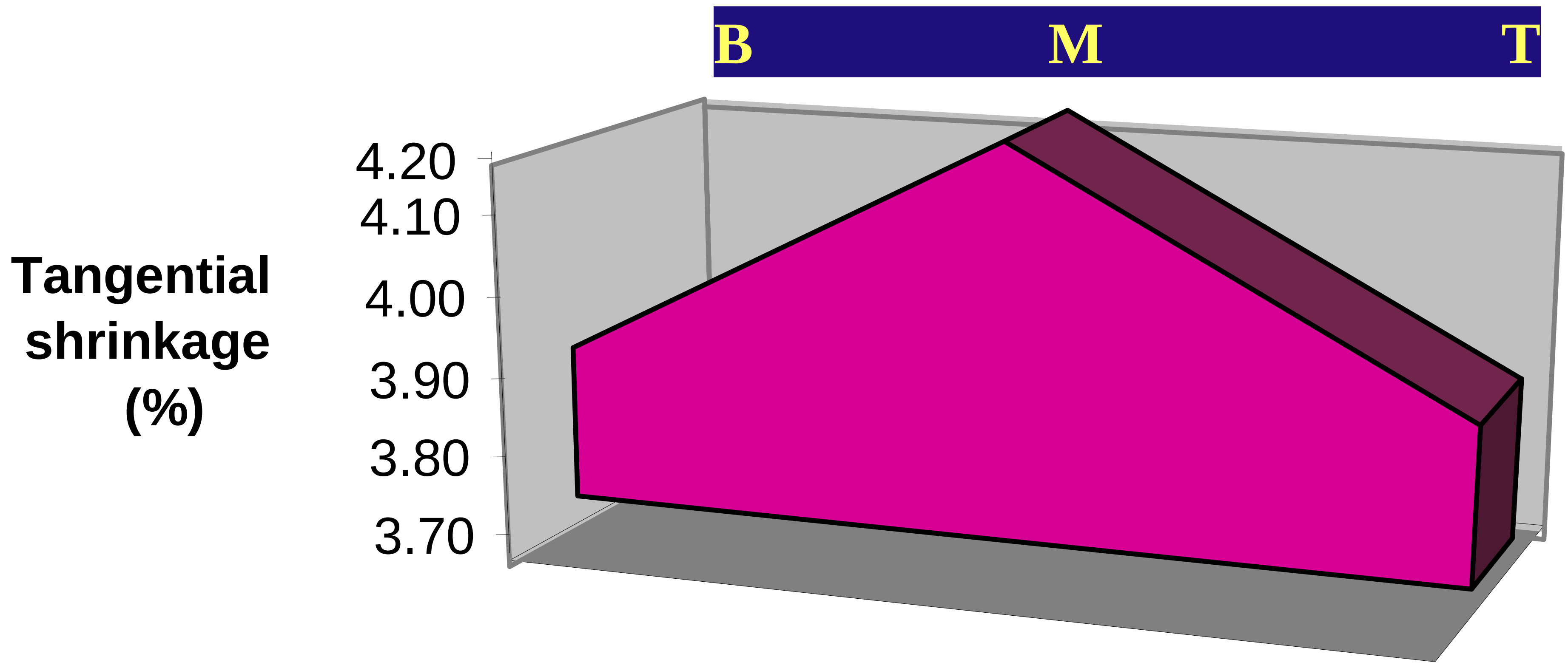
Modulus of Elasticity between Tree Locations for *R. heudelotti* (mean of 5 trees)



Radial Shrinkage between Tree Locations for *R. heudelotti* (mean of 5 trees)



Tangential Shrinkage between Trees of *R. heudelotti* (mean of 5 trees)



Significance Levels for Differences in Wood Properties

ns = not significant

* = significant at 95% probability

** = significant at 99% probability

Differences in Wood Properties between Locations in *A. boonei* (All trees within species combined; n-5 trees)

Wood Properties	*Location*	*Mean Difference/ Significance*
Specific Gravity	B/M	0.02*
*(F = 6.93**)*	B/T	0.03**
	M/T	0.01^{ns}
Maximum Crushing Strength	B/M	499.24**
*(F = 11.00**)*	B/T	28.00^{ns}
	M/T	471.24**

Differences in Wood Properties between Locations in *A. boonei*

Wood Properties	*Location*	*Mean Difference/ Significance*
Modulus of Elasticity	B/M	39.47 ^{ns}
(F = 3.36*)	B/T	59.13*
	M/T	19.66 ^{ns}
Radial Shrinkage	B/M	0.04 ^{ns}
(F = 4.39*)	B/T	0.22*
	M/T	0.22*
Tangential Shrinkage	B/M	0.04 ^{ns}
(F = 0.21 ^{ns})	B/T	0.07 ^{ns}
	M/T	0.07 ^{ns}

Differences in Wood Properties between Locations in *P. macrocarpus* (All trees within species combined; n-3 trees)

Wood Properties	*Location*	*Mean Difference/ Significance*
Specific Gravity	B/M	0.07**
(F = 21.43**)	B/T	0.03**
	M/T	0.41**
Maximum Crushing strength	B/M	2127**
(F = 24.07**)	B/T	1049**
	M/T	1078**

Differences in Wood Properties between Locations in *P. macrocarpus*

Wood Properties	*Location*	*Mean Difference/ Significance*
Modulus of Elasticity	B/M	0.07**
(F = 16.23**)	B/T	0.03**
	M/T	0.04**
Radial Shrinkage	B/M	1.04**
(F = 81.83**)	B/T	1.34**
	M/T	0.29*
Tangential Shrinkage	B/M	1.50*
(F = 11.09**)	B/T	0.81*
	M/T	0.69^{ns}

Differences in Wood Properties between Locations in *R. heudelotti* (All trees within species combined; n-5 trees)

Wood Properties	*Location*	*Mean Difference/ Significance*
Specific Gravity	B/M	0.01^{ns}
(F = 6.96**)	B/T	0.08^{ns}
	M/T	0.02**
Maximum Crushing strength	B/M	496.00**
(F = 38.19**)	B/T	575.00**
	M/T	79.73^{ns}

Differences in Wood Properties between Locations in *R. heudelotti*

Wood Properties	*Location*	*Mean Difference/ Significance*
Modulus of Elasticity	B/M	60.48**
(F = 11.86**)	B/T	75.36**
	M/T	14.88^{ns}
Radial Shrinkage	B/M	0.02^{ns}
(F = 2.07 ^{ns}***)***	B/T	0.13^{ns}
	M/T	0.15^{ns}
Tangential Shrinkage	B/M	0.33**
(F = 6.36**)	B/T	0.06^{ns}
	M/T	0.27*

Correlation of Wood Properties for *R. heudelotti* (n=5 trees)

Wood Properties		*Wood Properties*				
		SP. Grav	*MCS*	*MOE*	*R. shrink*	*T. shrink*
MCS	r	0.546**				
MOE	r	0.515**	0.495**			
R. shrink	r	0.213**	0.180**	0.123 ns		
T. shrink	r	0.344**	0.384**	0.156ns	0.103 ns	
T/R ratio	R	0.070 ns	0.136 ns	0.019 ns	-0.699 **	0.610 **

Comparison of Wood Properties of Three LUS

Species	*Loca-tion*	*Sp. Grav*	*MCS (psi)*	*MOE X 1000 (psi)*	*R. shrink (%)*	*T. shrink*
A. boonei	B	.31	4636	468	2.8	4.4
	M	.33	5135	428	2.8	4.4
	T	.34	4664	408	3.0	4.5
P. macrocar-pus	B	.66	7631	1438	3.2	6.1
	M	.73	9758	1818	4.3	7.6
	T	.69	8680	1557	4.6	6.9
R. heudelotti	B	.27	3261	496	2.2	3.9
	M	.26	3757	555	2.2	4.2
	T	.28	3836	570	2.3	3.9

Summary

- There was no dominant pattern of variation of wood properties within trees of the three LUS.
- Wood properties at breast height, middle and top were generally significantly different from one another.
- Specific gravity correlated positively with strength and shrinkage properties.

Summary

- *Petersianthus macrocarpus* had the highest specific gravity, and shrinkage. It is suitable for rough, heavy construction and for railway sleepers.
- *Ricinodendron heudelotti* had the least specific gravity and shrinkage values. It is suitable for applications which require dimensional stability.

Summary

- Specific gravity for *Alstonia boonei* was in between the other two LUS. It has potential to serve as a substitute for *Triplochiton scleroxylon* (specific gravity 0.33), a mainstay of Ghana's exports.

Next Steps

- Further studies on more tree samples at shorter intervals along the stem
- Other strength properties including bending, tension, nail-holding capacity, etc
- Wood in service
- Evaluation of utilization potential, marketability and performance