SPECIFIC GRAVITY OF *AGATHIS BORNEENSIS* WARB. OF THE KELABIT HIGHLANDS

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ABSTRACT

The dominant tree species, Agathis borneensis *Warb., found in the Kelabit Highlands is large, tall and straight. A study was carried out to evaluate the specific gravity (SG) of its wood. Woods from thirty* A. borneensis *trees were collected from two different locations of the Kelabit Highlands. Sapwood and heartwood specific gravities were determined from thirty cores measuring 5.15mm in diameter The specific gravity of sapwood from Pa' Merario varied from 0.34 to 0.54 and while that of Batu Lawi ranged from 0.31 to 0.45. The SG of sapwood from both sites however averaged at 0.37. For heartwood, the SG ranged from 0.35 to 0.56 and 0.34 to* 0.52*, for cores taken from Pa' Merario and Batu Lawi, respectively The average SG of the heartwood was significantly higher than the sapwood. Variation in SG was due to differences in wood types only SG did not differ significantly between tree characteristics and locations. No correlation was found among SG, diameter at breast height (DBH) and wood types.*

INTRODUCTION

The *Agathis borneensis* Warb. tree is known by a variety of vernacular names in many parts of Malaysia. The native Kelabit call it "Tumu" but generally it is known as "Bindang" in Sarawak (Anderson 1980 and Yii 1995). It is called "Damar Minyak" in Peninsular Malaysia (Whitmore 1972), "Manggilan" in Sabah and "Tulong" in Brunei (Yii 1995). There are also a number of synonym botanical names for this tree species including Agathis alba (Lamk.) Foxw (Anderson 1980) and Agathis damara (Corner 1988).

In Sarawak, *A. borneensis* occurs in mixed dipterocarp and kerangas forests. Anderson (1980) reported the occurrence of *A. borneensis* in both submontane and montane forests or in areas above 610m (2,000ft.). Yii (1995) stated that the upper limit for the distribution of this species is at 1,200m (3,900ft.). It occurs gregariously and is locally abundant in Sarawak, often forming dense and nearly pure stands in many locations.

The timber is light in weight and is classified as softwood, not because the wood is soft but it belongs to a taxonomic group of gymnosperm. The wood is excellent for furniture components, face veneers, joinery works and pattern-making items. Resin is harvested from the tiee for domestic use throughout Sarawak. *A. borneensis* occur in small quantities and thus the export of this species is controlled (STIDC 1987).

SG has served as a good indicator for many desirable properties associated with wood. For instance, SG is a good and reliable measure of wood substance. The higher the SG is, the higher the wood strength. Other properties associated with SG are dimensional stability, natural durability and yield of pulp. Therefore, SG values determines the wide utility of the wood and often undermines the importance of other wood properties. According to Zobel (1989) SG is the only wood characteristics that can be genetically manipulated.

Our study aims at determining the SG of *A. borneensis* which can give an indication on the future use of this valuable species. Currently studies of SG variation among *A. borneensis* occurring at different locations is not available. Attempts were also made to determine whether SG is related to the tree DBH.

MATERIALS AND METHOD

Thirty increment cores of *A. borneensis* were collected at breast height from two different forest locations of the Kelabit Highlands. The samples were taken from several areas around Pa' Merario and Batu Lawi at approximately 1,646m (5,400ft.) and 1,400m (4,560ft.) altitude, respectively Fifteen cores of 5.15mm in diameter were collected from each area. Due to the large size of trees the increment borer could only penetrate up to the heartwood zone. The 30cm length of increment borer could not reach and extract wood from pith zone of the trees. Prior to boring of trees, the DBH and altitude of each tree sample was recorded. Each core was wrapped in plastic, labelled and deposited into plastic bags to avoid dehydration and breakage. The cores were stored at 4^0C until SG detenninations were made. Sapwood and heartwood core samples were obtained. Two specimen cores each measuring 5mm in length were used.

Specimen cores were soaked in water until they sank, then determined its green volume by the water displacement method (ASTM, 1983). Each cores is immersed in beaker containing enough water to completely submerge the cores. The volume of water displaced by the specimen during immersion is the green volume. The volume in cm~ is numerically equal to the weight in grams. The cores were then oven-dried at 103^0C for 24 hours and immediately weighted after drying. The SG was determined on an oven-dry to green volume ratio, as follows;

$$SG = \frac{\text{Oven-dry wt. of core (g)}}{\text{Core green vol. (g)}}$$

The SG values were analysed using the 2 x 2 factorial design ANOVA (Steel and Torrie, 1980). The trees were regarded as sampling unit or replication while the locations and wood types were the source of variation.

The ANOVA was performed using the General Linear Model procedure of SAS, to identify the source of variation in SG values and the presence of any possible interaction effect between forest locations and wood types. Simple correlation coefficients were computed to examine the relationship on the average wood SG values obtained with the tree DBH.

RESULTS AND DISCUSSION

A. borneensis occur as large and emergent trees reaching up to 85m in height and 1.Sm in diameter. Occurring in pure stand or mixed stand, each tree grows upright, bearing small and compact crowns with usually over 80% of its bole being clear of branches. Due to its abundance coupled with its excellent bole form, *A. borneensis* constitutes the main tree species used for building houses in Bario. Since the climatic and environmental conditions of this area is conducive for growth of this particular species, tree plantations can potentially be established to sustain its production both for domestic and commercial uses.

The floristic composition study (Ipor et al. 1996) reported that *A. borneensis* is the most dominant species and the total above ground biomass contributed by this species alone is approximately 50%. The dense stand of this species is particularly notable from the foot of Gunung Buli all the way up to the foot of Batu Lawi. The tree is distinguishable from other species by its bark appearance, bole form and large diameter. Thus it would be appropriate to determine SG values of *A. borneensis* wood that grew in natural and undisturbed forest environments because they can served as a quality index for the overall utility of this valuable species.

The average diameter and SG for *A. borneensis* taken from both sites are summarized in Table 1. The result indicates that although large differences are seen between individual tree diameter, the SG values in the sapwood and heartwood from either sites shows little variation. This suggests that diameter size of the tree did not affect the SG of the species.

The average SG of heartwood is higher in both sites. Generally the average SG values are similar to other reported values (Lee et al. 1979; Chudnoff 1984). The average SG for sapwood is 0.37 for both sites. Small differences (0.01) in the tree SG values of heartwood collected from Pa' Merario and Batu Lawi forest areas. However large differences (0.06 to 0.07) are found between the average SGs of sapwood and heartwood. The high SG values of heartwood reflects the denser wood substance compared to sapwood.

Table 1. Diameter at breast height (DBH) and spenfic gravity ofAgat his borneensis

		SG	
	DBH	Sapwood	Heartwood
Pa' Merario			
Average (cm)	77.1	0.37	0.43
Range - minimum	58.2	0.34	0.35
- maximum	90.0	0.54	*0.56*
SD	9.25	0.049	0.058
CV *(%)*	12.0	13.2	13.5

		SG	
	DBH	Sapwood	Heartwood
Batu Lawi			
Average	95.6	0.37	0.44
Range - minimum	65	0.31	0.34
-maximum	152.1	0.45	0.52
SD	24.07	0.034	0.038
CV *(%)*	25.2	9.1	8.6

The analysis of variance (ANOVA) for SG is presented in Table 2. The analysis indicated that the differences in SG values between the wood type, sapwood and heartwood, was highly significant. SG values was high at the heartwood of the tree and decreases at the sapwood. This suggested that the amount of wood substance, which was mainly made up of tracheid cell wall, in the heartwood was significantly higher than sapwood.

Table 2. Analysis of variance of wood spec fic gravity in Agathis borneensis.

Source	**df**	**ms**	**F**	**Pr>F**
Tree	14	0.00167	0.76	0.7085
Site	1	0.00000	0.00	0.9782
Wood type	1	0.05828	26.39	0.000k
Site xWood type	1	0.00140	0.63	0.4301

The tree-to-tree variation was found to be not significant, suggesting that the SG of each tree was uniform for all trees. The uniformity of the sampled trees may be due to the fact that these individual trees could have originated from a common genetic stock and have been growing under similar conditions in the Kelabit Highlands.

The ANOVA also showed that there was no significant difference in the SG of wood collected from different• forest locations around Pa' Merario and Batu Lawt. This suggested that wood density among different upland locations within the geographic regions of Kelabit Highlands did not vary significantly

The interaction of sites and wood types was also not significant. This indicated that factors such as geographic location in the Kelabit Highlands and the wood type are independent of each other and did not influenced the SG of A. *borneensis* (Table 3).

Table 3. Comparisons of spec flc gravity between site and wood types.

Specific gravity comparison	**df**	**ms**	**F**
Between sites within sapwood	1	0.000653	0.295880 ns
Between sites within heartwood	1	0.000653	0.295880 ns
Between wood types within Pa' Merario	1	0.020803	9.421373 **
Between wood types within Batu Lawi	1	0.038163	17.283340 **

ns - not significant
***- significant at 1% level of probability*

As geographic site was not the source of variation, it was possible to pool the values from the two sites to determine the weighted average of SG in sapwood and heartwood. The SG of *A. borneensis* from the Kelabit Highlands is shown in Table 4.

The pooled SG values varied from 0.32 to 0.54 and 0.36 to 0.56 for sapwood and heartwood, respectively As indicated by coefficient of variation (CV%), the variation of SG values for individual tree was identical or relatively small in both sapwood and heartwood. However the SG variation coefficient was high for DBH. This was due to the sizes of the sampled trees which varied largely.

Table 4. Specific gravity of Agat his borneensis wood in the Kelabit Highlands.

	DBH (cm)	**Sapwood**	**Heartwood**
Weighted average	86.3	0.37	0.43
Range - minimum	58.2	0.32	0.36
- maximum	152.1	0.54	0.56
SD	20.241	0.042	0.049
CV(%)	23.5	11.4	11.4

A possible correlation between SG and tree size was determined. The SG was found to be not related to tree diameter (Table 5). The result implied that tree size did not necessarily affect wood specific gravity in mature *A. borneensis.*

Table 5. Correlation coefficients of tree diameter (DBH) and wood types specific gravity of Agathis borneensis.

Correlation variables	**Correlation coefficients**
DBH vs. Sapwood	0.1115 ns
DBH vs. Heartwood	0. 1435 ns
Sapwood vs. Heartwood.	0.2111 ns

ns - not significant

CONCLUSION

Our study showed that the SG of heartwood is higher than sapwood. Thus, it is advisable that the sapwood is removed first prior to utilizing the wood. In the Kelabit Highlands *A. bornecnsis* are growing under similar environmental conditions and probably controlled by similar genetic material. Tree size of this species seems to have little influence on the wood quality provided that the trees are felled at or above 60cm DBH.

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REFERENCES

ASTM, [1983] *Standard test methods for specific gravity of wood and wood-base materials.* American Society for Testing and Materials D 2395-69, Philadelphia. PA.

Anderson, J.A.R. 11980] *A checklist of the trees of Sarawak.* Forest Department Sarawak.

Chudnoff,m. [1984] *Tropical timbers of the world.* Forest service, USDA. Agriculture handbook No.607.

Ipor, I.B., C.S. Tawan and I. Ismail [1996] *Floristic compositions and structures of Bario.* Unpublished.

Lee, Y.H., Engku Abd. Rahman Chik and Y.P Chu. [1979] *The strength properties of some Malaysian timbers.* Malaysian Forest Service, Trade leaflet No. 34. Forestry Department, Peninsular Malaysia.

Steel, R.G.D. and J.H. Tome. [1980] *Principles and procedures of statistics. A biometrical approach.* McGraw-Hill, Inc.

STIDC [1987] *Manual of Sarawak timbers species.* Sarawak Timber lndustry Development Corporation, Kuching, Sarawak.

Whitmore, IC. [1972] *Tree flora of Malaya. A manual for foresters.* Longmans Malaysia Sdn Bhd.

Yii, P.C. [1995] Araucariaceae. in Soepadmo, E. and KM. Wong, (eds.) *Tree Flora of Sabah and Sarawak.* Forest Research Institute of Malaysia.

Zobel, B.J and J.P van Buijtenen. [1989] *Wood variation. Its causes and control.* Springer-Verlag, Berlin, Heidelberg.

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