The Specific Gravity of Balobo (Diplodiscus Paniculatus Turcz). from the Makiling National Park

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INTRODUCTION

The specific gravity of balobo (*Diplodiscus paniculatus* Turcz.), a "weed species" which is abundant in many forests of the Philippines, has not been determined so far, although Reyes (7) described the structure as well as the general characteristics and properties of the wood. Had this been determined earlier, it might have been useful in appraising the strength of the timber and in the exploration of any possible or special uses to which this wood could be put. In the past, there were trials on balobo for the manufacture of tennis rackets and bowling pin but the results of these attempts were not conclusive because studies on its physical properties were inadequate, particularly its specific gravity.

The specific gravity of wood, of course, is the ratio of the density of a unit volume of that substance to the density of distilled water at 4 degrees Centigrade. There is the common and accepted knowledge that this specific gravity or relative density of the wood is a reasonably good indication of its strength and to a certain extent its workability, shrink age and ability to hold paint in comparison with other species. Within a given species, also pieces of low specific gravity will be found weaker than those of higher specific gravity.

The investigation here reported covered the specific gravity of balobo from the Makiling National Park, Laguna. The objects were: (1) to determine the average specific gravity of balobo from this locality and (2) to find the range of variation of the specific gravity within the tree as well as between trees.

This study was carried out in the Forest Products Laboratory, Bureau of Forestry, College, Laguna from October, 1955 to April, 1956.

REVIEW OF LITERATURE

No reports of studies on the specific gravity of balobo were found but numerous studies along this line with other species have been conducted locally as well as abroad.

It is well known (1) that specific gravity varies between different species and even with the different parts of the tree. Desch (2) further stated that in general the heaviest wood is found at the base of the tree, and a gradual decrease in density occurs in samples from the base to higher levels in the rank as well as at any given height in the trunk from the pith to the outside of the tree in ring-porous hardwoods.

With one species, bagtikan (*Parashorea plicata* Brandis), Faustino (3) asserted that climate had something to do with specific gravity as trees from along the Pacific coast side of the Philippines had a higher specific gravity than those along the western coast.

On the other hand, Paul (5) mentioned that specific gravity is dependent upon the relationship of soil fertility, transpiration of water by the tree crown and assimilation. He also observed that crowded, slow growing

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harwood trees had lower specific gravity than rapidly growing trees of the same species.

In some instances, specific gravity may be partly useful indication of certain hardwoods which may be considered desirable for pulp and paper making studies. This was implied by Muhlsteph (4) when he grouped cellulose fibers into four types[3], namely: *Group I* comprises the cellulose of *very light* tropical woods, which yield very strong hard sheets; *Group III* comprises woods of deciduous trees of medium density, which yield soda pulp sheets of a still good cohesion; and *Group IV* are heavy woods which yield only very loose sheets.

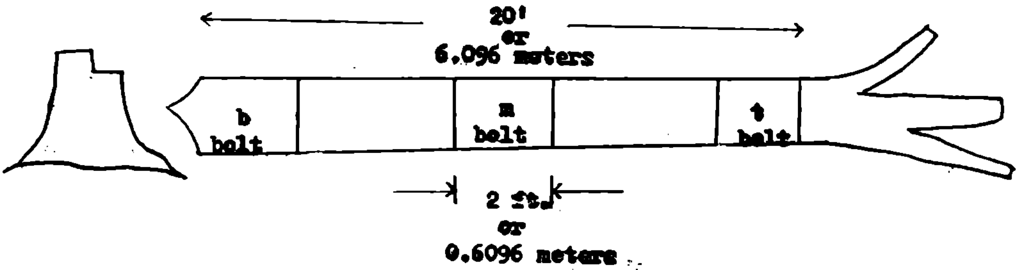
Reyes (7) used the following descriptive terms for wood of different specific gravities:

Specific gravity	*Description*
less than 0.3	— exceptionally light
0.3 to 0.4	— very light
0.4 to 0.5	— light
0.5 to 0.6	— comparatively light
0.6 to 0.75	— comparatively heavy
0.75 to 0.9	— heavy
0.9 to 1.05	— very heavy
over 1.05	— extremely heavy

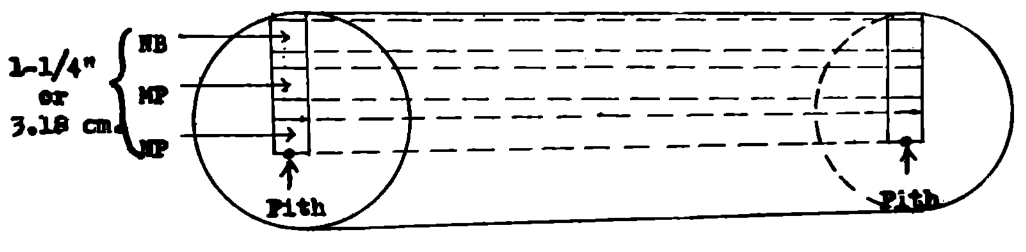
MATERIALS AND METHODS

1. *Materials.* — Four trees of balobo (*Diplodiscus paniculatus* Turcz.) were cut in Makiling National Park, from each of which one log, about 20 feet long, was collected. Botanical vouchers and materials were collected from each tree. The measurements of the trees were as follows:

[3] *Group II comprises* conifers which yield strong sheets woolly to the touch.



a. Sampling diagram for each tree.



b. Cutting diagram for each bolt.

Figure 1. Sampling design for the determination of specific gravity of balobo.

Tree No.	Ht. of stump in meters	Diameter in cm.			Direction of lean of tree	Clear length (meters)
		Butt	Top	Average		
1	1.8	27.00	16.50	21.52	North	6.1
2	2.1	30.00	25.25	27.62	East	7.6
3	1.5	26.30	20.00	23.15	West	6.7
4	1.4	24.25	20.35	22.25	South	9.1

From each log (Fig. 1), three bolts 2 feet or 0.6096 meters long were obtained, one each from the butt, middle and top sections respectively. Also from each bolt, three samples or sticks 1-1/4 inches (3.18 cm.) square and 2 feet (0.6096 meters) long were taken from three portions of the cross section, i.e. near the pith, near the bark and the midportion. Each stick was planed so as to produce a cross section 1-inch (2.54 cm.) square. From each stick, twenty 1-inch cubes or test blocks were cut which were labeled to indicate their source and position in the stick and whose edges and ends were smoothed with sandpaper to remove silvers and other protrusions. Each tree, therefore, was represented by 180 test blocks or cubes from 9 sticks and, for the four trees there was a total of 720 test blocks from 36 sticks.

2. *Methods.* — To recover any loss of moisture of the test blocks during their preparation and make certain that each block was saturated or water-logged before beginning the measurements, they were immersed in water for about one day and one night (depending upon the length of time they were exposed to drying during preparation) until they sank, after which they were considered practically saturated. After the blocks were removed from the water and drained, they were kept in their saturated condition as much as possible by covering them with wet gunny sack while their individual weights were being taken.

a. *Determination of volume and weights.* In this water-saturated condition, each test block was weighed on a Torsion balance to determine its green weight. It was then immersed in a beaker full of mercury to determine its volume by displacement. The weight of the displaced mercury that overflowed from the full beaker was determined and recorded and provided the data from which the volume could be calculated. After the blocks had undergone this process, they were dried to constant weight in an electric oven at a temperature of 100° to 105° C. maintained for at least a period of forty-eight hours. They were then removed from the oven and immediately placed in a desiccator so as to allow them to cool without reabsorbing moisture. Finally, the oven-dry weight of each block was determined.

b. *Computation of data.* — The standard method being used by the Forest Products Laboratories of the Philippines and the United States (Madison) was used in the computation of the specific gravity of each block. This is the ratio of the oven-dry weight of the test block to the weight of the volume of water displaced by the block at the time of test. However, since mercury was used instead of water in the displacement procedure, the weight of water displaced was calculated by dividing the weight of the displaced mercury by 13.59, the specific gravity of mercury. Also, using the standard formula used by both laboratories, the moisture content (M.C.) of each block was determined.

All data for each tree as well as for the four trees were arrayed and their respective dispersion tables prepared. Such statistical constants as true mean, standard deviation, standard error, required number of samples to attain a desired accuracy of 5 per cent, and coefficient of variation were computed. The significances of the difference of specific gravity were also determined.

RESULTS AND DISCUSSION

The average specific gravity at test (ave. 70.90% M.C.) of balobo in each sample ranged from 0.568 to 0.714 (table 1). The coefficient of variation was 6.06 per cent indicating that the samples were slightly variable. The variations in average specific gravity were found associated with the location of the samples from the butt to the top section or bolt of the log as well as from the pith to the bark (table 2). In the former, the trend of decrease was from the butt (0.678), the middle (0.658) the next, then the top (0.651). In the latter, the trend of increase was from the pith (0.645), the midportion (0.672) the next, then near the bark (0.673). Between the butt and middle sections and between the butt and top sections, the variations in specific gravity were significant while that between the middle and top sections was insignificant. These showed that, on the average, balobo at the butt was definitely denser than either of the middle or top sections although there was also the tendency for the middle to be denser than the top as manifested by a probability of 87.24 out of 100. On the other hand, between the three portions of the cross section of the log, only the variation between those near the bark and the midportion was insignificant. This indicated that both portions were evidently denser than that near the pith. Coincidentally, these manifestations of density variation substantiated the trend of decrease in the thickness of the cell wall of balobo fibers from near the bark to the pith as well as from the butt to the top sections of the trunk as previously observed by earlier investigators (8).

Comparison between trees. — In table 3, all four trees studied were found to vary significantly with each other in their specific gravity. An attempt to analyze the variations in each tree unexpectedly showed an interesting result which may lead to the discovery of another probable factor (not assessed before) affecting the incidence of specific gravity variations. Apparently in table 4, the different portions of the trunk of each tree varied significantly in specific gravity. The densest portions of the log were found near the bark in the case of the two trees whose lean was either toward the north or south while those whose lean was either toward the east or west had their densest portions near the mid-portion. However, there was the lack of replications in each case; hence, it is speculative, as yet, to consider whether or not this variable effect in density is really affected by the lean of the tree. To be appreciated, nevertheless, this finding although incidental, may prove of value as a clue to further study and consideration of this nature for one of those conditions influencing the occurrence of variability in specific gravity of wood.

SUMMARY

Specific gravity determinations were made on balobo (*Diplodiscus paniculatus* Turcz.) trees from the Makiling National Park, Laguna. From the results of the investigation, the following points were noted:

1. The average specific gravity at test (ave. 70.90% M.C.) of balobo in the several samples ranged from 0.568 to 0.714 with an average for all the samples of 0.663 + or — 0.002. The co-efficient of variation was 6.06% indicating that the samples were slightly variable.

2. The specific gravity of balobo in the several samples were found to decrease from the butt to the top section of the log as well as from near the bark to the pith.

3. Between trees, the average specific gravity varied significantly.

4. In the attempt to analyze the variations in each tree, it was found that trees leaning either toward the north or south were densest near the bark whereas those that leaned either toward the east or west were densest near the the mid-portion. This finding, although incidental, may serve as a starting point for further study on the possible effect of the lean of a tree on its specific gravity.

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Table 1. Statistics of the specific gravity of balobo (Diplodiscus paniculatus Turcz.).

Items	No. of Samples		Specific Gravity							
	Tested	Re-quired	M 1 S. E.	Cv. %	Near Bark S.E.	Cv. %	Mid-portion S.E.	Cv. %	Near Pith S.E.	Cv. %
4 trees:										
Whole	720	4	0.663 + − 0.002	6.06	0.673 + − 0.002	4.55	0.672 + − 0.002	5.24	0.645 + − 0.003	7.12
Butt	240	3	0.678 + − 0.002	4.16	0.695 + − 0.001	1.58	0.685 + − 0.003	4.16	0.658 + − 0.003	1.65
Middle	240	7	0.658 + − 0.003	6.62	0.676 + − 0.002	3.11	0.663 + − 0.005	6.58	0.637 + − 0.006	8.07
Top	240	6	0.651 + − 0.003	6.08	0.648 + − 0.004	5.12	0.668 + − 0.003	4.13	0.640 + − 0.006	7.64
Tree No. 1										
Whole	180	8	0.624 + − 0.003	6.89	0.646 + − 0.005	5.85	0.634 + − 0.003	3.93	0.600 + − 0.006	7.76
Butt	60	1	0.670 + − 0.002	2.76	0.690 + − 0.002	1.47	0.663 + − 0.002	1.57	0.655 + − 0.001	1.70
Middle	60	2	0.608 + − 0.004	5.36	0.645 + − 0.003	2.22	0.609 + − 0.002	1.50	0.572 + − 0.003	1.94
Top	60	4	0.601 + − 0.004	5.12	0.604 + − 0.002	1.79	0.631 + − 0.002	1.62	0.568 + − 0.004	2.90
Tree No. 2										
Whole	180	1	0.692 + − 0.001	2.46	0.693 + − 0.001	1.36	0.707 + − 0.001	1.49	0.678 + − 0.002	1.78
Butt	60	1	0.698 + − 0.002	2.44	0.700 + − 0.002	1.40	0.714 + − 0.002	1.03	0.681 + − 0.003	1.87
Middle	60	1	0.693 + − 0.002	2.28	0.693 + − 0.001	0.92	0.710 + − 0.002	1.32	0.677 + − 0.002	1.12
Top	60	1	0.684 + − 0.002	2.27	0.686 + − 0.002	0.96	0.698 + − 0.002	1.00	0.699 + − 0.003	1.72
Tree No. 3										
Whole	180	2	0.686 + − 0.002	3.35	0.673 + − 0.004	4.32	0.706 + − 0.002	2.17	0.688 + − 0.002	2.01
Butt	60	1	0.695 + − 0.002	2.23	0.696 + − 0.002	1.08	0.709 + − 0.001	0.90	0.678 + − 0.003	1.84
Middle	60	1	0.693 + − 0.001	1.36	0.687 + − 0.002	0.99	0.696 + − 0.002	1.29	0.694 + − 0.002	1.49
Top	60	3	0.669 + − 0.004	4.38	0.634 + − 0.004	2.44	0.683 + − 0.002	1.33	0.692 + − 0.004	2.30
Tree No. 4										
Whole	180	3	0.648 + − 0.002	4.48	0.678 + − 0.002	2.16	0.652 + − 0.002	2.02	0.619 + − 0.002	2.54
Butt	60	4	0.656 + − 0.004	4.97	0.695 + − 0.003	1.99	0.653 + − 0.001	0.83	0.619 + − 0.003	1.81
Middle	60	4	0.659 + − 0.004	4.88	0.676 + − 0.002	1.54	0.640 + − 0.003	2.11	0.609 + − 0.002	1.43
Top	60	1	0.631 + − 0.002	2.49	0.662 + − 0.002	1.36	0.661 + − 0.001	0.97	0.632 + − 0.002	1.04

LEGEND TO ABBREVIATIONS:

S. E. = Standard Error.
Cv. = Coefficient of variation.

Table 2. Significance of the difference of the specific gravity of balobo (4 trees) between the different portions of the bole.

Between Sections of trees	Means	Diff. of Means	Standard Error	Standard Error of the Difference	Normal Deviate	Significance *
Butt Middle	0.678 0.658	0.020	0.0018 0.0028	0.00333	6.01	Significant
Butt Top	0.678 0.651	0.027	0.0018 0.0026	0.00316	8.54	Significant
Middle Top	0.658 0.651	0.007	0.0028 0.0026	0.00382	1.83	Insignificant
Near Bark Mid-portion	0.673 0.672	0.001	0.0020 0.0023	0.00305	0.33	Insignificant
Near Bark Near Pith	0.673 0.645	0.028	0.0020 0.0030	0.00361	7.76	Significant
Mid-portion Near Pith	0.672 0.645	0.027	0.0023 0.0030	0.00378	7.14	Significant

* Level of significance used is twice the standard error of the difference between the two means or a probability of 95.45%

Table 3. Significance of the difference of specific gravity between four trees of balobo (Diplodiscus paniculatus **Turcz.).**

Between trees	Means	Diff. of Means	Standard Error	Standard Error of the Difference	Normal Deviate	Significance *
No. 1 No. 2	0.624 0.692	0.068	0.0032 0.0013	0.00345	19.71	Significant
No. 1 No. 3	0.624 0.686	0.062	0.0032 0.0017	0.00362	17.13	Significant
No. 1 No. 4	0.624 0.648	0.024	0.0032 0.0022	0.00388	6.19	Significant
No. 2 No. 3	0.692 0.686	0.006	0.0013 0.0017	0.00214	2.80	Significant
No. 2 No. 4	0.692 0.648	0.044	0.0013 0.0022	0.00256	17.19	Significant
No. 3 No. 4	0.686 0.648	0.038	0.0017 0.0022	0.00278	13.67	Significant

* Level of significance used is twice the standard error of the difference between the two means or a probability of 95.45%.

Table 4. Significance of the difference of specific gravity between the three portions of the cross section of the trunk in four trees of balobo (Diplodiscus paniculatus **Turcz.**).

Between Sections of trees	Means	Diff. of Means	Standard Error	Standard Error of the Difference	Normal Deviate	Significance *
			Tree No. 1			
Near Bark Mid-portion	0.646# 0.634	0.012	0.0049 0.0032	0.00585	2.05	Significant
Near Bark Near Pith	0.646 0.600	0.046	0.0049 0.0060	0.00774	5.94	Significant
Mid-portion Near Pith	0.634 0.600	0.034	0.0032 0.0060	0.00680	5.00	Significant
			Tree No. 2			
Near Bark Mid-portion	0.693 0.707#	0.014	0.0012 0.0014	0.00184	7.61	Significant
Near Bark Near Pith	0.693 0.678	0.015	0.0012 0.0016	0.00200	7.50	Significant
Mid-portion Near Pith	0.707 0.678	0.029	0.0014 0.0016	0.00213	13.62	Significant
			Tree No. 3			
Near Bark Mid-portion	0.673 0.706#	0.033	0.0038 0.0020	0.00429	7.69	Significant
Near Bark Near Pith	0.673 0.688	0.015	0.0038 0.0018	0.00420	3.57	Significant
Mid-portion Near Pith	0.706 0.688	0.018	0.0020 0.0018	0.00269	6.69	Significant
			Tree No. 4			
Near Bark Mid-portion	0.678# 0.652	0.026	0.0017 0.0017	0.00240	10.83	Significant
Near Bark Near Pith	0.678 0.619	0.059	0.0017 0.0022	0.00278	21.22	Significant
Mid-portion Near Pith	0.652 0.619	0.033	0.0017 0.0022	0.00278	11.87	Significant

Highest value per tree.
* Level of significance used is twice the standard error of the difference between the two means or a probability of 95.45%.

[4] According to Richardson, C.H. (*An Introduction to Statistical Analysis*) if the normal deviate is greater than 3, the difference is certainly significant. Likewise, if it is greater tha 2, the difference is (possible) significant and if it is less than 2, the difference is (probable) not significant.