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Agronomic Features of *Metroxylon* Palms Growing on Gaua in the Banks Islands, Vanuatu

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ヴァヌアツ・バンクス諸島ガウア島における *Metroxylon* 属ヤシの生産特性

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Introduction

Two species of *Metroxylon* section *Coelococcus*, *M. salomonense* (Warb.) Becc. and *M. warburgii* (Heim) Becc., are distributed in Vanuatu. The biology of *Metroxylon* palms in Vanuatu has been reported previously (Beccari 1918, Rauwerdink 1986, Dowe 1989, Dowe and Cabalion 1996, McClatchey 1999). However, as few studies exist of the agronomic features of *Metroxylon* palms in Vanuatu, we made a field survey in the northern and central islands. We reported the distribution, growth environment and utilization of *M. salomonense* and *M. warburgii* (Ehara et al. 2003). Here, we report the morphological and growth characteristics and yield components of both species on Gaua in the Banks Islands.

Materials and Methods

One moderately high palm was selected from each population of *M. salomonense* and *M. warburgii* (hereafter M.s and M.w, respectively) at a site (14° 15.91'S, 167° 36.10'E; 5m alt.) on Gaua and was harvested. M.s was at the flowering and M.w was at the bearing stage. Morphological indicators of plant type were measured. The length of seven rachillae attached to the mid-branch of inflorescence was measured. A fully expanded leaf was cut from the middle position among the green leaves, its length and width were measured and the leaflet number was noted. Three mid-rachis leaflets were cut from the leaf sample to measure their length and width. A chlorophyll meter (SPAD 502, Minolta) was used to estimate the chlorophyll content of the middle part of the three leaflets and also the chlorophyll content was measured by using Mackinney method (Mackinney

1941).

The bottom (50cm above the ground), middle and top (50cm below the uppermost leaf scar) parts of the trunk were cut into a disk. The disk sample was cut into a triangular prism shape of which the apex was the centre of the disk after removing the bark. After measuring the bulk density, the pith sample was cut into small pieces and dried at 70℃, and the dry weight was measured. The pith dry matter yield was estimated by $\pi\ [(\text{mean trunk diameter}) / 2 - (\text{mean bark thickness})]^2 \cdot (\text{trunk length}) \cdot (\text{mean bulk density}) \cdot (\text{mean dry matter percentage of pith})$. Total sugar was extracted from the ground pith with 80% ethanol and then starch was extracted from the residue by using the perchloric acid treatment. The sugar content of the pith was measured by using the procedure of Osaki (1990) and the starch content was measured by using the anthrone-sulphuric acid method. The mean value of yield components was calculated from data collected from the bottom, middle and top parts of trunk.

Table 1 Plant characteristics and yields.

Characteristic	*M. salomonense* (M.s)	*M. warburgii* (M.w)
Plant height (m)	18.6	11.0
Trunk length (m)	8.5	5.0
diameter (cm)	58.0 ± 1.1	28.6 ± 0.7
Leaf scar no.	66	36
Green leaf no.	8	13
Inflorescence length (m)	9.6	6.0
1st-order branch no.	28	14
2nd-order branch no.	14.0 ± 2.1*	14.0 ± 1.9*
Rachilla length (cm)	24.9 ± 0.8	6.9 ± 1.1
Leaf length (m)	4.0	3.2
width (m)	2.4	2.0
Leaflet no. (pairs)	65	51
length (cm)	125 ± 0	112 ± 4
width (cm)	12.0 ± 0	7.2 ± 0.2
SPAD value	71.0 ± 1.7	69.0 ± 4.9
Chlorophyll (μ g/cm^2)	112.8 ± 8.3	125.5 ± 18.0
Bulk density (gFW/cm^3)	0.85 ± 0.05	0.95 ± 0.05
DM % of pith	18.5 ± 1.9	21.3 ± 1.9
Starch content (%)	48.9 ± 7.1	54.2 ± 6.1
Total sugar content (%)	15.3 ± 5.6	14.1 ± 3.1
Estimated yield (kg/plant)		
Pith DM	326.0	48.4
Starch	159.4	26.2
Total sugar	49.8	6.8

Numerals after ± indicate the standard error.
*: data collected from three 1st-order branches
DM: dry matter.

Results and Discussion

Morphological and Growth Characteristics

(1) Plant type

Table 1 shows all measured characteristics. Plant height, trunk length, inflorescence length, leaf length and width, and leaflet number were larger in M.s than in M.w. The mean trunk diameter was larger in M.s than in M.w as 58.0cm and 28.6cm with small variation at 1m intervals as 5.2% and 2.7% CV, respectively. Beccari (1918) described that *M. salomonense* is a large palm and *M. warburgii* is apparently a smaller plant than the other sago palms ('sago palms' means '*Metroxylon palms*'). In this survey, *M. salomonense* was clearly large in plant size compared with *M. warburgii*.

(2) Inflorescence

The inflorescence of M.s had many 1st-order branches and long rachillae compared with M.w. M.s branched to 3rd orders (3rd-branch corresponded to

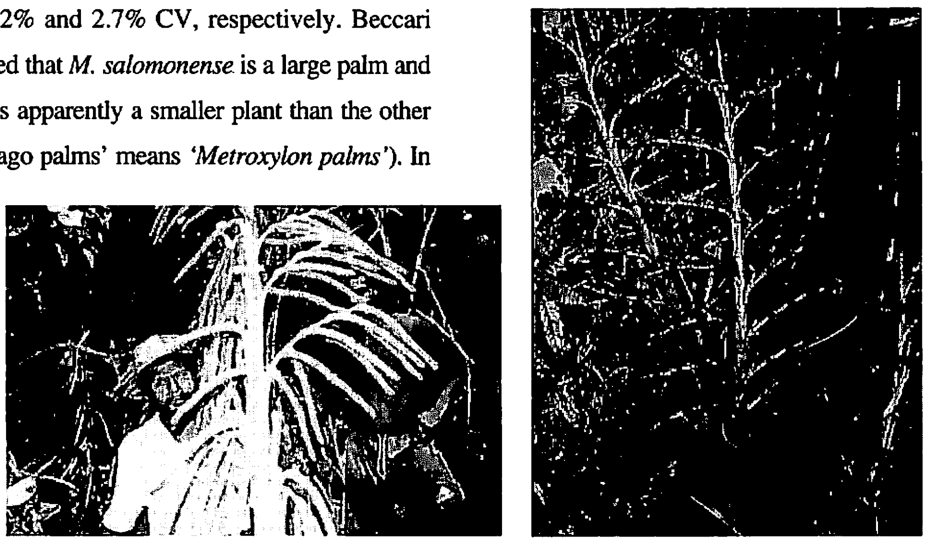

Fig. 1 Inflorescence of *M. salomonense* (left) and *M. warburgii* (right).

rachilla) or to 2nd orders (2nd-branch corresponded to rachilla) even in a single inflorescence (Fig.1). The inflorescence of *M. salomonense* branches to 2nd or 3rd orders (Dowe 1989) and also recently it was reported to branch only to 2nd orders (Dowe and Cabalion 1996). Thus *M. salomonense* can be said to have variation in branching pattern. On the contrary, M.w branched to the 3rd order (Fig.1), as also reported by Dowe (1989) and Dowe and Cabalion (1996). The rachillae of M.s were pendulous, but those of M.w were obliquely erect.

(3) Leaflet

The leaflet was long and wide in M.s that was a comparatively large palm. The differences in both SPAD value and chlorophyll content in each unit leaflet area were not distinct between the two palm samples. The leaflet surface was glossy on both sides in M.s, but was less glossy on abaxial side than on adaxial side in M.w (Fig. 2). The leaflet of *M. salomonense* is dark green on both sides and that of *M. warburgii* is dark green on the adaxial side and is lighter green on the abaxial side (Dowe and Cabalion 1996). *M. warburgii* shows a markedly different leaflet surface on the abaxial side from *M. salomonense*. Probably, this is attributed to the difference in secretion or accumulation, or both, of the external cuticle on the abaxial leaflet surface between the two species.

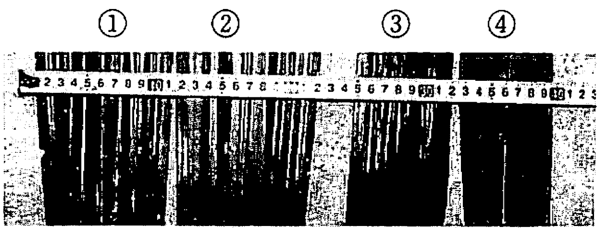

Fig. 2 Leaflets of *M. salomonense* (1, 2) and *M. warburgii* (3, 4). 1, 3: adaxial side; 2, 4: abaxial side.

(4) Petiole and rachis

Spines were on the petiole and rachis in both M.s and M.w. The spines of M.w were strong (hard) like those of *M. sagu* Rottb., but the spines of M.s were soft. The spine character of M.s in Vanuatu was the same as of *M. salomonense* at Singapore Botanical Garden.

Yields and Yield Components

Fresh bulk density, dry matter percentage and starch content of pith were slightly lower in M.s than in M.w, but the total sugar content of the pith was the opposite to them. In *M. sagu*, the starch content increases and total sugar content decreases with growth after trunk formation (Yamamoto et al. 1994, 1995). The differences in pith characters described above between M.s and M.w were small and might be caused by the difference in their growth stages. Estimated yields of pith dry matter, starch and total sugar contents were clearly higher in M.s than in M.w, which were attributed to the difference in trunk volume. However, the estimated yields of pith dry matter and starch of M.s which had a large trunk were 326.0 kg and 159.4 kg, respectively, and these were still low compared with those of *M. sagu* grown in the eastern archipelago of Indonesia (Ehara et al. 1995, 2000). The mean values of dry matter percentage and starch content of pith were 18.5% and 48.9%, respectively, in M.s and 21.3% and 54.2%, respectively, in M.w. These values were low by about 20% compared with those of *M. sagu* (Ehara et al. 1995, 2000). The low pith dry matter and starch yields of M.s were obviously due to the low dry matter percentage and starch content of pith. However, the mean value of total sugar content of pith was 15.3% and 14.1%, respectively, in M.s and M.w, the values of which were high despite their growth stages as at flowering or bearing compared with those of matured *M. sagu* at around 5% (Yamamoto et al. 1995). The propagation of M.s and M.w palms both belong to section *Coelococcus*, depends on only their seeds, which is different from *M. sagu* of section *Metroxylon (Eumetroxylon)* that can be propagated by both offshoots (suckers) and seeds.

The dry matter percentage and starch content of pith were low and on the contrary, the total sugar content of pith was a bit higher in matured stands of

M. salomonense and *M. warburgii*, which may attribute to their specific characters. Investigation of the variations in their starch and total sugar contents of pith at various growth stages should be one of the subjects for further study to understand the production characteristics and physiology of *Metroxylon* palms in Vanuatu.

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