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Morphological Characters of the Cultivated Rice Grains of Fiji (Ⅱ)

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Introduction

In the 1982 academic year, the Kagoshima University Research Center for the South Pacific carried out the second-year's research in Fiji and Solomon Islands. This project examined the ecological, ethnological and bio-productive features of the natural environment, as well as the resources in Fiji and Solomon Islands. The present author took part in researching the agricultural sciences, *i.e.*, agricultural productivity, cultural patterns, pathological and physiological conditions, land-use practices in the tropical areas.

As a part of the project, 20 strains of cultivated rice, *Oryza sativa* L., under using in Fiji were collected. The most of them were delivered him through the kindness of Dr. S. A. Haque, and some of them were directly collected in the fields by the members of the survey team. The grains of these strains were used for the morphological studies. The main purpose are to clarify the varietal variations and the phylogenetic relationships of the cultivated-rice-strains (= cultivars) using in the south Pacific areas.

In the countries belonging to South Pacific, several trials on rice cultivation had been attempted, most of which were looked upon as unsuccessful, but just one in Fiji as successful[4].

The present experimental series has been made to search the varietal variations, taking historical and racial improvements into considerations.

In the previous paper[6], the records of morphological characters of the unhusked and the husked grains and variation ranges of 12 characters, were reported, in order to confirm the morphological characters of grains fitting to make the strain's specificities clearer. In the present paper, comparisons of the unhusked and the husked grains of 12 characters and variation ranges in 12 characters were mainly described.

Materials and Methods

Twenty strains of rice cultivars, *Oryza sativa* L., collected during the trip in Fiji, at the regions lying from 15°S to 22°S and from 174°E to 174°W, along the South Pacific, were used in the experimental series. They are listed up in Table 1. In this table, strain number, ordinary sowing and harvesting times in the respective sites and remarks in brief are mentioned.

Thirty grains were used for measurements of each strain. Comparative values for 6 characters (Table 2) were illustrated by the ratios of the values fixed in the unhusked grains in the respective characters. The following 6 characters of the unhusked and the husked grains (Table 3) were illustrated by the area (= length x width) and volume (= length x width x thickness) for unhusked and the husked grains, the area and volume quotients (= ratio of value of husked to value of unhusked grains). The whole data referring to the 12 characters were illustrated by the average

Table 1. Locality, some agronomical characters of cultivated rice, *Oryza sativa* L., collected in Fiji

Strain No.	Stock No.	Variety name	Original place	Sowing time	Harvesting time	Remarks
1	923	Bhallu	Koroqara, Nausori	Oct/Nov	Feb	Traditional
2	924	Uttam	Koronivia	Non–seasonal	Non–seasonal	Improved
3	925	Chetua	Visama, Nausori	Oct/Nov	May/April	Traditional
4	926	New Guinea	Nssasa, Navua	Non–seasonal	Non–seasonal	Traditional
5	927	Lalka Motka	Navua	Oct/Nov	May/April	Traditional
6	928	China Patta	Navua	Oct/Nov	May/April	Traditional
7	929	Jinka	Navua	Oct/Nov	April/May	Traditional
8	930	Saraya	Nausori	Oct/Nov	April/May	Traditional
9	931	Ram Kajara	Koronivia, Nausori	Oct/Nov	April/May	Traditional
10	932	BG75	Lokia, Nausori	Oct/Nov	April/May	Traditional
11	933	BG79	Koronivia	Oct/Nov	April/May	Traditional
12	934	Bold Grain	Koronivia	Non–seasonal	Non–seasonal	Improved
13	935	Ajral	Koronivia	Non–seasonal	Non–seasonal	Traditional
14	936	Bilo	Koronivia	Non–seasonal	Non–seasonal	Traditional
15	937	Japanese	Ra, Nausori	Oct/Nov	April/May	Traditional
16	938	K109–27–1	Koronivia	Non–seasonal	Non–seasonal	Improved
17	939	–	Nausori	–	–	Traditional
18	940	–	Dreketi	–	–	Traditional
19	941	–	Dreketi	–	–	Traditional
20	942	–	Dreketi	–	–	Traditional

value through the whole grains.

The variation ranges in 12 characters (Tables 4 and 5) were illustrated by the maximum, the minimum and pure-range value in the whole grains. Moreover, the summed-up data on variation ranges in the previous[6] and the present experiments were analysed (Tables 6 and 7).

In the present paper, the following abbreviations were used, *i.e.*, L (length), W (width), T (thickness), L/W (ratio of length to width), L/T (ratio of length to thickness), W/T (ratio of width to thickness), s.d. (standard deviations), UHG (unhusked grain), HG (husked grain).

Results

PART I. The respective characters

1. Quotients in length

Quotients in length (abbreviated as L) were calculated, and are shown in Table 2. The values for the individual grain level ranged from 0.77 (strain No.15) to 0.63 (strain No.20). In the strain level, the largest (0.74) was obtained in No.15, followed by Nos.8 and 16 (0.73). The smallest (0.66) was noted in No.20, followed by Nos.17 and 18 (0.69). Average and its s.d. through the whole strains were found to be 0.71 ± 0.02. The s.d. of each strain, *i.e.*, those showing intra-population's variations obtained, were found to be 0.02 ± 0.01.

2. Quotients in width

The values for the individual grain level ranged from 0.96 (No.8) to 0.70 (No.15). In the strain

Table 2. Comparative table showing six morphological characters of the unhusked and the husked grains; illustrated by the ratios of value in husked to value in unhusked grains in the respective characters

Strain No.	Length	Width	Thickness	L/W	L/T	W/T
1	0.72±0.02	0.85±0.03	0.90±0.02	0.85±0.03	0.80±0.02	0.94±0.03
2	0.70±0.01	0.84±0.03	0.89±0.02	0.84±0.03	0.79±0.02	0.93±0.03
3	0.71±0.01	0.83±0.02	0.91±0.02	0.85±0.02	0.78±0.02	0.92±0.03
4	0.72±0.01	0.87±0.03	0.90±0.01	0.83±0.03	0.81±0.04	0.96±0.05
5	0.71±0.02	0.83±0.01	0.90±0.02	0.86±0.02	0.79±0.02	0.91±0.02
6	0.72±0.03	0.76±0.04	0.86±0.05	0.94±0.03	0.84±0.05	0.89±0.02
7	0.70±0.02	0.82±0.02	0.91±0.05	0.85±0.03	0.77±0.05	0.91±0.05
8	0.73±0.01	0.87±0.03	0.90±0.02	0.84±0.04	0.81±0.02	0.96±0.04
9	0.71±0.02	0.88±0.02	0.92±0.02	0.82±0.03	0.78±0.04	0.95±0.04
10	0.71±0.02	0.81±0.01	0.85±0.02	0.87±0.02	0.74±0.02	0.86±0.01
11	0.71±0.01	0.83±0.02	0.90±0.01	0.86±0.02	0.79±0.03	0.93±0.04
12	0.68±0.02	0.84±0.02	0.90±0.01	0.82±0.03	0.76±0.02	0.93±0.03
13	0.72±0.01	0.84±0.02	0.90±0.01	0.85±0.02	0.79±0.02	0.94±0.02
14	0.71±0.01	0.85±0.01	0.90±0.02	0.84±0.02	0.79±0.02	0.94±0.02
15	0.74±0.04	0.73±0.04	0.83±0.05	0.78±0.06	0.86±0.06	0.85±0.06
16	0.73±0.01	0.86±0.02	0.90±0.01	0.85±0.02	0.81±0.02	0.96±0.03
17	0.69±0.01	0.84±0.01	0.91±0.02	0.82±0.02	0.77±0.02	0.93±0.03
18	0.69±0.01	0.84±0.02	0.91±0.01	0.83±0.03	0.76±0.02	0.93±0.02
19	0.71±0.01	0.84±0.02	0.91±0.01	0.84±0.02	0.78±0.01	0.93±0.02
20	0.66±0.01	0.81±0.03	0.90±0.02	0.82±0.03	0.73±0.02	0.90±0.03

level, the largest (0.88) was obtained in No.9, followed by Nos.4 and 8 (0.87). The smallest (0.73) was noted in No.15, followed by No.6 (0.76) and Nos.10 and 20 (0.81). Average and its s.d. through the whole strains were found to be 0.83±0.03. The s.d. of each strain were found to be 0.02±0.01.

3. Quotients in thickness

The values for the individual grain level ranged from 0.96 (No.9) to 0.79 (No.15). In the strain level, the largest (0.92) was obtained in No.9, which was the same as in case of the W, followed by Nos.3, 7, 17, 18 and 19 (0.91). The smallest (0.83) was noted in No.15, which was the same as in case of the W, followed by No.10 (0.85) and No.6 (0.86). These combinations of strains (6·10·15) were found to be the same as in case of the W. Average and its s.d. through the whole strains were found to be 0.90±0.02. The s.d. of each strain were found to be 0.02±0.01.

4. Quotients in L/W

The values for the individual grain level ranged from 0.96 (No.6) to 0.73 (Nos.12 and 15). In the strain level, the largest (0.94) was obtained in No.6, followed by No.10 (0.87) and Nos.5 and 11 (0.86). It was noted that the value was particularly large in No.6. The smallest (0.78) was noted in No.15, which was the same as in cases of the W and T, followed by Nos.9, 12, 17 and 20 (0.82). Average and its s.d. through the whole strains were found to be 0.84±0.03. The s.d. of each strain were found to be 0.03±0.01.

5. Quotients in L/T

The values for the individual grain level ranged from 0.91 (No.4) to 0.69 (No.20). In the strain level, the largest (0.86) was obtained in No.15, which was the same as in case of the L, followed by

No.6 (0.84) and Nos.4, 8 and 16 (0.81). The smallest (0.73) was noted in No.20, which was the same as in case of the L, followed by No.10 (0.74) and Nos.12 and 18 (0.76). Average and its s.d. through the whole strains were found to be 0.79±0.03. The s.d. of each strain were found to be 0.03±0.01.

6. Quotients in W/T

The values for the individual grain level ranged from 1.06 (Nos.8 and 11) to 0.79 (No.4). In the strain level, the largest (0.96) was obtained in Nos.4, 8 and 16. The smallest (0.85) was noted in No.15, which was the same as in cases of W, T and L/W, followed by No.10 (0.86) and No.6 (0.89). These orders of strains (15<10<6) were found to be the same as in case of the T. Moreover, these combinations of strains (6·10·15) were found to be the same as in case of the W. Average and its s.d. through the whole strains were found to be 0.92±0.03. The s.d. of each strain were found to be 0.03±0.01.

7. Areas in UHG

Areas in UHG were calculated, and are shown in Table 3.

The practical values for the individual grain level ranged from 34.77 mm^2 (strain No.20) to 19.71 mm^2 (strain No.6). In strain level, the widest (32.59 mm^2) was obtained in No.20, followed by No.18 (31.15 mm^2) and No.12 (31.14 mm^2). The narrowest (20.79 mm^2) was noted in No.10, followed by No.6 (21.09 mm^2) and No.2 (22.39 mm^2). Average and its s.d. through the whole strains were found to be 26.21±3.51.

The largest s.d. (1.57) was obtained in Nos.4 and 19, followed by No.15 (1.48). The smallest

Table 3. Six characters of the unhusked and the husked grains; illustrated by the area (=length x width), the volume (=length x width x thickness), the area and volume quotients (=ratios of value of husked to value of unhusked grains)

Strain No.	Unhusked		Husked		Quotient	
	Area (mm^2)	Volume (mm^3)	Area (mm^2)	Volume (mm^3)	Area	Volume
1	28.82±0.99	59.11±3.35	17.61±0.85	32.58±2.10	0.61±0.02	0.55±0.03
2	22.39±0.92	43.26±2.04	13.18±0.48	22.79±0.99	0.59±0.02	0.53±0.02
3	24.93±0.91	52.31±3.45	14.69±0.56	27.94±1.84	0.59±0.02	0.53±0.02
4	25.23±1.57	53.68±4.32	15.83±0.80	30.39±2.08	0.63±0.02	0.57±0.02
5	28.54±1.41	63.31±4.32	16.69±0.67	33.44±1.94	0.59±0.02	0.53±0.02
6	21.09±0.87	43.25±2.31	11.81±0.52	20.31±1.78	0.55±0.05	0.47±0.06
7	29.24±1.20	65.79±3.00	16.80±0.58	34.27±1.77	0.58±0.03	0.52±0.04
8	25.44±1.32	53.85±3.58	16.15±0.66	30.90±1.82	0.64±0.02	0.58±0.02
9	24.00±1.11	52.56±2.53	14.82±0.54	29.64±1.51	0.62±0.02	0.54±0.02
10	20.79±1.38	40.05±3.12	12.42±0.47	21.51±1.12	0.57±0.02	0.54±0.02
11	22.87±1.10	45.94±2.32	13.43±0.63	24.19±1.16	0.59±0.02	0.53±0.02
12	31.14±1.34	70.25±3.48	17.79±0.82	36.29±2.15	0.57±0.02	0.52±0.02
13	27.78±1.07	58.70±2.87	16.74±0.73	31.90±1.77	0.60±0.01	0.54±0.01
14	22.05±1.29	43.45±3.46	13.18±0.71	23.32±1.76	0.60±0.02	0.54±0.02
15	22.99±1.48	43.73±4.80	11.89±0.69	18.83±0.92	0.52±0.03	0.43±0.03
16	26.16±1.39	53.07±3.55	16.36±0.80	29.78±1.96	0.62±0.02	0.56±0.01
17	30.22±1.06	68.23±3.07	17.65±0.66	36.15±1.85	0.58±0.01	0.53±0.02
18	31.15±1.32	70.06±4.39	17.99±0.90	36.74±2.56	0.58±0.02	0.52±0.02
19	26.84±1.57	59.71±4.64	16.08±0.94	32.46±2.43	0.60±0.02	0.54±0.01
20	32.59±1.20	74.82±4.58	17.48±0.89	36.31±2.63	0.54±0.02	0.48±0.02

(0.87) was noted in No.6, followed by No.3 (0.91) and No.2 (0.92). The s.d. of each strain were found to be 1.23±0.21.

8. Volumes in UHG

The practical values for the individual grain level ranged from 86.24 mm^3 (No.20) to 35.00 mm^3 (No.10). In the strain level, the largest (74.82 mm^3) was obtained in No.20, which was the same as in case of the area (UHG), followed by No.12 (70.25 mm^3) and No.18 (70.06 mm^3). It was noted that the value was particularly large in No.20. These combinations of strains (12·18·20) were found to be the same as in case of the area (UHG). The smallest (40.05 mm^3) was noted in No.10, which was also the same as in case of the area (UHG), followed by No.6 (43.25 mm^3) and No.2 (43.26 mm^3). These orders of strains (10<6<2) were found to be the same as in case of the area (UHG). Average and its s.d. through the whole strains were found to be 55.76±10.29.

The largest s.d. (4.80) was obtained in No.15, followed by No.19 (4.64) and No.20 (4.58). The smallest (2.04) was noted in No.2, followed by No.6 (2.31) and No.11 (2.32). The s.d. of each strain were found to be 3.46±0.81.

9. Areas in HG

The practical values for the individual grain level ranged from 20.01 mm^2 (No.18) to 10.00 mm^2 (No.10). In the strain level, the widest (17.99 mm^2) was obtained in No.18, followed by No.12 (17.79 mm^2) and No.17 (17.65 mm^2). The narrowest (11.81 mm^2) was noted in No.6, followed by No.15 (11.89 mm^2) and No.10 (12.42 mm^2). These combinations of strains (6·10·15) were found to be the same as in cases of the W, T and W/T. Average and its s.d. through the whole strains were found to be 15.43 ±2.04.

The largest s.d. (0.94) was obtained in No.19, which was the same as in case of the area (UHG), followed by No.18 (0.90) and No.20 (0.89). The smallest (0.47) was noted in No.10, followed by No.2 (0.48) and No.6 (0.52). These combinations of strains (2·6·10) were the same as in cases of the practical values of area and volume (UHG). The s.d. of each strain were found to be 0.70±0.14.

10. Volumes in HG

The practical values for the individual grain level ranged from 42.96 mm^3 (No.18) to 15.50 mm^3 (No.15). In the grain level, the largest (36.74 mm^3) was obtained in No.18, which was the same as in case of the area (HG), followed by No.20 (36.31 mm^3) and No.12 (36.29 mm^3). These combinations of strains (12·18·20) were found to be the same as in cases of the area (UHG) and volume (UHG). The smallest (18.83 mm^3) was noted in No.15, which was the same as in cases of the W, T, L/W and W/T, followed by No.6 (20.31 mm^3) and No.10 (21.51 mm^3). These orders of strains (15<6<10) was found to be the same as in case of the W. Moreover, these combinations of strains (6·10·15) were found to be the same as in cases of W, T, W/T and area (HG). Average and its s.d. through the whole strains were found to be 29.49±5.61.

The largest s.d. (2.63) was obtained in No.20, followed by No.18 (2.56) and No.19 (2.43). These combinations of strains (18·19·20) were found to be the same as in case of the area (HG). The smallest (0.92) was noted in No.15, followed by No.2 (0.99) and No.10 (1.12). The s.d. of each strain were found to be 1.81±0.47.

11. Quotients in areas

The values for the individual grain level ranged from 0.69 (No.8) to 0.49 (No.15). In the strain level, the largest (0.64) was obtained in No.8, followed by No.4 (0.63) and Nos.9 and 16 (0.62). These combinations of strains (4·8·16) were found to be the same as in case of W/T. The smallest (0.52) was noted in No.15, which was the same as in cases of the W, T, L/W, W/T and volume (HG), followed by No.20 (0.54) and No.6 (0.55). Average and its s.d. through the whole strains were found

to be 0.59±0.03. The s.d. of each strain were found to be 0.02±0.01.

12. Quotients in volumes

The values for the individual grain level ranged from 0.63 (No.8) to 0.40 (No.15). In the strain level, the largest (0.58) was obtained in No.8, which was the same as in case of the quotient of areas, followed by No.4 (0.57) and No.16 (0.56). These orders of strains (8<4<16) were found to be the same as in case of the quotient of areas. Moreover, these combinations of strains (4·8·16) were found to be the same as in case of the W/T. The smallest (0.43) was noted in No.15, which was the same as in cases of the W, T, L/W, W/T, volume (HG) and quotient of areas, followed by No.6 (0.47) and No.20 (0.48). These combinations of strains (6·15·20) were found to be the same as in case of the quotient of areas. Average and its s.d. through the whole strains were found to be 0.53±0.03. The s.d. of each strain were found to be 0.02±0.01.

PART II. Variation ranges in the respective characters of comparative values, area and volume items

1. Quotients in L

Maximum: The variation ranges in comparative items were calculated, and are shown in Table 4. In this table, the maximum, the minimum and their range are shown. The largest (0.77) was obtained in No.15, followed by Nos.8, 9 and 16 (0.75). The smallest (0.69) was noted in No.20, followed by No.17 (0.71) and Nos.3, 11 and 18 (0.72). Average and its s.d. through the whole strains were found to be 0.73±0.02.

Minimum: The largest (0.71) was obtained in Nos.8, 15 and 16. These combinations of strains (8·15·16) were found to be the same as in case of the maximum of L. The smallest (0.63) was noted in No.20, which was the same as in case of the maximum of L, followed by No.1 (0.65) and Nos.12 and 18 (0.66). Average and its s.d. through the whole strains were found to be 0.68±0.02.

Range: The largest (0.09) was obtained in No.1, followed by Nos.5, 6, 9, 12 and 19 (0.07). The smallest (0.02) was noted in No.2. Average and its s.d. through the whole strains were found to be 0.05±0.02.

2. Quotients in W

Maximum: The largest (0.96) was obtained in No.8, followed by Nos.4 and 9 (0.93). The smallest (0.77) was noted in No.15, followed by No.6 (0.81) and No.5 (0.84). Average and its s.d. through the whole strains were found to be 0.88±0.04.

Minimum: The largest (0.83) was obtained in Nos.9 and 17, followed by No.4 (0.82). The smallest (0.70) was noted in No.15, which was the same as in case of the maximum of W, followed by No.6 (0.71) and Nos.10 and 20 (0.70). Average and its s.d. through the whole strains were found to be 0.79±0.03.

Range: The largest (0.16) was obtained in No.8, which was the same as in case of the maximum of W, followed by Nos.1 and 4 (0.11). It was noticeable that the value was particularly large in No.8. The smallest (0.04) was noted in Nos.5 and 17 (0.04), followed by No.13 (0.05). Average and its s.d. through the whole strains were found to be 0.09±0.03.

3. Quotients in T

Maximum: The largest (0.96) was obtained in No.9, followed by Nos.1, 2, 3, 5, 8 and 14 (0.95). The smallest (0.87) was noted in No.15, which was the same as in cases of the maximum and the minimum of W, followed by No.10 (0.90) and No.20 (0.91). Average and its s.d. through the whole strains were found to be 0.93±0.02.

Table 4. Ranges of comparative values in the strain level

Strain No.	Length			Width			Thickness			Length/Width			Length/Thickness			Width/Thickness		
	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range
1	0.74	0.65	0.09	0.90	0.79	0.11	0.95	0.86	0.09	0.91	0.79	0.12	0.85	0.72	0.13	1.01	0.87	0.14
2	0.73	0.68	0.05	0.88	0.78	0.10	0.95	0.85	0.10	0.91	0.79	0.12	0.81	0.76	0.05	0.99	0.83	0.16
3	0.72	0.70	0.02	0.90	0.81	0.09	0.95	0.87	0.08	0.89	0.79	0.10	0.82	0.73	0.09	1.01	0.87	0.14
4	0.74	0.70	0.04	0.93	0.82	0.11	0.93	0.87	0.06	0.90	0.77	0.13	0.91	0.76	0.15	1.02	0.79	0.23
5	0.74	0.67	0.07	0.84	0.80	0.04	0.95	0.84	0.11	0.90	0.80	0.10	0.84	0.74	0.10	0.96	0.88	0.08
6	0.74	0.67	0.07	0.81	0.71	0.10	0.92	0.82	0.10	0.96	0.87	0.09	0.87	0.76	0.11	0.95	0.87	0.08
7	0.74	0.68	0.06	0.85	0.78	0.07	0.94	0.88	0.06	0.90	0.81	0.09	0.82	0.73	0.09	1.00	0.90	0.10
8	0.75	0.71	0.04	0.96	0.80	0.16	0.95	0.86	0.09	0.91	0.75	0.16	0.84	0.76	0.08	1.06	0.88	0.18
9	0.75	0.68	0.07	0.93	0.83	0.10	0.96	0.88	0.08	0.87	0.77	0.10	0.82	0.74	0.08	1.00	0.90	0.10
10	0.73	0.68	0.05	0.86	0.76	0.10	0.90	0.82	0.08	0.90	0.79	0.11	0.79	0.69	0.10	0.91	0.81	0.10
11	0.72	0.69	0.03	0.89	0.80	0.09	0.92	0.85	0.07	0.89	0.79	0.10	0.84	0.65	0.19	1.06	0.88	0.18
12	0.73	0.66	0.07	0.90	0.80	0.10	0.91	0.86	0.05	0.90	0.73	0.17	0.82	0.73	0.09	1.01	0.88	0.13
13	0.73	0.69	0.04	0.86	0.81	0.05	0.91	0.86	0.05	0.89	0.81	0.08	0.84	0.77	0.07	0.99	0.89	0.10
14	0.73	0.68	0.05	0.88	0.81	0.07	0.95	0.87	0.08	0.86	0.80	0.06	0.82	0.74	0.08	0.98	0.90	0.08
15	0.77	0.71	0.06	0.77	0.70	0.07	0.87	0.79	0.08	0.82	0.73	0.09	0.90	0.81	0.09	0.90	0.80	0.10
16	0.75	0.71	0.04	0.91	0.82	0.09	0.91	0.86	0.05	0.89	0.79	0.10	0.86	0.80	0.06	1.03	0.91	0.13
17	0.71	0.67	0.04	0.87	0.83	0.04	0.93	0.82	0.11	0.85	0.79	0.06	0.83	0.74	0.09	1.03	0.89	0.14
18	0.72	0.66	0.06	0.88	0.78	0.10	0.92	0.88	0.04	0.88	0.78	0.10	0.80	0.74	0.06	0.97	0.88	0.09
19	0.74	0.67	0.07	0.88	0.81	0.07	0.92	0.89	0.03	0.88	0.76	0.12	0.82	0.74	0.08	0.97	0.89	0.08
20	0.69	0.63	0.06	0.86	0.76	0.10	0.91	0.86	0.05	0.89	0.76	0.13	0.77	0.69	0.08	0.99	0.84	0.15

Minimum: The largest (0.89) was obtained in No.19, followed by Nos.7, 9 and 18 (0.88). The smallest (0.79) was noted in No.15, which was the same as in cases of the maxima of W and T, and the minimum of W, followed by Nos.6, 10 and 17 (0.82). Average and its s.d. through the whole strains were found to be 0.86 ± 0.03.

Range: The largest (0.11) was obtained in Nos.5 and 17, followed by Nos.2 and 6 (0.10). The smallest (0.03) was noted in No.19, followed by No.18 (0.04). Average and its s.d. through the whole strains were found to be 0.07 ± 0.03.

4. Quotients in L/W

Maximum: The largest (0.96) was obtained in No.6, followed by Nos.1, 2 and 8 (0.91). The smallest (0.82) was noted in No.15, which was the same as in cases of the maxima and the minima of W and T, followed by No.17 (0.85) and No.14 (0.86). Average and its s.d. through the whole strains were found to be 0.89 ± 0.03.

Minimum: The largest (0.87) was obtained in No.6, which was the same as in case of the maximum of L/W, followed by Nos.7 and 13 (0.81). It was noticeable that the value was particularly large in No.6. The smallest (0.73) was noted in Nos.12 and 15, followed by No.8 (0.75). Average and its s.d. through the whole strains were found to be 0.78 ± 0.03.

Range: The largest (0.17) was obtained in No.12, followed by No.8 (0.16) and Nos.4 and 20 (0.13). The smallest (0.06) was noted in Nos.14 and 17, followed by No.13 (0.08). Average and its s.d. through the whole strains were found to be 0.11 ± 0.03.

5. Quotients in L/T

Maximum: The largest (0.91) was obtained in No.4, followed by No.15 (0.90) and No.6 (0.87). The smallest (0.77) was noted in No.20, which was the same as in cases of the maximum and the minimum of L, followed by No.10 (0.79) and No.2 (0.81). Average and its s.d. through the whole strains were found to be 0.83 ± 0.03.

Minimum: The largest (0.81) was obtained in No.15, which was the same as in case of the maximum of L, followed by No.16 (0.80) and Nos.4, 6 and 8 (0.76). These combinations of strains (8·15·16) were found to be the same as in cases of the maximum and the minimum of L. The smallest (0.69) was noted in Nos.10 and 20, followed by No.1 (0.72). Average and its s.d. through the whole strains were found to be 0.74 ± 0.04.

Range: The largest (0.19) was obtained in No.11, followed by No.4 (0.15) and No.1 (0.13). The smallest (0.05) was noted in No.2, followed by Nos.16 and 18 (0.06). Average and its s.d. through the whole strains were found to be 0.09 ± 0.03.

6. Quotients in W/T

Maximum: The largest (1.06) was obtained in Nos.8 and 11, followed by Nos.16 and 17 (1.03). The smallest (0.90) was noted in No.15, which was the same as in cases of the maxima and the minima of W, T and L/W, followed by No.10 (0.91) and No.6 (0.95). These combinations of strains (6·10·15) were found to be the same as in case of the minimum of W. Average and its s.d. through the whole strains were found to be 0.99 ± 0.04.

Minimum: The largest (0.91) was obtained in No.16, followed by Nos.7, 9 and 14 (0.90). The smallest (0.79) was noted in No.4, followed by No.15 (0.80) and No.10 (0.81). Average and its s.d. through the whole strains were found to be 0.87 ± 0.03.

Range: The largest (0.23) was obtained in No.4, followed by Nos.8 and 11 (0.18). It was noticeable that the value was particularly large in No.4. The smallest (0.08) was noted in Nos.5, 6, 14 and 19. Average and its s.d. through the whole strains were found to be 0.13 ± 0.04.

7. Areas in UHG

Maximum: The variation ranges in area and volume items were calculated, and are shown in Table 5. In this table, the maximum, the minimum and their range are shown. The widest (34.77 mm^2) was obtained in No.20, followed by Nos.12 and 18 (33.83 mm^2). The narrowest (23.93 mm^2) was noted in No.10, followed by No.2 (24.30 mm^2) and No.14 (24.75 mm^2). Average and its s.d. through the whole strains were found to be 28.71 ± 3.28.

Minimum: The widest (30.02 mm^2) was obtained in No.20, which was the same as in case of the maximum of area (UHG), followed by Nos.12 and 18 (28.50 mm^2). These orders of strains ($20 > 12 = 18$) were found to be the same as in case of the maximum of area (UHG). The smallest (19.71 mm^2) was noted in No.6, followed by No.10 (19.92 mm^2) and No.14 (20.25 mm^2). Average and its s.d. through the whole strains were found to be 23.97 ± 0.10.

Range: The largest (5.50 mm^2) was obtained in No.4, which was the same as in cases of the maximum of L/T and range of W/T, followed by No.16 (5.42 mm^2) and No.6 (5.41 mm^2). The smallest (3.30 mm^2) was noted in No.2, which was the same as in case of the range of L/T, followed by No.17 (3.77 mm^2) and No.10 (4.01 mm^2). Average and its s.d. through the whole strains were found to be 4.75 ± 0.63.

8. Volumes in UHG

Maximum: The largest (86.24 mm^3) was obtained in No.20, which was the same as in cases of the maximum and the minimum of area (UHG), followed by No.18 (81.18 mm^3) and No.12 (77.80 mm^3). These combinations of strains (12·18·20) were found to be the same as in cases of the maximum and the minimum of area (UHG). The smallest (45.30 mm^3) was noted in No.10, which was the same as in cases of the maxima of W/T and area (UHG), followed by No.6 (45.35 mm^3) and No.2 (48.60 mm^3). Average and its s.d. through the whole strains were found to be 62.54 ± 11.37.

Minimum: The largest (64.83 mm^3) was obtained in No.20, which was the same as in cases of the maxima of area (UHG) and volume (UHG), and the minimum of volume (UHG), followed by No.17 (61.98 mm^3) and No.12 (61.52 mm^3). The smallest (35.00 mm^3) was noted in No.10, which was the same as in cases of the maxima of W/T, area (UHG) and volume (UHG), followed by No.14 (36.45 mm^3) and No.15 (39.16 mm^3). Average and its s.d. through the whole strains were found to be 47.81 ± 8.63.

Range: The largest (21.41 mm^3) was obtained in No.20, which was the same as in cases of the maxima and the minima of area (UHG) and volume (UHG), followed by No.18 (21.33 mm^3) and No.19 (17.70 mm^3). The smallest (8.70 mm^3) was noted in No.2, which was the same as in cases of the ranges of L/T and area (UHG), followed by No.11 (9.54 mm^3) and No.10 (10.30 mm^3). Average and its s.d. through the whole strains were found to be 14.72 ± 3.40.

9. Areas in HG

Maximum: The widest (20.01 mm^2) was obtained in No.18, followed by No.12 (19.32 mm^2) and No.20 (19.18 mm^2). These combinations of strains (12·18·20) were found to be the same as in cases of the maxima of area (UHG) and volume (UHG), and the minimum of area (UHG). The narrowest (12.89 mm^2) was noted in No.15, which was the same as in cases of the maxima of W, T, L/W and W/T, and the minima of W and T, followed by No.10 (13.11 mm^2) and No.6 (13.21 mm^2). The orders of strains ($15 < 10 < 6$) were found to be the same as in case of the maximum of W/T. Moreover, these combinations of strains (6·10·15) were found to be the same as in case of the minimum of W. Average and its s.d. through the whole strains were found to be 16.71 ± 2.17.

Minimum: The widest (16.25 mm^2) was obtained in No.17, followed by No.12 (15.84 mm^2) and No.5 (15.68 mm^2). The narrowest (10.00 mm^2) was noted in No.10, which was the same as in cases of the maxima of W/T, area (UHG) and volume (UHG), and the minimum of volume (UHG), followed by

Table 5. Ranges of area, volume and quotient

Strain No.	Unhusked						Husked						Quotient					
	Area			Volume			Area			Volume			Area			Volume		
	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range
1	30.86	25.82	5.04	66.35	49.04	17.31	18.90	15.00	3.90	36.46	27.85	8.61	0.64	0.53	0.11	0.61	0.48	0.13
2	24.30	21.00	3.30	48.60	39.90	8.70	14.26	12.39	1.87	24.55	21.06	3.49	0.62	0.54	0.08	0.55	0.48	0.07
3	27.52	23.52	4.00	61.92	46.17	15.75	15.99	13.57	2.42	32.78	24.43	8.35	0.63	0.56	0.07	0.57	0.51	0.06
4	27.60	22.10	5.50	60.68	46.27	14.41	17.16	13.76	3.40	33.50	25.45	8.05	0.68	0.59	0.09	0.61	0.53	0.08
5	31.05	25.73	5.32	70.38	54.02	16.36	17.92	15.68	2.24	37.63	28.67	8.96	0.62	0.56	0.06	0.57	0.48	0.09
6	25.12	19.71	5.41	45.35	39.42	15.93	13.21	11.40	1.81	23.59	18.60	4.99	0.60	0.51	0.09	0.53	0.44	0.09
7	30.29	25.31	4.98	60.66	44.31	16.35	15.82	13.11	2.71	33.16	25.29	7.87	0.67	0.57	0.10	0.59	0.53	0.06
8	28.21	22.95	5.26	62.04	44.59	17.09	17.68	14.88	2.80	35.19	27.45	7.74	0.69	0.58	0.11	0.63	0.53	0.10
9	26.60	22.40	4.20	64.71	42.16	12.55	16.21	13.91	2.30	33.80	27.09	6.71	0.67	0.57	0.10	0.60	0.52	0.08
10	23.93	19.92	4.01	45.30	35.00	10.30	13.11	10.00	3.11	23.01	18.50	4.51	0.60	0.53	0.07	0.59	0.51	0.08
11	25.20	20.75	4.45	51.66	42.12	9.54	15.00	12.47	2.53	27.00	22.57	4.43	0.63	0.56	0.07	0.57	0.49	0.08
12	33.83	28.50	5.33	77.80	61.52	16.28	19.32	15.84	3.48	40.57	31.12	9.45	0.60	0.54	0.06	0.55	0.47	0.08
13	30.45	26.06	4.39	64.53	52.11	12.42	18.13	15.41	2.72	35.10	28.15	6.95	0.62	0.57	0.05	0.56	0.51	0.05
14	24.75	20.25	4.50	50.19	36.45	13.74	14.75	12.15	2.60	26.64	19.50	7.14	0.62	0.57	0.05	0.58	0.51	0.07
15	25.82	21.10	4.72	51.81	39.16	12.65	12.89	10.10	2.79	22.16	15.50	6.66	0.55	0.49	0.06	0.46	0.40	0.06
16	28.42	23.00	5.42	58.80	46.00	12.80	17.89	14.52	3.37	33.29	26.14	7.15	0.66	0.54	0.12	0.59	0.54	0.05
17	31.93	28.16	3.77	73.66	61.98	11.68	18.70	16.25	2.45	38.84	32.56	6.28	0.62	0.56	0.06	0.57	0.47	0.10
18	33.83	28.50	5.33	81.18	59.85	21.33	20.01	15.50	4.51	42.96	29.45	13.51	0.62	0.53	0.09	0.56	0.47	0.09
19	29.75	24.49	5.26	68.90	51.20	17.70	18.00	14.82	3.18	37.32	27.00	10.32	0.64	0.57	0.07	0.58	0.52	0.06
20	34.77	30.02	4.75	86.24	64.83	21.41	19.18	15.66	3.52	41.11	30.54	10.57	0.57	0.50	0.07	0.52	0.44	0.08

No.15 (10.10 mm^2) and No.6 (11.40 mm^2). These combinations of strains (6·10·15) were found to be the same as in cases of the maxima of W/T and area (HG), and the minimum of W. Average and its s.d. through the whole strains were found to be 13.82±1.84.

Range: The largest (4.51 mm^2) was obtained in No.18, which was the same as in case of the maximum of area (HG), followed by No.1 (3.90 mm^2) and No.20 (3.52 mm^2). The smallest (1.81 mm^2) was noted in No.6, which was the same as in case of the minimum of area (UHG), followed by No.2 (1.87 mm^2) and No.5 (2.24 mm^2). Average and its s.d. through the whole strains were found to be 2.89 ±0.66.

10. Volumes in HG

Maximum: The largest (42.96 mm^3) was obtained in No.18, which was the same as in cases of the maximum and range of area (HG), followed by No.20 (41.11 mm^3) and No.12 (40.57 mm^3). These combinations of strains (12·18·20) were found to be the same as in cases of the maxima of areas (UHG and HG) and volume (UHG), and the minimum of area (UHG). The smallest (22.16 mm^3) was noted in No.15, which was the same as in cases of the maxima of W, T, L/W, W/T and area (HG), and the minima of the W and T, followed by No.10 (23.01 mm^3) and No.6 (23.59 mm^3). These orders of strains (15<10<6) were found to be the same as in cases of the maxima of W/T and area (HG). Moreover, these combinations of strains (6·10·15) were found to be the same as in cases of the minima of W and area (HG). Average and its s.d. through the whole strains were found to be 32.93± 6.21.

Minimum: The largest (32.56 mm^3) was obtained in No.17, which was the same as in case of the minimum of area (HG), followed by No.12 (31.12 mm^3) and No.20 (30.54 mm^3). These combinations of strains (12·17·20) were found to be the same as in case of the minimum of volume (UHG). The smallest (15.50 mm^3) was noted in No.15, which was the same as in cases of the maxima of W, T, L/W, W/T, area (HG) and volume (HG), and the minima of W and T, followed by No.10 (18.50 mm^3) and No.6 (18.60 mm^3). These orders of strains (15<10<6) were found to be the same as in cases of the maxima of W/T, area (HG) and volume (HG). Moreover, these combinations of strains (6·10·15) were found to be the same as in cases of the minima of W and area (HG). Average and its s.d. through the whole strains were found to be 25.35±4.56.

Range: The largest (13.51 mm^3) was obtained in No.18, which was the same as in cases of the maxima of area (HG) and volume (HG), and the range of area (HG), followed by No.20 (10.57 mm^3) and No.19 (10.32 mm^3). These combinations of strains (18·19·20) were found to be the same as in case of the range of volume (UHG). The smallest (3.49 mm^3) was noted in No.2, which was the same as in cases of the ranges of L/T, area (UHG) and volume (UHG), followed by No.11 (4.43 mm^3) and No.10 (4.51 mm^3). These orders of strains (2<11<10) were found to be the same as in case of the range of volume (UHG). Average and its s.d. through the whole strains were found to be 7.59±2.30.

11. Quotients in areas

Maximum: The largest (0.69) was obtained in No.8, which was the same as in cases of the maximum and the range of W, followed by No.4 (0.68) and Nos.7 and 9 (0.67). These combinations of strains (4·8·9) were found to be the same as in case of the maximum of W. The smallest (0.55) was noted in No.15, which was the same as in cases of the maxima of W, T, L/W, W/T, area (HG) and volume (HG), the minima of W, T and volume (HG), followed by No.20 (0.57) and Nos.6, 10 and 12 (0.60). These combinations of strains (6·15·20) and (10·15·20) were found to be the same as in case of the minimum of W, and the maximum of T, respectively. Average and its s.d. through the whole strains were found to be 0.63±0.03.

Minimum: The largest (0.59) was obtained in No.4, which was the same as in cases of the

maximum of L/T, and the ranges of W/T and area (UHG), followed by No.8 (0.58) and Nos.7, 9, 13 and 19 (0.57). These combinations of strains (4·8·9) were found to be the same as in cases of the maxima of W and quotient of areas. The smallest (0.49) was noted in No.15, which was the same as in cases of the minima of W, T, L/W, W/T, area (HG), volume (HG) and quotient of areas, the minima of W, T and volume (HG), followed by No.20 (0.50) and No.6 (0.51). These orders of strains (15< 20<10) were found to be the same as in case of the maximum of quotient of areas. Moreover, these combinations of strains (6·15·20) were found to be the same as in cases of the maximum of quotient of areas and the minimum of W. Average and its s.d. through the whole strains were found to be 0.55± 0.03.

Range: The largest (0.12) was obtained in No.16, which was the same as in case of the minimum of W/T, followed by Nos.1 and 8 (0.11). The smallest (0.05) was noted in Nos.13 and 14, followed by Nos.5, 12, 15 and 17 (0.06). These combinations of strains (13·14·17) were found to be the same as in case of the range of L/W. Average and its s.d. through the whole strains were found to be 0.08± 0.02.

12. Quotients in volumes

Maximum: The largest (0.63) was obtained in No.8, which was the same as in cases of the maximum and the range of W and the maximum of quotient of areas, followed by Nos.1 and 4 (0.61). These orders of strains (8>1=4) were found to be the same as in case of the range of W. The smallest (0.46) was noted in No.15, which was the same as in cases of the maxima of W, T, L/W, W/T, area (HG), volume (HG) and quotient of areas, the minima of W, T, volume (HG) and quotient of areas, followed by No.20 (0.52) and No.6 (0.53). These orders of strains (15<20<6) were found to be the same as in cases of the maximum and the minimum of quotient of areas. Moreover, these combinations of strains (6·15·20) were found to be the same as in cases of the minimum of W, and the maximum and the minimum of quotient of areas. Average and its s.d. through the whole strains were found to be 0.54±0.11.

Minimum: The largest (0.54) was obtained in No.16, which was the same as in cases of the minimum of W/T and the range of quotient of areas, followed by Nos.4, 7 and 8 (0.53). The smallest (0.40) was noted in No.15, which was the same as in cases of the maxima of W, T, L/W, W/T, area (HG), volume (HG), quotients of areas and volumes, the minima of W, T, volume (HG), quotient of areas, followed by Nos.6 and 20 (0.44). These combinations of strains (6·15·20) were found to be the same as in cases of the maxima of quotients of areas and volumes, the minima of W and quotient of areas. Average and its s.d. through the whole strains were found to be 0.49±0.04.

Rangē: The largest (0.13) was obtained in No.1, followed by Nos.8 and 17 (0.10). The smallest (0.05) was noted in Nos.13 and 16, followed by Nos.3, 7, 15 and 19 (0.06). Average and its s.d. through the whole strains were found to be 0.08±0.02.

Discussion

Basing on the results obtained in the previous[6] and the present experiments, the following problematic items are to be discussed here.

Comparative values

1. In L/W, the largest (0.94) was obtained in No.6. This value was attributable both to the relatively large value (0.72) in L and to the nearly smallest value (0.76) in W. On the other hand, the nearly smallest (0.82) was noted in No.9. This value was attributable both to the relatively small value (0.71) in L and the largest value (0.88) in W. In L/T, the largest (0.86) was obtained in No.15.

This value was attributable both to the largest value (0.74) in L and the smallest value (0.83) in T. On the other hand, the smallest (0.73) was noted in No.20. This value was attributable both to the smallest value (0.66) in L and to the nearly largest value (0.90) in T. In W/T, the largest (0.96) was obtained in No.8. This value was attributable both to the nearly largest value (0.87) in W and to the relatively small value (0.90) in T. On the contrary, nearly the smallest (0.89) was noted in No.6. This value was attributable both to the nearly smallest value (0.76) in W and to the relatively large value (0.86) in T.

In quotient of areas, the largest (0.64) was obtained in No.8. This value was attributable to the relatively large value (25.44 mm^2) in UHG. On the other hand, the smallest (0.52) was noted in No.15. This value was attributable to the nearly narrowest value (22.99 mm^2) in UHG. In quotient of volumes, the largest (0.58) was obtained in No.8. This value was attributable to the relatively large value (53.85 mm^3) in UHG. On the other hand, the smallest (0.43) was noted in No.15. This value was attributable to the nearly smallest value (43.73 mm^3) in UHG. In general, these analyses in the quotient items were fixed to be more difficult than those in case of the comparative characters.

2. Although the values were particularly large or small in some characters, the values were found to be in the standard level on other characters in view of the same strains. For example, No.16 showed the nearly largest value (0.73) in L, but showed the middle value (0.90) in T. In another case, No.20 showed the smallest value (0.66) in L, but showed the middle value (0.90) in T.

Although a few values were particularly large in some characters, those were found to be quite small in the other characters in view of the same strains, and *vice versa*. For example, No.15 showed the largest value (0.74) in L, but showed the smallest values in W (0.73) and T (0.83). In another case, No.9 showed the largest value (0.88) in W, but showed the nearly smallest value (0.82) in L/W. These phenomena were found in a few character-combinations.

In view of area and volume characters, it was ascertained that the larger is the value of one character, the larger is the value of another character.

3. In view of s.ds., the following items were ascertained to some extent. Owing to the fact that the values of s.d. of the comparative columns were ascertained to be very small, excepting s.ds. of L/W, L/T and W/T in strain No.15 (0.06), it was only in the area and volume columns that the considerations could be done. In general, larger is the s.d. in some character, the larger is the s.d. in another character. For example, No.19 showed the largest s.d. (1.57) in area (UHG), and showed the largest s.d. (0.94) in area (HG). However, some exceptions were found. No.15 showed nearly the largest s.d. (1.48) in area (UHG), but showed the middle value of s.d. (0.69) in area (HG).

In general, the larger is the practical value, the larger is its s.d. For example, No.18 showed the largest value (17.99 mm^2) and the nearly largest s.d. (0.90) in area (HG). However, some exceptions were found. For example, No.10 showed the narrowest value (20.79 mm^2) and at the same time relatively large s.d. (1.38) in area (UHG). These discrepancies may be looked upon as an expression of some evolutional meaning. But it was left inexplicable in the present time. It was noticeable that Nos.5, 7, 18, 20, and Nos.2, 3, 6, 10 showed always the large s.ds. and the small s.ds. through the whole area- and volume-characters, respectively. All of the former and the latter were fixed to be belonging to type B and type C, respectively, in accordance with the tripartite classification[9], which was the same as in cases of Indian cultivars[7] and Madura-strains[8].

4. In comparison of type B and type C made in accordance with the tripartite classification, the following items were ascertained. Type B (7 strains, *i.e.*, strain Nos.1, 5, 7, 12, 17, 18 and 20) showed some general features as follows; the values of areas (UHG and HG), and volumes (UHG and HG) were found to be larger than average of the whole strains (=20); the values of W, T, L/W and W/T

were found to be the same as those in that; and the values of L, L/T, quotients of areas and volumes were found to be smaller than those in that. It was noted that the s.ds. of area (UHG), and area (HG) and volumes (UHG and HG) were fixed to be smaller and larger than those in that.

In type C (the remaining 13 strains), the values of L, L/W, L/T and W/T were found to be larger than average of the whole strains (=20); the values of W, quotients of areas and volumes were found to be the same as those in that; and the values of T, areas (UHG and HG), and volumes (UHG and HG) were found to be smaller than those in that. It was noted that s.ds. of area (HG) and volumes (UHG and HG) were fixed to be smaller than average of the whole strains (=20), formally making a striking contrast to type B. These facts meant that type B (=*javanica*) is to be looked upon as variable features in Fiji and having only light breeding weight than those of type C (=*indica*). These findings proposed an interesting problem on the locality-specificities, strain-differentiations and agronomical importance of the native people.

5. In the larger sets of quotients of areas and volumes, the largest ones (0.64 in quotient of areas and 0.58 in quotient of volumes) were obtained in No.8, followed by No.4 (0.63 in quotient of areas and 0.57 in quotient of volumes) and No.16 (0.62 in quotient of areas and 0.56 in quotient of volumes). These orders of strains were fixed to be the same in quotients both of areas and of volumes. These phenomena were found in the other 3 cases; ② 15<6<10 --- No.15 (0.73 and 18.83 mm^3), No.6 (0.76 and 20.31 mm^3) and No.10 (0.81 and 21.51 mm^3) in the smaller sets of W and volume (HG); ③ 15<10<6 --- No.15 (0.83 and 0.85), No.10 (0.85 and 0.86) and No.6 (0.86 and 0.89) in the smaller sets of T and W/T; ④ 10<6<2 --- No.10 (20.79 mm^2 and 40.05 mm^3), No.6 (21.09 mm^2 and 43.25 mm^3) and No.2 (22.39 mm^2 and 43.26 mm^3) in the smaller sets of area (UHG) and volume (UHG).

On the other hand, some sets of strains did not show the same orders, but showed the same combinations, meaning the same strain numbers regardless of orders. Six cases were ascertained as follows; ① 4·8·16 in the larger sets --- W/T (4=8=16), quotient of areas (8>4>16) and quotient of volumes (8>4>16); ② 12·18·20 in the larger sets --- area (UHG) (20>18>12), volume (UHG) (20>12>18) and volume (HG) (18>20>12); ③ 18·19·20 in the larger sets of s.ds. --- area (HG) (18>20>19) and volume (HG) (20>18>19); ④ 6·10·15 in the smaller sets --- W (15<6<10), T (15<10<6), W/T (15<10<6) and area (HG) (6<15<10), volume (HG) (15<6<10); ⑤ 2·6·10 in the smaller sets --- area (UHG) (10<6<2), volume (UHG) (10<6<2) and s.d. of area (HG) (10<2<6); ⑥ 6·15·20 in the smaller sets --- quotient of areas (15<20<6) and quotient of volumes (15<6<20).

It was noticeable that these synchronized orders and combinations of strains were found to be the fewer cases in the comparative columns than those of area- and volume-columns. It meant that gene actions of characters were independently expressed of each other. It was also noticeable that the combinations of s.ds. in areas and volumes were nearly the same ones as in the whole cases of UHG and HG.

Ranges in the respective characters of comparative values, area and volume items

6. Although the values were particularly large or small in some characters, the values were found to be in the standard level in the other characters, in view of the same strains. For example, No.8 showed the largest value (0.96) in the maximum of W, but showed the middle value (0.80) in the minimum of W. In another example, No.3 showed the nearly smallest value (0.72) in the maximum of L, but showed the middle value (0.70) in the minimum of L.

On the other hand, although the values were particularly large in some characters, the values were found to be particularly small in the other characters in view of the same strains, and *vice versa*.

For example, No.8 showed nearly the largest value (0.91) in the maximum of L/W, but showed the nearly smallest value (0.75) in the minimum of L/W. In another case, No.19 showed the nearly smallest value (0.92) in the maximum of T, but showed the largest value (0.89) in the minimum of W. These phenomena were found in the several combinations.

In view of area and volume characters, it was said, in general, that the larger are the value of the maximum, the larger are the values on the minimum and the range in the respective characters. This tendency was looked upon as the same one as in case of the comparative characters. However, some disorders were found. For example, No.17 showed the largest or relatively large values (31.93 mm^2, 73.66 mm^3, 18.70 mm^2, 38.84 mm^3; 28.16 mm^2, 61.98 mm^3, 16.25 mm^2 and 32.56 mm^3) in the maxima and the minima of area (UHG), volume (UHG), area (HG) and volume (HG), respectively, but showed relatively small values (3.77 mm^2, 11.68 mm^3, 2.45 mm^2 and 6.28 mm^3) in the ranges in the same order, respectively. In another case, No.16 showed nearly the smallest or relatively smaller values (28.42 mm^2, 58.80 mm^3, 17.89 mm^2, 33.29 mm^3; 23.00 mm^2, 46.00 mm^3, 14.52 mm^2 and 26.14 mm^3) in the maxima and the minima of the same order, but showed nearly the largest or relatively larger values (5.42 mm^2, 12.80 mm^3, 3.37 mm^2 and 7.15 mm^3) in the ranges in the same order, respectively. This tendency was looked upon as strain specificity in these strains.

7. In comparison with type B and type C in accordance with the tripartite classification, the following facts were ascertained. Type B showed the general features as follows: In the comparative characters (Table 4), 3 characters (the maximum of W/T, the minimum of W/T, the range of L) and 7 characters (the maxima of L, W and L/T, the minima of L and L/T, the ranges of W and W/T) showed the larger and the smaller values than the average of the whole strains, respectively. The remaining 8 characters showed the same ones as the average of the whole strains.

In area- and volume-characters (Table 5), 14 characters (the maxima, the minima and the ranges of area [UHG and HG], volumes [UHG and HG], and the maximum and range of quotient of volumes), and 3 characters (the maximum of quotient of areas, the minima of quotients of areas and volumes) showed the larger and the smaller values than the average of the whole strains, respectively. The remaining 1 character (the range of quotient of areas) showed the same one as the average of the whole strains.

In type C, in comparative characters (Table 4), 6 characters (the maxima of L and L/T, the minima of L, L/W and L/T, the range of L/T), and 3 characters (the minima of T and W/T, the range of L/W) showed the larger and the smaller values than the average of the whole strains, respectively. The remaining 9 characters showed the same ones as the average of the whole strains. In area- and volume-characters (Table 5), 1 character (the minimum of quotient of volumes), and 13 characters (the maxima, the minima and the ranges of areas [UHG and HG], volumes [UHG and HG], the range of quotient of volumes) showed the larger and the smaller values than the average of the whole strains, respectively. The remaining 4 characters showed the same ones as the average of the whole strains.

The tendency was looked upon as the reversed results observable between type B and type C, and between the comparative characters and area- and volume-characters.

8. In the larger sets of volumes, the largest (0.16 in the range of W and 0.63 in the maximum of quotient of volumes) were obtained in No.8, followed by Nos.1 and 4 (0.11 and 0.61 in the same order). These orders of strains were finally illustrated in these characters as $8>1=4$. These phenomena were found in the other 4 cases; *i.e.*, ② $20>12=18$ --- No.20 (34.77 mm^2 and 30.02 mm^2) and Nos.12 and 18 (33.83 mm^2 and 28.50 mm^2) in the larger sets of the maximum and the minimum of area [UHG]; ③ $15<10<6$ --- No.15 (0.90, 12.89 mm^2, 22.16 mm^3 and 15.50 mm^3), No.10 (0.91, 13.11 mm^2, 23.01 mm^3

and 18.50 mm^3) and No.6 (0.95, 13.21 mm^2, 23.59 mm^3 and 18.60 mm^3) in the smaller sets of the maximum of W/T, the maximum of area [HG], the maximum and the minimum of volume [HG]; ④ 2<11<10 --- No.2 (8.70 mm^3 and 3.49 mm^3), No.11 (9.54 mm^3 and 4.43 mm^3) and No.10 (10.30 mm^3 and 4.51 mm^3) in the smaller sets of the ranges of volumes [UHG and HG]; ⑤ 15<20<6 --- No.15 (0.55, 0.49 and 0.46), No.20 (0.57, 0.50 and 0.52) and No.6 (0.60, 0.51 and 0.53) in the smaller sets of the maximum and the minimum of quotients of areas and the maximum of quotient of volumes.

It was noticed that these phenomena were found in more cases in area- and volume-columns than those of the comparative characters. No case was found in ranges at all. Moreover, case No. ② was constituted by 7 character-combinations. It was also noticeable that order Nos. ②, and ③·④ were constituted by only the strains belonging to type B and type C, respectively.

On the other hand, some sets of strains did not show the same orders, but showed the same combinations, meaning the strain numbers regardless of the orders. Nine cases were found, *i.e.*, ① 8·15·16 in the larger sets --- the maximum of L (15>8=16) and the minimum of L (8=15=16); ② 4·8·9 in the larger sets --- the maximum of W (8>4=9), the maximum (8>4=9) and the minimum (4>8>9) of quotients of areas; ③ 12·18·20 in the larger sets --- the maximum of area [UHG] (20>12=18), the minimum of area [UHG] (20>12=18), the maximum of volume [UHG] (20>18>12), the maximum of area [HG] (18>12>20), the maximum of volume [UHG] (18>20>12); ④ 12·17·20 in the larger sets --- the minimum of volume [UHG] (20>17>12) and the minimum of volume [HG] (17>12>20); ⑤ 18·19·20 in the larger sets --- the ranges of volume [UHG] (20>18>19) and of volume [HG] (18>20>19); ⑥ 6·10·15 in the smaller sets --- the minimum of W (15<6<10), the maximum of W/T (15<10<6), the maximum (15<10<6) and the minimum (10<15<6) of areas [HG], the maximum and the minimum of volumes [HG] (15<10<6); ⑦ 6·15·20 in the smaller sets --- the minimum of W (15<6=20), the maximum and the minimum of quotients of areas (15<20<6), the maximum (15<20<6) and the minimum (15<6=20) of quotients of areas; ⑧ 10·15·20 in the smaller sets --- the maximum of T (15<10<20) and the maximum of quotient of areas (15<20<10); ⑨ 13·14·17 in the smaller sets --- the range of L/W (14=17<13) and the range of quotient of areas (13=14<17).

It was noted that these phenomena were found in more cases in area- and volume-columns than those of the comparative characters, which was the same as in case of the orders. Moreover, combination Nos. ⑥, and ③·⑦ were constituted by 6 and 5 character-combinations, respectively. It was also noticeable that combination Nos. ③·④, and ①·②·⑥ were constituted by only the strains belonging to type B and type C, respectively.

9. From the data obtained in the previous[6] and the present experiments, varietal variations were summed-up in view of the pure-ranges, and are shown in Table 6. In this table, strains showing the relatively large (roman figure in the table) and relatively small (*italic figure* in the table) values were illustrated in Nos.1, 2 and 3 in 24 characters. These were some developing new techniques.

In the larger ranges, the highest frequency (=10) was found in No.18, followed by No.8 (=9). The lowest frequency (=0) was noted in Nos.7, 10, 13 and 14. One, 1, 4, 1, 1, 1, 2, 3, 2 and 4 strains showed the larger values in 10, 9, 8, 7, 6, 4, 3, 2, 1 and 0 characters, respectively. Average and its s.d. through the whole characters were found to be 4.10±3.42.

In the smaller ranges, the highest frequency (=12) was found in No.2, followed by No.13 (=11) and No.5 (=9). The lowest frequency (=0) was noted in Nos.4 and 9, followed by No.7 (=1). One, 1, 1, 1, 2, 3, 1, 1, 6, 1 and 2 strains showed the smaller values in 12, 11, 9, 8, 7, 5, 4, 3, 2, 1 and 0 characters, respectively. Average and its s.d. through the whole characters were found to be 4.45±

Table 6. Strains showing the relatively large values (roman figure) and the small values (*italic figure*) in the 24 characters, cited from the pure-ranges; 1—the largest or smallest, 2—the second, 3—the third values in the respective characters

Strain No.	Character numbers																								Total		
	Unhusked						Husked						Comparison						Area and Volume								
	1	2	3	4	5	6	11	12	13	14	15	16	21	22	23	24	25	26	31	32	33	34	35	36	L	*S*	T
1	*2*	*2*					2				2		1	2			3				2		2	1	8	*2*	10
2			*1*		*2*		*2*	*1*	*1*		*1*	*3*			3		*1*		*1*	*1*	*2*	*1*			1	*12*	13
3	*2*		3		*3*		*2*		1			3	*1*											*3*	3	*5*	8
4			3		2			1						2		3	2	1	1						8	*0*	8
5			*2*		*3*			*3*		*1*	*3*		2	*1*	1			*1*			*3*		*3*		2	*9*	11
6		*2*		*3*									2		3			*2*	3		*1*				3	*4*	7
7																								*3*	0	*1*	1
8		1	3	2		2		*3*	*2*					1		2		2					2	2	9	*2*	11
9													2												1	*0*	1
10			*2*									*2*							*3*	*3*		*3*			0	*5*	5
11	*1*	1	*2*			3	*1*		*2*				*2*				1	2		*2*		*2*			4	*7*	11
12			*2*										2			1							*3*		2	*2*	4
13		*1*	*2*			*1*		*2*	*2*		*3*	*3*		*3*		*3*							*1*	*1*	0	*11*	11
14				*1*	*1*	*2*		*3*		*3*						*1*		*1*					*1*		0	*8*	8
15			3							3	*1*												*3*	*3*	2	*3*	5
16	3	1		1		1						3					*2*		2				1	*1*	7	*2*	9
17	1		*2*			*2*	1	*3*	1	2	1	3		*1*	1	*1*			*2*				*3*	3	8	*7*	15
18	2			3	1		3	2		1	3				*2*		*2*			2	1	1			10	*2*	12
19			2	*1*					1	*2*		2	2		*1*			*1*		3		3		*3*	6	*5*	11
20	3	*2*	1		3			2				*1*				3				1	3	2			8	*2*	10

Character numbers; 1, 11, 21—length, 2, 12, 22—width, 3, 13, 23—thickness, 4, 14, 24—L/W, 5, 15, 25—L/T, 6, 16, 26—W/T, 1~6—unhusked grains, 11~16—husked grains, 21~26--comparative values (=husked/unhusked), 31—area (UHG), 32—volume (UHG), 33—area (HG), 34—volume (HG), 35—quotient of areas (=33/31), 36—quotient of volumes (=34/32)

Total; L - relatively large values, *S* - relatively small values, T - both of L and *S*

3.44.

In the whole ranges, the highest frequency (=15) was found in No.17, followed by No.2 (=13) and No.18 (=12). The lowest frequency (=1) was noted in Nos.7 and 9, followed by No.12 (=4) and Nos.10 and 15 (=5). One, 1, 1, 5, 2, 1, 3, 1, 2, 1 and 2 strains showed the total frequencies in 15, 13, 12, 11, 10, 9, 8, 7, 5, 4 and 1 characters, respectively. Average and its s.d. through the whole characters were found to be 8.55±3.68. It was reasonably found that the results found in larger ranges were fixed to be the reversed status of those of the smaller ranges. It was noticeable that the s.d. were remarkably larger through the 3 categories mentioned above.

In view of the tripartite classification, the following facts were ascertained. Type B in the larger ranges, 1, 3, 2 and 1 strains showed the larger values in 10, 8, 2 and 0 characters, respectively. Average and its s.d. through the whole characters were found to be 5.42±3.65. In the smaller ranges, 1, 1, 4 and 1 strains showed the smaller values in 9, 7, 2 and 1 characters, respectively. Average and its s.d. through the whole characters were found to be 3.57±2.87. In the whole ranges, 1, 1, 1, 2, 1 and 1 strains showed the total frequencies in 15, 12, 11, 10, 4 and 1 characters, respectively. Average

and its s.d. through the whole characters were found to be 9.00±4.47.

Type C in the larger ranges, 1, 1, 1, 1, 1, 2, 1, 2 and 3 strains showed the larger values in 9, 8, 7, 6, 4, 3, 2, 1 and 0 characters, respectively. Average and its s.d. through the whole characters were found to be 3.39±3.05. In the smaller ranges, 1, 1, 1, 1, 3, 1, 1, 2 and 2 strains showed the smaller values in 12, 11, 8, 7, 5, 4, 3, 2 and 0 characters, respectively. Average and its s.d. through the whole characters were found to be 4.92±3.63. In the whole ranges, 1, 4, 1, 3, 1, 2 and 1 strains showed the total frequencies in 13, 11, 9, 8, 7, 5 and 1 characters, respectively. Average and its s.d. through the whole characters were found to be 8.31±3.15.

It was noticeable that type B showed relatively higher frequencies in the larger ranges and total ones. On the other hand, type B showed relatively lower frequencies in the smaller ranges. Moreover, s.ds. were fixed to be of higher level through the whole cases. It meant that varietal variations were ascertained to be of conspicuous values.

These analysing techniques were used for the recently by the present author. Further practices should be requested, using much more strains.

10. Basing on the previous[6] and the present experiments, another new technique to analyse the varietal variations was adopted. On the strain-average, the maximum, the minimum and their range, strains of the relatively large or small values were picked-up and arranged in accordance with the tripartite classification. The results are shown in Table 7. For example, # mark dotted at C line in character No.4 (=L/W of UHG) in strain-average at the larger column means that 3 strains showing the largest (strain No.13=3.50), the second (No.16=3.49) and the third (No.4=3.30) were classified into type C. In another example, # mark at M line in character No.1 (=length of UHG) in strain-average at the larger column means that 3 strains showing relatively large values were found to be a mixed one with type B and type C, *i.e.*, the largest (strain No.13=9.86 mm), the second (No.12=9.85 mm) and the third (No.18=9.75 mm) belonged to type C, type B and type B, respectively.

In the total, cases of type B, type C and the mixed one were ascertained as 22 (11.5% for the grand total cases as 192 [8×24]), 70 (36.5%) and 100 (52.1%), respectively. Numbers of strains were ascertained at 7 (35.0% for the total 20 strains) and 13 (65.0% for the total 20 strains) in type B and type C, respectively. Accordingly, ratios of 22 to 70 showed significant differences in comparison with ratio of 7 to 13 (χ^2 test). It meant that type B had the tendency of showing a few relatively extreme values through the whole characters and the whole strains. Average and its s.d. through the whole characters (=24) were found to be 0.92±1.32, 2.92±1.26 and 4.17±2.10 in type B, type C and the mixed one, respectively. It was noticed that the value of s.d. in the type B was found to be very small being the same as in case of the practical value.

In type B, average and its s.d. through the average values, the maximum, the minimum, the range and the total were found to be 5.00±1.23, 0.50±0.50 and 2.75±2.44 in the larger, the small and the total ones, respectively. In type C, these were found to be in the same order as 4.00±1.64, 11.25±3.11 and 8.75±3.53, respectively. In the mixed one, these were 9.00±4.90, 12.25±3.42 and 12.50±3.00, respectively. Significant differences were ascertained between the mutual columns in the whole cases. It might be of universal validity in analysing the strain differentiations.

It was noticeable that all of the s.ds. through the 4 characters (character Nos.31~34, area and volume items) was classified into the mixed one and type C in the large and small columns, respectively. It was nearly the same results as those in the strains of Madura, Indonesia[8].

11. Rice cultivation in Fiji had been started in Navua areas in late 19th century by Indo-Fijians, who migrated here as contract-workers of sugarcane plantation. Cultivation areas were increased from year by year mainly by Indo-Fijians[1,5]. In countries belonging to South Pacific, several trials

Table 7. Characters showing the relatively large and small values in 20 strains; cited mainly from the pure-range shown in Table 6. # mark dotted at C line in character number 1 in strain-average at the large colume means that 3 strains showing the largest (strain No.13), the second (No.12) and the third (No.18) were classified to type C, type B and type B, respectively. This case is detected to "Mixed group".

Character No.	Average						Maximum						Minimum						Range						Total		
	Large			Small			Large			Small			Large			Small			Large			Small					
	B	C	M	B	C	M	B	C	M	B	C	M	B	C	M	B	C	M	B	C	M	B	C	M	B	C	M
1			#		#				#		#				#		#				#			#	0	3	5
2			#		#				#		#				#		#			#				#	0	4	4
3	#				#		#				#		#				#				#			#	3	3	2
4		#				#		#				#		#				#			#		#		0	4	4
5			#			#			#		#				#			#			#			#	0	2	6
6			#		#				#		#				#		#			#				#	0	4	4
11			#		#				#			#			#			#	#				#		1	2	5
12			#		#				#		#				#		#				#			#	0	3	5
13	#				#		#				#				#		#				#		#		2	4	2
14		#				#		#				#		#				#			#			#	0	3	5
15		#				#			#			#		#				#	#					#	1	2	5
16			#		#				#		#				#		#			#				#	0	4	4
21		#		#				#				#		#		#					#		#		2	4	2
22		#				#		#				#			#			#			#			#	0	2	6
23			#		#				#			#			#			#			#			#	0	1	7
24			#			#			#			#			#			#			#			#	0	0	8
25		#				#		#				#		#				#			#			#	0	3	5
26		#			#				#		#				#		#			#				#	0	5	3
31	#				#		#				#		#				#			#				#	3	4	1
32	#				#		#				#		#				#				#		#		3	4	1
33	#				#		#				#		#				#		#					#	4	3	1
34	#				#		#				#		#				#				#		#		3	4	1
35		#				#			#			#			#			#			#			#	0	1	7
36		#				#			#			#			#			#			#			#	0	1	7
L	6	9	9				6	5	13				5	6	13				3	5	16				20	25	51
S				1	14	9				0	13	11				1	12	11				0	6	18	2	45	49

Character numbers; the same as mentioned in Table 6.

B, C, M; type B, type C and those mixed out of them in accordance with the tripartite classification, respectively

of rice cultivation had been attempted, most of which were looked upon as unsuccessful, but just one in Fiji as successful[4].

Recently, the total rice consumption was estimated in the increasing cultivation area and production per unit area. The following items were considered to be a counterplan for the advancement of rice production[2], *i.e.*, irrigation system, increment of cultivation area, selection of adaptive varieties, improvement of soil condition, removal of salt element, protection from insects and diseases, herbicide, trial of manure, renewal of seeds, betterment of cultivation techniques, extension services.

In another island of South Pacific, Solomon Islands, extensive researches have been carried out

from several aspects, *i.e.*, protection of insects and diseases[10], herbicide[3].

For genetic and breeding purposes, however, varietal variations and some methodologies of those should be ascertained as early as possible. Taking these facts into account, the present author had made efforts to accomplish the work, the aim of which was to clarify the varietal variations and the phylogenetic relationships of cultivars, using some relatively primitive, unadvanced and advanced ones in Fiji.

Summary

In order to confirm the morphological characters of the cultivated rice collected in Fiji, South Pacific, comparative values, area- and volume-characters, the variation ranges for 12 characters were investigated, following the previous paper. The main results obtained during this study were summarized as follows:

Comparative values of length, width, thickness, L/W, L/T and W/T were measured as 0.71, 0.83, 0.90, 0.84, 0.79 and 0.92 in the average values, respectively. Area (UHG), volume (UHG), area (HG), volume (HG), quotient of areas and quotient of volumes were measured as 26.21 mm^2, 55.76 mm^3, 15.43 mm^2, 29.49 mm^3, 0.59 and 0.53 in average values, respectively.

The maximum, the minimum and the range of the comparative values of length, width, thickness, L/W, L/T and W/T in views of UHG were ascertained as 0.73, 0.68, 0.05; 0.88, 0.79, 0.09; 0.93, 0.86, 0.07; 0.89, 0.78, 0.11; 0.83, 0.74, 0.09; 0.99, 0.87, 0.13 in average values, respectively. The maximum, the minimum and their ranges of area (UHG), volume (UHG), area (HG), volume (HG), quotient of areas and the quotient of volumes were ascertained as 28.71 mm^2, 23.97 mm^2, 4.75 mm^2; 62.54 mm^3, 47.81 mm^3, 14.72 mm^3; 16.71 mm^2, 13.82 mm^2, 2.89 mm^2; 32.93 mm^3, 25.35 mm^3, 7.59 mm^3; 0.63, 0.55, 0.08; 0.54, 0.49, 0.08 in average values, respectively.

Basing on the data obtained in these characters, several patterns were found as variety- and strain-specificities. According to the tripartite classification, some specific features were found. Strains showing relatively large or small values in the respective characters were picked-up and grouped into the categories of "order" and "combination". These techniques were already fixed to be useful for testing the strain or geographical differentiations of rice varieties. From the data obtained in the previous and the present experiments, varietal variations were summed-up in view of the pure-ranges for 24 characters. Some interesting facts were ascertained.

On analysing the strain-average, the maximum, the minimum and their ranges, a new method was adopted, with the ascertainment of some aspects of type B and type C carried out successfully. It might be expected that this newly devised method might have some universal validity in analysing the strain-differentiations.

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