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Physical Characteristics and Weight Relationship of *Gigantochloa scortechinii* (Buluh Semantan) 1-, 2- and 3-Year Old Natural Stand Bamboos

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ABSTRACT

Physical characteristics, such as average number of internodes, internode length, culm wall thickness, circumference of internodes, and weight of culm, branch and leaf of 1-, 2- and 3-year old culms were determined. Data were gathered from 47 to 62 of 1-, 2- and 3-year old culms in Kedah, Peninsular Malaysia. Significant linear relationships between weight and solid volume of the bamboo were observed for all the various ages studied. In addition, their corresponding regression equations were also determined. The 3-year old culm had the biggest mean for all the characteristic features, except for the Diameter-breast height (Dbh) and the culm wall thickness at the base. This was followed by the 2-year old culm. Meanwhile, regression of the height and culm weight on the Dbh gave the best regression line for 1 year old culm in terms of its r-squared value of 84 and 86 percent in comparison to the 2 and 3-year old culm.

Keywords: Culm age-internodes, Diameter-breast height (Dbh), weight, volume

INTRODUCTION

Most of Malaysian bamboos are found in logged-over areas and disturbed forests (Burton, 1979; Ng and Mohd Noor, 1980). Out of 50 cultivated and wild bamboo species in the forest, only 14 types of bamboo have been exploited for their culms and shoots (Wong, 1989).

The cottage industries in Malaysia use bamboo on an organized scale. For this purpose, some bamboo species, such as *Gigantochloa scortechinii* (buluh semantan) and *G. wrayi* (buluh beti), have been used in the manufacturing of poultry cages, shade blinds and barbeque sticks, vegetables baskets, incense sticks, and tooth picks (Wong, 1989; Azmy, 1989). In particular, *Gigantochloa scortechinii* (buluh semantan) has been an important bamboo commercial species used in the utilization of bamboo products in the country. In addition, the culms can be used to produce high value-added products such as laminated panelling for parquets and furniture.

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It is important to note that bamboos vary considerably in size, depending on their species, locality and vigour of the clump (Krishnaswamy, 1956). Meanwhile, certain attributes, such as stem size and wall thickness, influence the range of their usage (Wong, 1982). The strength, straightness, lightness combined with hardness, variation in size, ease with which they can be propagated and the short period taken to mature and the available for harvesting have rendered bamboos immense uses (Sharma, 1982).

The anatomical structure of a bamboo culm determines its properties and assesses the characteristics of the culm in relation to its end product (Abd. Latif, 2001). The anatomical properties are insignificantly correlated with the age and height of culm (Abd. Latif, 1993). For instance, the growth towards the maturation stage of *Gigantochloa scortechinii* began at the age of 3.5 years and above (Norul Hisham *et al*., 2006).

A study on the physical characteristics and weight relationship of *Gigantochloa scortechinii* (buluh semantan), based on various age levels, has not been reported in Peninsular Malaysia. Therefore, this study is an attempt to give comprehensive information on the characteristic qualities of the most important natural stand bamboos in Peninsular Malaysia for cottage and commercial industries references. Additionally, using regression techniques, the weight-volume relationships were also determined based on various ages.

MATERIALS AND METHODS

The study was conducted in north Peninsular Malaysia, whereby culms of 3 various ages were selected, namely 55 culms of 1 year old, 47 culms of 2 year old and 62 culms of 3 year old, taken from Nami, located in Kedah, Peninsular Malaysia (see *Fig. 1*). The culm age of *Gigantochloa scortechinii* was determined by tagging it four years earlier at an experimental area during the shoot's sprouting stage. The required data were gathered from the freshly harvested culms: (1) for each whole culm, the circumferences of the node and the internode were measured from the base upward at an interval of five nodes; (2) the length of each internode was also measured from the base upward and the number of internodes was noted for all the culms in each age; (3) the culm's wall thicknesses of the base and apex were measured using a vernier caliper to the nearest tenth of a centimetre. The average culm wall thickness on all four directions and the average Dbh were also determined. The Dbh was determined at 1.3m above the ground.

For each age, the culms were cut into four equal sections, and these are 0 to 25, 25 to 50, 50 to 75, and 75 to 100% of the whole culm. The culm wall thickness, fresh weight and solid volume were determined from each section. The culms were cut into four equal sections to determine them to the nearest estimate of the culm wall thickness. In addition, the branch and leaf weight of each culm were also measured. The solid volume of each equal section was computed using the formula by Tandug and Torres (1985). The formula is given below:

$$V = \frac{(A1 - A2) + (a1 - a2)}{2} \times L$$

where

V = solid volume of each section of the culm (cm^3);
A1 = area of the large end of the section (cm^2);
A2 = area of the large end of the hollow portion (cm^2);
a1 = area of the small end of the section (cm^2);
a2 = area of the small end of the hollow portion (cm^2);
L = length of the section (cm).

The total green weight (kg) was derived by summing up the values obtained for each section. Meanwhile, the total volume and weight for each culm were determined and used in the fitted regression. The branch and leaf weight of each culm were also measured according to each age. The culms were harvested during the dry season and the green weight was recorded in the forest.

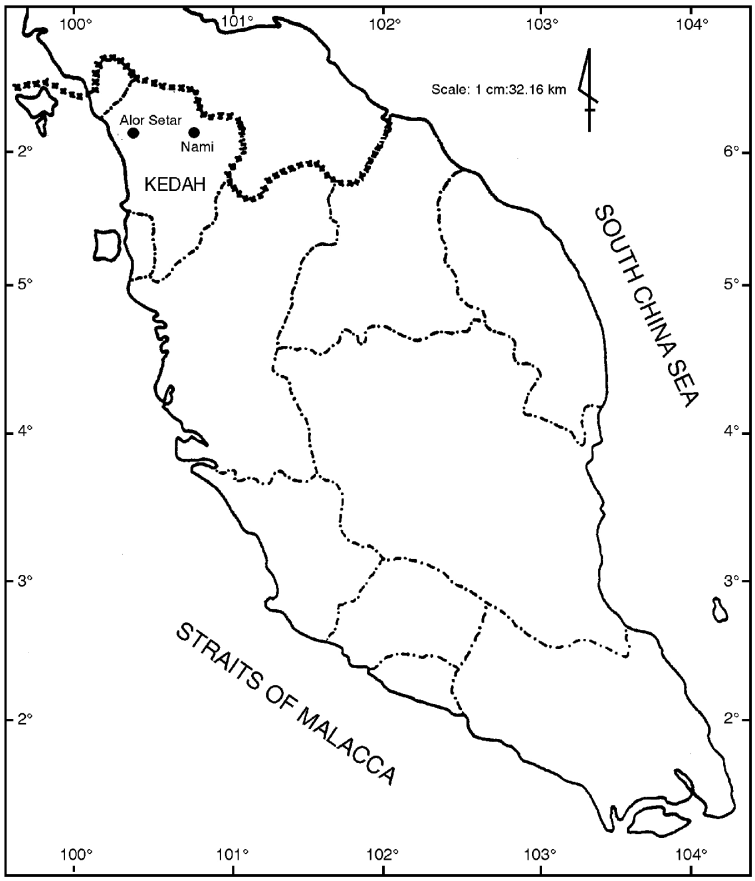

Fig. 1: Location map of study

RESULTS AND DISCUSSION

Measurement Attributes

1 year old culms

55 culms of 1 year old *G. scortechinii* that were gathered for the study had the mean culm lengths ranging from 11.5 to 13.9 m, as depicted in Table 1. The average internode was 33.8 cm, with the shortest at both ends (apex and base) and the longest in the middle. A normal culm of the 1 year old had relatively thick walls all throughout and become gradually thinner towards the top. The thickest section was located at the base, and this ranged from 0.4 to 0.7 mm (Table 1). It was large at the base and gradually tapered towards the top. The mean Dbh was 9.5 cm, while the mean culm wall thickness at the base was 0.4 mm. The mean culm length and the mean number of internodes were 11.5 m and 33.3 cm, respectively. In addition, the mean average internode length and the mean average circumference were 33.8 and 4.7 cm, respectively. The mean culm weight was 10.7 kg, while the mean branch and leaf weight were 0.7 and 1.1 kg, respectively (Table 2).

2 year old culms

47 culms selected in this study had a mean length of 12.3 m (Table 1). The mean number of the internodes was 35.1 cm whereas their

TABLE 1
The physical characteristics of *Gigantochloa scortechinii* culm (1- 3 year old)

Year	No. of samples	Culm length (m)		No. of internodes (cm)		Average internode length (cm)		Average circumference of internodes (cm)		Dbh (cm)		Culm wall thickness at base (mm)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	55	11.5	2.0	33.3	3.5	33.8	2.5	4.7	1.2	9.5	1.8	0.4	0.3
2	47	12.3	1.9	35.1	3.3	35.3	2.9	5.3	1.14	10.0	1.4	0.5	0.4
3	62	13.9	1.6	35.6	2.9	37.2	2.5	5.7	1.1	10.2	1.2	0.7	0.6

mean average internode length was 35.3 cm. Meanwhile, the mean average circumference of the internodes was 5.3 cm. The mean Dbh and culm wall thickness at the base were 10 cm and 0.5 mm, respectively. The 2 year old culms had a mean weight of 13.2 kg, and this was found to be 0.8 kg for the branch and 1.9 kg for the leaf (Table 2). Its standing culm does not have any culm sheath available. As presented in Table 2, the mean volume for the 2 year old culm was 177.2 cm^3.

3 year old culms

Sixty two samples of the culms had a mean length of 13.9 m. From Table 1, all the mean physical characteristics of the 3 year old culms tended to be higher than those of the 1 and 2 year old culms. Apparently, the mean volume for the 3 year old culms was greater than the culms of other ages, i.e. 219.1 cm^3 (*see* Table 2).

Measurement Attributes of Natural Stand Bamboos According to Age

The measurement attributes of the natural stand bamboos undertaken in this study were determined according to their various ages of 1, 2, and 3 years and above. A simple linear regression was used to retrieve the relationship between heights versus Dbh. From Table 3, it was observed that the linear regression equation for the one year old culms gave the best equation in terms of the correlation coefficient of 84 percent of its r-squared compared to the 2 and 3 year old culms with merely 77 percent and 76 percent, respectively. On the contrary, the 3 year old culms gave a poor coefficient of correlation. The regression of height versus Dbh was significant for all the culms of the 3 years covered, except for the 3 year old culms whereby they had a significant value of 1.981 at 0.05 level (*see* Table 3).

Meanwhile, the regression equation of the culm weight versus Dbh for the 1 year old also gave the best equation, as presented in Table 4, with 86 percent of its r-squared. The 3 year old culms, once again, gave the lowest value for 79 percent of their r-square. All the regressions were found to be significant for the culms of 1, 2, and 3 year old and above. The T-values were 13.0, 74.3 and 62.5, respectively. Thus, it was significant at 0.05 level.

TABLE 2
Volume and weight of *Gigantochloa scortechinii* culm (1-3 year old)

Year	No. of samples	Weight of culm (kg)		Branch weight (kg)		Leaf weight (kg)		Volume (cm^3)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	55	10.7	2.6	0.7	1.0	1.1	0.7	147.5	10.0
2	47	13.2	2.7	0.8	0.7	1.9	0.9	177.2	11.0
3	62	15.8	2.8	0.9	0.8	2.03	1.03	219.1	9.7

TABLE 3
The regression equations of the height on Dbh for 1, 2 and 3 year old *Gigantochloa scortechinii* culms

Year	Y = a + bx	r^2 (%)	T values
1	Y= 0.425433 + 1.93322x	0.84	11.60
2	Y= 0.286244 + 1.89367x	0.77	8.09
3	Y= 4.47962 + 1.31436x	0.56	1.98

TABLE 4
Regression equations of the culm weight on Dbh for 1, 2 and 3 year old *Gigantochloa scortechinii* culms

Year	Y = a + bx	r^2 (%)	T values
1	Y = -9.69221 + 3.38073x	0.86	13.00
2	Y = -13.1258 + 4.15221x	0.87	74.3
3	Y = -21.1764 + 5.09095x	0.79	62.5

Based on the above results, the significant regressions could therefore be used in predicting the height and culm weight from the Dbh measurement. In particular, a higher r-squared would give us more confidence in the prediction.

Weight Volume Relationship

The relationship between the green weight and solid volume of the culms of different ages (Table 5) was also determined using the regression method in this study. It was found that the 3 year old had the heaviest mean culm, branch, and leaf weight (15.8 kg) compared to the 1 and 2 year old culms, with merely 0.9 and 2.03 kg, respectively. The mean volume for 1 year old culms was 147.5, and this was 177.2 for the 2 year old culms and 219.1 cm^3 for the 3 year old culms. The highest volume was found for the 3-year old culms.

The regression results presented in Table 5 indicate a highly positive linear relationship between the volume and weight of the bamboo culms of all ages. In more specific, the highest coefficient of determination of the r-squared was 86, which was obtained for the 1 year old culms. The fitted regression lines are shown in *Fig. 2*.

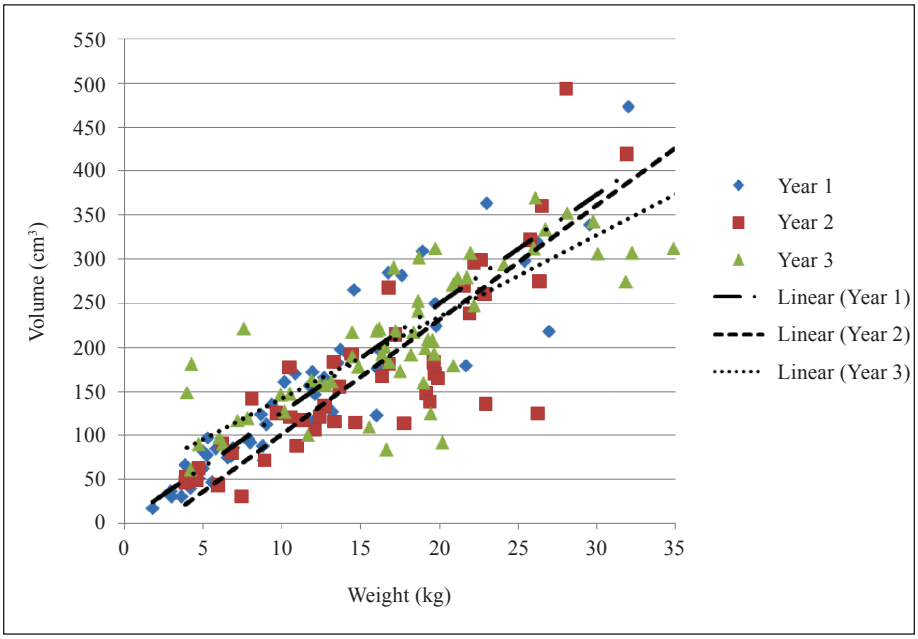

Fig. 2: Fitted regression lines of volume on weight for the 1, 2 and 3 year old culms

TABLE 5
Regression equations of the volume on weight of each culm age

Year	Y = a + bx	r^2 (%)
1	Y = 12.385 + 2.032x	0.86
2	Y = 13.003 + 29.462x	0.75
3	Y = 9.276 + 48.519x	0.72

where Y = volume (cm^3); x = weight (kg); r^2 = coefficient of determination

CONCLUSIONS

Among the culms of the three ages studied, the 3-year old ones had the highest mean for all the characteristics, except for the Dbh and the wall thickness at the base. Meanwhile, the 2-year old culm was second, followed by the 3-year old culms in terms of all the characteristics except for the wall thickness.

The mean diameter-breast height and the wall thickness at the base of the culms of all ages seemed to be bigger and thicker in relation to the age factor. This is probably because both these characteristics only expanded and grew in their culm wall thickness at the age beyond 1 year old, as compared to the growth and thickening of the culm walls which occur at the early establishment stage, i.e. from the shoot sprouting stage until almost 3-4 months, and up to its utmost height. They become mature culms at three year old and above.

As for the 3-year old culm, it had the longest mean internode length. Based on the distinguished features, the 3 year old culm is suitable for making chopsticks, barbeque sticks, toothpicks, and other bamboo products (Azmy, 1989). Based on the physical characteristics of bamboos, moreover, the 3 year old culm is much better in terms of its length, internode length as well as Dbh and circumference. Thus, at this age, the utilization of culm is much preferred compared to culms of other age (i.e. 1 and 2 years old).

Significant positive linear relationships between green weight and solid volume of all the culm ages were observed for all the culms of different ages undertaken in the study. Therefore, the relationship between the measurement characteristics and weight-volume for all the culms of different ages is important in determining their yields and uses.

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