

## Morphological Characters of the Cultivated Rice Grains of Burma (III)

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### Introduction

During the period from December in 1978 to February in 1979, four scientists including the present author were sent to India and Burma for collection of the wild and cultivated rices under the project, designated "The Distribution of Wild Rice and the Ecotypic Differentiation of Cultivated Rice in Burma and Assam", supported by a Grant from the Ministry of Education, Japan. In this opportunity, 64 strains of cultivated rice distributed in large areas of Burma, for example, Myodwin, Kalagyaung, Yezin, Kyamathauk, Bassein, were collected by the members of the party. The grains of these strains were used for the morphological studies.

The generally accepted indigenous centre of rice is an area embracing south Asia, south-east Asia and China. Morinaga<sup>4)</sup> stated that spacial gene-pattern of ecospecies "*japonica*" is probably to be established around southeast Himalaya. East and northeast parts of India has been considered to be one of the differentiation centres of rice in accordance with many investigations. Sharma *et al.*<sup>5)</sup> carried out some systematic collection of current and primitive cultivars of rice in the northeastern part of India.

Burma is located in the adjacent to region mentioned above, and has long history of rice cultivations. All over the land of Burma, rice varieties showed very large varietal variations<sup>6)</sup>.

However, accumulation of complete data endorsed by discussions on these aspects has been unfortunately far from being perfect. The present experimental series has made to search the varietal variations, taking these facts into account. In the previous papers, the records of morphological characters of the unhusked and the husked grains, some mutual relations<sup>2)</sup>, comparative data of the unhusked and husked grains and their variation ranges<sup>3)</sup> were reported, in order to confirm the morphological characters of grains which were to make the strain's specificities clear. Variation ranges were used in the wild species of *Vigna* sp. at the first time by the present author<sup>1)</sup>, and some useful informations were obtained. So, these characters were applied for the cultivated rice.

### Materials and Methods

Sixty-four strains of rice cultivars, *Oryza sativa* L., collected in Burma were used in this experiment. They are listed up in Table 1 of the previous paper<sup>2)</sup>. In this table, collection

number, collection date, collection place, and detailed informations are mentioned.

Thirty grains were used for the measurement of each strain. Variation ranges in 12 characters (Tables 1 and 2) were illustrated by the maximum, the minimum and the pure-range value in the whole grains. In those tables, comparative values for 6 characters (Table 1) were illustrated by the ratios of value in the husked to value in the unhusked grains in the respective characters. The following 6 characters (Table 2) were illustrated by the areas (=length x width) and volumes (=length x width x thickness) for the 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 value in the whole grains.

In this 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

### 1. Quotients in L

*Maximum* : The results are given in Table 1. In this table, the maximum, the minimum and their range are shown. The largest (0.78) was obtained in No. 40, followed by No. 34 (0.77) and Nos. 9, 14, 29, 55 and 57 (0.76). The smallest (0.69) was noted in No. 11, followed by No. 27 (0.70) and Nos. 10, 54 and 62 (0.71). Average and its s. d. through the whole strains were found to be  $0.73 \pm 0.02$ .

*Minimum* : The largest (0.72) was obtained in No. 29, followed by Nos. 31 and 57 (0.71). The smallest (0.63) was noted in Nos. 11 and 28, followed by Nos. 4, 10, 22 and 53 (0.64). Average and its s. d. through the whole strains were found to be  $0.68 \pm 0.02$ .

*Range* : The largest (0.10) was obtained in Nos. 14 and 22, followed by Nos. 9, 28, 34, 40 and 54 (0.09). The smallest (0.03) was noted in Nos. 19, 26, 27 and 51. Average and its s. d. through the whole strains were found to be  $0.06 \pm 0.02$ .

### 2. Quotients in W

*Maximum* : The largest (0.95) was obtained in No. 45, followed by Nos. 8 and 52 (0.94). The smallest (0.82) was noted in No. 16, followed by Nos. 30 and 61 (0.84). Average and its s. d. through the whole strains were found to be  $0.89 \pm 0.03$ .

*Minimum* : The largest (0.89) was obtained in Nos. 46 and 52, followed by No. 64 (0.88). The smallest (0.74) was noted in Nos. 7 and 15, followed by Nos. 10 and 28 (0.76). Average and its s. d. through the whole strains were found to be  $0.82 \pm 0.04$ .

*Range* : The largest (0.17) was obtained in No. 8, followed by Nos. 2 and 15 (0.15). The smallest (0.03) was noted in Nos. 23 and 61. Average and its s. d. through the whole strains were found to be  $0.70 \pm 0.03$ .

### 3. Quotients in T

*Maximum* : The largest (0.96) was obtained in No. 1, followed by Nos. 4, 28, 56 and 59 (0.95). The smallest (0.90) was noted in No. 62, followed by Nos. 16, 21, 22, 25, 51, 53 and 58 (0.91). Average and its s. d. through the whole strains were found to be  $0.93 \pm 0.01$ .

Table 1. 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	0.69	0.05	0.88	0.80	0.08	0.96	0.88	0.08	0.87	0.80	0.07	0.83	0.74	0.09	0.98	0.86	0.12
2	0.75	0.70	0.05	0.92	0.77	0.15	0.93	0.85	0.08	0.93	0.77	0.16	0.84	0.78	0.06	1.02	0.88	0.14
3	0.74	0.68	0.06	0.89	0.79	0.10	0.93	0.86	0.07	0.89	0.76	0.13	0.83	0.74	0.09	1.00	0.87	0.13
4	0.72	0.64	0.08	0.85	0.77	0.08	0.95	0.88	0.07	0.89	0.78	0.11	0.80	0.68	0.12	0.96	0.85	0.11
5	0.74	0.68	0.06	0.87	0.79	0.08	0.93	0.86	0.07	0.91	0.82	0.09	0.85	0.74	0.11	0.96	0.86	0.10
6	0.74	0.68	0.06	0.90	0.79	0.11	0.92	0.88	0.04	0.93	0.78	0.15	0.82	0.76	0.06	0.99	0.88	0.11
7	0.73	0.67	0.06	0.85	0.74	0.11	0.93	0.89	0.04	0.97	0.84	0.13	0.80	0.74	0.06	0.93	0.82	0.11
8	0.72	0.68	0.04	0.94	0.77	0.17	0.93	0.87	0.06	0.91	0.74	0.17	0.83	0.73	0.10	1.05	0.85	0.20
9	0.76	0.67	0.09	0.88	0.80	0.08	0.94	0.87	0.07	0.96	0.79	0.17	0.85	0.74	0.11	0.98	0.87	0.11
10	0.71	0.64	0.07	0.89	0.76	0.13	0.93	0.88	0.05	0.92	0.74	0.18	0.80	0.66	0.14	0.98	0.83	0.15
11	0.69	0.63	0.06	0.88	0.79	0.09	0.93	0.87	0.06	0.86	0.75	0.11	0.78	0.70	0.08	0.98	0.88	0.10
12	0.74	0.67	0.07	0.90	0.80	0.10	0.93	0.89	0.04	0.90	0.76	0.14	0.83	0.73	0.10	0.99	0.84	0.15
13	0.72	0.68	0.04	0.90	0.82	0.08	0.92	0.89	0.03	0.86	0.76	0.10	0.80	0.70	0.10	0.99	0.90	0.09
14	0.76	0.66	0.10	0.86	0.80	0.06	0.93	0.88	0.05	0.91	0.81	0.10	0.84	0.73	0.11	0.95	0.90	0.05
15	0.72	0.66	0.06	0.89	0.74	0.15	0.94	0.89	0.05	0.92	0.82	0.10	0.80	0.73	0.07	0.98	0.84	0.14
16	0.72	0.67	0.05	0.82	0.77	0.05	0.91	0.88	0.03	0.90	0.83	0.07	0.81	0.74	0.07	0.93	0.84	0.09
17	0.72	0.67	0.05	0.88	0.81	0.07	0.93	0.90	0.03	0.88	0.78	0.10	0.79	0.73	0.06	0.97	0.87	0.10
18	0.73	0.69	0.04	0.89	0.81	0.08	0.93	0.86	0.07	0.90	0.79	0.11	0.84	0.76	0.08	1.00	0.89	0.11
19	0.73	0.70	0.03	0.88	0.81	0.07	0.93	0.88	0.05	0.89	0.82	0.07	0.80	0.76	0.04	0.97	0.89	0.08
20	0.75	0.67	0.08	0.90	0.83	0.07	0.93	0.88	0.05	0.87	0.77	0.10	0.86	0.73	0.13	0.99	0.93	0.06
21	0.72	0.68	0.04	0.88	0.82	0.06	0.91	0.88	0.03	0.85	0.77	0.08	0.80	0.75	0.05	0.99	0.91	0.08
22	0.74	0.64	0.10	0.85	0.77	0.08	0.91	0.87	0.04	0.92	0.79	0.13	0.82	0.71	0.11	1.06	0.85	0.21
23	0.74	0.67	0.07	0.88	0.85	0.03	0.92	0.89	0.03	0.86	0.76	0.10	0.82	0.73	0.09	0.98	0.92	0.06
24	0.73	0.69	0.04	0.89	0.82	0.07	0.92	0.86	0.06	0.87	0.82	0.05	0.82	0.76	0.06	1.02	0.90	0.12
25	0.74	0.68	0.06	0.90	0.79	0.11	0.91	0.90	0.01	0.89	0.75	0.14	0.82	0.75	0.07	0.99	0.88	0.11
26	0.72	0.69	0.03	0.88	0.80	0.08	0.94	0.87	0.07	0.87	0.80	0.07	0.80	0.76	0.04	0.99	0.88	0.11
27	0.70	0.67	0.03	0.85	0.79	0.06	0.93	0.90	0.03	0.87	0.80	0.07	0.78	0.73	0.04	0.94	0.88	0.06
28	0.72	0.63	0.09	0.85	0.76	0.09	0.95	0.89	0.06	0.94	0.83	0.11	0.80	0.74	0.06	0.93	0.84	0.09
29	0.76	0.72	0.04	0.91	0.80	0.11	0.93	0.88	0.05	0.90	0.82	0.08	0.85	0.79	0.06	1.00	0.88	0.12
30	0.75	0.70	0.05	0.84	0.79	0.05	0.92	0.88	0.04	0.91	0.83	0.08	0.81	0.77	0.04	0.95	0.87	0.08
31	0.75	0.71	0.04	0.90	0.81	0.09	0.92	0.87	0.05	0.92	0.82	0.10	0.86	0.77	0.09	1.03	0.91	0.12
32	0.74	0.68	0.06	0.92	0.85	0.07	0.92	0.84	0.08	0.85	0.75	0.10	0.85	0.74	0.11	1.07	0.93	0.14

(Continued)

Table I. (Continued)

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
33	0.74	0.69	0.05	0.92	0.84	0.08	0.92	0.88	0.04	0.87	0.77	0.10	0.82	0.76	0.06	1.03	0.92	0.11
34	0.77	0.68	0.09	0.91	0.80	0.11	0.93	0.87	0.06	0.89	0.77	0.12	0.85	0.74	0.11	1.02	0.89	0.13
35	0.72	0.68	0.04	0.87	0.83	0.04	0.92	0.89	0.03	0.86	0.80	0.06	0.80	0.74	0.06	0.97	0.91	0.06
36	0.73	0.69	0.04	0.92	0.85	0.07	0.93	0.88	0.05	0.84	0.76	0.08	0.86	0.75	0.11	1.03	0.90	0.13
37	0.75	0.69	0.06	0.90	0.83	0.07	0.93	0.89	0.04	0.86	0.77	0.09	0.82	0.76	0.06	1.00	0.90	0.10
38	0.74	0.70	0.04	0.92	0.84	0.08	0.94	0.89	0.05	0.87	0.77	0.10	0.82	0.75	0.07	1.01	0.93	0.08
39	0.74	0.68	0.06	0.89	0.85	0.04	0.94	0.87	0.07	0.87	0.77	0.10	0.82	0.74	0.08	1.02	0.93	0.09
40	0.78	0.69	0.09	0.89	0.82	0.07	0.93	0.88	0.05	0.91	0.80	0.11	0.85	0.74	0.11	0.97	0.91	0.06
41	0.73	0.68	0.05	0.89	0.85	0.04	0.92	0.89	0.03	0.84	0.78	0.06	0.80	0.74	0.06	1.04	0.92	0.12
42	0.73	0.69	0.04	0.91	0.86	0.05	0.94	0.90	0.04	0.85	0.77	0.08	0.81	0.76	0.05	1.00	0.93	0.07
43	0.72	0.68	0.04	0.89	0.85	0.04	0.92	0.89	0.03	0.83	0.77	0.06	0.78	0.74	0.04	0.99	0.93	0.06
44	0.73	0.68	0.05	0.93	0.87	0.06	0.93	0.88	0.05	0.85	0.74	0.11	0.82	0.76	0.06	1.04	0.95	0.09
45	0.73	0.69	0.04	0.95	0.77	0.08	0.92	0.85	0.07	0.93	0.75	0.08	0.85	0.76	0.09	1.05	0.88	0.17
46	0.75	0.67	0.08	0.93	0.89	0.04	0.92	0.91	0.01	0.83	0.74	0.09	0.87	0.74	0.13	1.02	0.97	0.05
47	0.74	0.68	0.06	0.91	0.83	0.08	0.94	0.89	0.05	0.86	0.77	0.09	0.81	0.75	0.06	1.02	0.91	0.11
48	0.72	0.67	0.05	0.91	0.82	0.09	0.94	0.89	0.05	0.86	0.74	0.12	0.79	0.72	0.07	0.99	0.89	0.10
49	0.74	0.70	0.04	0.91	0.87	0.04	0.92	0.91	0.01	0.83	0.77	0.06	0.81	0.77	0.04	1.00	0.96	0.04
50	0.75	0.68	0.07	0.93	0.86	0.07	0.92	0.91	0.01	0.86	0.75	0.11	0.82	0.74	0.08	1.02	0.94	0.08
51	0.73	0.70	0.03	0.87	0.83	0.04	0.91	0.88	0.03	0.86	0.81	0.05	0.82	0.77	0.05	0.98	0.92	0.06
52	0.73	0.68	0.05	0.94	0.89	0.05	0.92	0.89	0.03	0.82	0.76	0.06	0.80	0.74	0.06	1.03	0.97	0.06
53	0.73	0.64	0.09	0.91	0.84	0.07	0.91	0.87	0.04	0.87	0.72	0.15	0.80	0.71	0.09	1.03	0.92	0.11
54	0.71	0.67	0.04	0.92	0.85	0.07	0.92	0.87	0.05	0.81	0.74	0.07	0.79	0.74	0.05	1.03	0.94	0.09
55	0.76	0.70	0.06	0.90	0.85	0.05	0.93	0.87	0.06	0.91	0.78	0.13	0.85	0.77	0.08	1.02	0.95	0.07
56	0.72	0.66	0.06	0.88	0.83	0.05	0.95	0.85	0.10	0.85	0.76	0.09	0.88	0.72	0.16	1.00	0.93	0.07
57	0.76	0.71	0.05	0.89	0.82	0.07	0.93	0.87	0.06	0.90	0.82	0.08	0.84	0.78	0.06	0.99	0.91	0.08
58	0.73	0.68	0.05	0.86	0.82	0.04	0.91	0.87	0.04	0.87	0.81	0.06	0.82	0.75	0.07	0.97	0.91	0.06
59	0.74	0.68	0.06	0.90	0.85	0.05	0.95	0.88	0.07	0.87	0.80	0.07	0.82	0.76	0.06	0.99	0.90	0.09
60	0.72	0.66	0.06	0.87	0.83	0.04	0.93	0.86	0.07	0.87	0.79	0.08	0.80	0.74	0.06	0.98	0.90	0.08
61	0.74	0.69	0.05	0.84	0.81	0.03	0.92	0.89	0.03	0.89	0.83	0.06	0.82	0.74	0.08	0.94	0.89	0.05
62	0.71	0.67	0.04	0.90	0.84	0.06	0.90	0.85	0.05	0.82	0.76	0.06	0.81	0.76	0.05	1.03	0.96	0.07
63	0.74	0.69	0.05	0.93	0.83	0.10	0.93	0.88	0.05	0.89	0.74	0.15	0.81	0.75	0.06	1.05	0.91	0.14
64	0.73	0.69	0.04	0.92	0.88	0.04	0.92	0.91	0.01	0.82	0.75	0.07	0.80	0.75	0.05	1.02	0.96	0.06

*Minimum* : The largest (0.91) was obtained in Nos. 46, 49, 50 and 64. The smallest (0.84) was noted in No. 32, followed by Nos. 2, 45, 56 and 62 (0.85). Average and its s. d. through the whole strains were found to be  $0.88 \pm 0.02$ .

*Range* : The largest (0.10) was obtained in No. 56, followed by Nos. 1, 2 and 32 (0.08). The smallest (0.01) was noted in Nos. 25, 46, 50 and 64. Average and its s. d. through the whole strains were found to be  $0.05 \pm 0.02$ .

#### 4. Quotients in L/W

*Maximum* : The largest (0.97) was obtained in No. 7, followed by No. 9 (0.96) and No. 28 (0.94). The smallest (0.81) was noted in No. 54, followed by Nos. 52, 62 and 64 (0.82). Average and its s. d. through the whole strains were found to be  $0.88 \pm 0.04$ .

*Minimum* : The largest (0.84) was obtained in No. 7, which was the same as in case of the maximum of L/W, followed by Nos. 16, 28, 30 and 61 (0.83). The smallest (0.72) was noted in No. 53, followed by Nos. 8, 44, 46, 48, 54 and 63 (0.74). Average and its s. d. through the whole strains were found to be  $0.78 \pm 0.03$ .

*Range* : The largest (0.18) was obtained in No. 10, followed by Nos. 8 and 9 (0.17). The smallest (0.05) was noted in Nos. 24 and 51. Average and its s. d. through the whole strains were found to be  $0.10 \pm 0.03$ .

#### 5. Quotients in L/T

*Maximum* : The largest (0.88) was obtained in No. 56, which was the same as in case of the range of T, followed by No. 46 (0.87) and Nos. 20, 31 and 36 (0.86). The smallest (0.78) was noted in Nos. 11, 27 and 43. Average and its s. d. through the whole strains were found to be  $0.82 \pm 0.02$ .

*Minimum* : The largest (0.79) was obtained in No. 29, which was the same as in case of the minimum of L, followed by Nos. 2 and 57 (0.78). The smallest (0.66) was noted in No. 10, followed by No. 4 (0.68) and Nos. 11 and 13 (0.70). Average and its s. d. through the whole strains were found to be  $0.74 \pm 0.02$ .

*Range* : The largest (0.16) was obtained in No. 56, which was the same as in cases of the range of T and of the maximum of L/T, followed by No. 10 (0.14) and Nos. 20 and 46 (0.13). The smallest (0.04) was noted in Nos. 19, 26, 27, 30, 43 and 49. These combinations of strains were found to be the same as in case of the range of L. Average and its s. d. through the whole strains were found to be  $0.08 \pm 0.03$ .

#### 6. Quotients in W/T

*Maximum* : The largest (1.07) was obtained in No. 32, followed by No. 22 (1.06) and Nos. 8, 45 and 63 (1.05). The smallest (0.93) was noted in Nos. 7, 16 and 28. Average and its s. d. through the whole strains were found to be  $1.00 \pm 0.04$ .

*Minimum* : The largest (0.97) was obtained in Nos. 46 and 52, which were the same as in case of the minimum of W, followed by Nos. 49, 62 and 64 (0.96). These orders of strains were found to be the same as in case of the minimum of W. The smallest (0.82) was noted in No. 7, followed by No. 10 (0.83) and Nos. 12, 15, 16 and 28 (0.84). These combinations of strains 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  $0.90 \pm 0.04$ .

*Range*: The largest (0.21) was obtained in No. 22, followed by No. 8 (0.20) and No. 45 (0.17). The smallest (0.04) was noted in No. 49, followed by Nos. 14, 46 and 61 (0.05). Average and its s. d. through the whole strains were found to be  $0.10 \pm 0.04$ .

### 7. Areas in UHG

*Maximum*: The results are given in Table 2. In this table, the maximum, the minimum and their range are shown. The widest ( $37.43 \text{ mm}^2$ ) was obtained in No. 31, followed by No. 28 ( $35.64 \text{ mm}^2$ ) and No. 36 ( $35.34 \text{ mm}^2$ ). The narrowest ( $20.80 \text{ mm}^2$ ) was noted in No. 62, which was the same as in case of the maximum of T (Table 1), followed by No. 54 ( $25.11 \text{ mm}^2$ ) and No. 44 ( $25.52 \text{ mm}^2$ ). Average and its s. d. through the whole strains were found to be  $30.07 \pm 2.73$ .

*Minimum*: The widest ( $30.40 \text{ mm}^2$ ) was obtained in No. 31, which was the same as in case of the maximum of area (UHG), followed by No. 28 ( $27.70 \text{ mm}^2$ ) and No. 36 ( $27.54 \text{ mm}^2$ ). These orders of strains were found to be the same as in case of the maximum of area (UHG). The narrowest ( $15.62 \text{ mm}^2$ ) was noted in No. 9, followed by No. 62 ( $16.54 \text{ mm}^2$ ) and No. 54 ( $18.28 \text{ mm}^2$ ). Average and its s. d. through the whole strains were found to be  $23.27 \pm 2.62$ .

*Range*: The largest ( $13.18 \text{ mm}^2$ ) was obtained in No. 9, followed by No. 5 ( $10.60 \text{ mm}^2$ ) and No. 4 ( $10.36 \text{ mm}^2$ ). It was noticeable that the value was particularly large in No. 9. The smallest ( $3.52 \text{ mm}^2$ ) was noted in No. 43, followed by Nos. 52 and 62 ( $4.26 \text{ mm}^2$ ). Average and its s. d. through the whole strains were found to be  $6.81 \pm 1.85$ .

### 8. Volumes in UHG

*Maximum*: The largest ( $85.96 \text{ mm}^3$ ) was obtained in No. 31, which was the same as in cases of the maximum and of the minimum of area (UHG), followed by No. 36 ( $84.82 \text{ mm}^3$ ) and No. 7 ( $83.67 \text{ mm}^3$ ). The smallest ( $37.07 \text{ mm}^3$ ) was noted in No. 62, which was the same as in cases of the maxima of T and area (UHG), followed by No. 44 ( $53.59 \text{ mm}^3$ ) and No. 54 ( $53.99 \text{ mm}^3$ ). These combinations of strains were found to be the same as in case of the maximum of area (UHG). Average and its s. d. through the whole strains were found to be  $68.98 \pm 8.43$ .

*Minimum*: The largest ( $69.66 \text{ mm}^3$ ) was obtained in No. 31, which was the same as in cases of the maxima of area and volume and the minima of area and volume (UHG), followed by No. 36 ( $68.28 \text{ mm}^3$ ) and No. 28 ( $60.94 \text{ mm}^3$ ). These combinations of strains were found to be the same as in cases of the maximum and the minimum of area (UHG). The smallest ( $28.12 \text{ mm}^3$ ) was noted in No. 9, which was the same as in case of the minimum of area (UHG), followed by No. 62 ( $28.95 \text{ mm}^3$ ) and No. 54 ( $33.82 \text{ mm}^3$ ). These orders of strains were found to be the same as in case of the minimum of area (UHG). Average and its s. d. through the whole strains were found to be  $49.39 \pm 8.51$ .

*Range*: The largest ( $35.87 \text{ mm}^3$ ) was obtained in No. 9, which was the same as in case of the range of area (UHG), followed by No. 8 ( $32.66 \text{ mm}^3$ ) and No. 7 ( $32.63 \text{ mm}^3$ ). The smallest ( $8.12 \text{ mm}^3$ ) was noted in No. 62, which was the same as in cases of the maxima of T, area and volume (UHG), followed by No. 18 ( $11.25 \text{ mm}^3$ ) and No. 19 ( $12.15 \text{ mm}^3$ ). Average and its s. d. through the whole strains were found to be  $19.61 \pm 5.95$ .

Table 2. Ranges of area, volume and quotient

Strain No.	Unhusked						Husked						Quotient					
	Area		Volume		Range		Area		Volume		Range		Area		Volume		Range	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	32.51	24.51	8.00	78.02	55.92	22.10	19.32	14.63	4.69	40.57	30.48	10.09	0.63	0.56	0.07	0.58	0.51	0.07
2	27.65	21.30	6.35	60.64	38.76	21.88	17.69	11.99	5.70	35.96	18.10	17.86	0.67	0.55	0.12	0.61	0.47	0.14
3	28.32	21.00	7.32	65.14	42.00	23.14	16.61	11.97	4.64	34.88	23.07	11.81	0.66	0.55	0.11	0.59	0.49	0.10
4	29.45	19.09	10.36	67.74	36.54	31.20	17.55	10.45	7.10	37.73	18.66	19.13	0.60	0.52	0.08	0.55	0.47	0.08
5	31.72	21.12	10.60	71.37	40.13	31.24	18.00	12.00	6.00	36.00	21.00	15.00	0.64	0.56	0.08	0.58	0.50	0.08
6	32.38	23.80	8.58	74.47	50.74	23.73	19.00	14.76	4.24	39.90	28.20	11.70	0.64	0.58	0.06	0.58	0.52	0.06
7	32.96	25.20	7.76	83.67	51.04	32.63	18.09	13.60	4.49	41.61	24.48	17.13	0.61	0.51	0.10	0.55	0.47	0.08
8	29.07	19.00	10.07	66.86	34.20	32.66	17.55	11.34	6.21	35.98	18.14	17.84	0.65	0.53	0.12	0.60	0.47	0.13
9	28.80	15.62	13.18	63.99	28.12	35.87	17.50	9.62	7.88	35.88	15.39	20.49	0.63	0.54	0.09	0.57	0.50	0.07
10	31.85	22.49	9.36	73.26	41.61	31.65	18.06	12.98	5.08	37.02	21.42	15.60	0.62	0.53	0.09	0.57	0.48	0.09
11	29.26	22.17	7.09	59.60	41.06	18.54	16.22	12.10	4.12	29.90	20.57	9.33	0.59	0.50	0.09	0.53	0.44	0.09
12	30.98	24.34	6.64	74.35	53.92	20.43	17.67	14.69	2.98	38.87	29.82	9.05	0.64	0.55	0.09	0.58	0.51	0.07
13	29.48	23.49	5.99	67.80	51.68	16.12	18.29	13.68	4.61	38.41	27.36	11.05	0.63	0.57	0.06	0.57	0.52	0.05
14	30.31	25.52	4.79	66.68	51.07	15.61	18.74	14.08	4.66	37.48	25.03	12.45	0.65	0.54	0.11	0.59	0.49	0.10
15	34.68	26.74	7.94	78.66	60.35	18.31	19.38	16.00	3.38	41.67	31.75	9.92	0.61	0.50	0.11	0.56	0.41	0.15
16	34.51	24.84	9.67	77.65	48.07	29.58	18.90	13.75	5.15	38.75	23.94	14.81	0.59	0.52	0.07	0.53	0.47	0.06
17	32.40	24.98	7.42	71.35	51.02	20.33	18.63	14.45	4.18	38.56	24.57	13.99	0.62	0.54	0.08	0.56	0.48	0.08
18	26.62	21.70	4.92	56.70	46.45	11.25	16.20	13.20	3.00	31.90	25.74	6.16	0.64	0.57	0.07	0.58	0.52	0.06
19	28.73	24.00	4.73	63.18	51.03	12.15	16.96	14.84	2.12	35.71	27.97	7.74	0.63	0.57	0.06	0.57	0.51	0.06
20	33.33	26.10	7.23	79.99	52.50	27.49	20.59	15.36	5.23	45.14	28.78	16.36	0.67	0.58	0.09	0.63	0.51	0.08
21	33.29	25.81	7.48	78.23	52.20	26.03	20.25	15.60	4.65	42.53	29.03	13.50	0.63	0.58	0.05	0.57	0.51	0.06
22	32.03	23.13	8.90	68.87	45.07	23.80	17.76	12.69	5.07	33.74	22.21	11.53	0.61	0.52	0.09	0.55	0.47	0.08
23	27.95	22.10	5.85	69.88	47.52	22.36	16.96	13.20	3.76	39.01	25.08	13.93	0.64	0.59	0.05	0.57	0.53	0.04
24	29.28	24.60	4.68	66.25	51.05	15.20	17.42	14.40	3.02	35.62	26.64	8.98	0.64	0.57	0.07	0.57	0.52	0.05
25	26.97	21.00	5.97	56.64	42.82	13.82	16.38	12.54	3.84	31.12	22.23	8.89	0.64	0.56	0.08	0.58	0.51	0.07
26	32.93	25.23	7.70	75.74	53.59	22.15	19.68	14.95	4.73	41.51	29.24	12.27	0.63	0.55	0.08	0.59	0.50	0.09
27	31.32	24.70	6.62	70.47	52.73	17.74	17.14	13.86	3.28	35.14	27.03	8.11	0.59	0.54	0.05	0.53	0.49	0.04
28	35.64	27.70	7.94	81.97	60.94	21.03	21.42	15.64	5.78	44.98	29.72	15.26	0.60	0.53	0.07	0.56	0.48	0.08
29	31.69	24.57	7.12	71.30	51.60	19.70	18.87	15.87	3.00	37.74	30.15	7.59	0.67	0.57	0.10	0.61	0.52	0.09
30	29.44	22.69	6.75	65.12	46.52	18.60	17.28	13.16	4.12	34.69	24.35	10.34	0.60	0.56	0.04	0.60	0.49	0.11
31	37.43	30.40	7.03	85.96	69.66	16.30	23.27	18.56	4.71	48.87	35.82	13.05	0.67	0.58	0.09	0.58	0.51	0.07
32	28.40	23.78	4.62	69.70	54.69	15.01	18.85	14.31	4.54	41.31	28.62	12.69	0.67	0.58	0.09	0.61	0.49	0.12

(Continued)

Table 2. (Continued)

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
33	33.22	25.83	7.39	81.39	59.41	21.98	21.12	16.20	4.92	46.46	34.02	12.44	0.67	0.61	0.06	0.61	0.55	0.06
34	27.89	19.71	8.18	61.36	37.45	23.91	16.80	12.31	4.49	34.44	21.62	12.82	0.67	0.57	0.10	0.60	0.51	0.09
35	30.10	24.80	5.30	72.24	54.56	17.68	18.00	14.56	3.44	39.60	28.94	10.66	0.61	0.57	0.04	0.55	0.52	0.03
36	35.34	27.54	7.80	84.82	68.28	16.54	21.78	17.83	3.95	49.44	38.38	11.06	0.65	0.60	0.05	0.60	0.55	0.05
37	31.14	25.08	6.06	72.93	56.43	16.50	19.07	15.66	3.41	40.90	32.10	8.80	0.66	0.58	0.08	0.61	0.54	0.07
38	29.41	22.96	6.45	70.58	55.44	15.14	18.45	14.16	4.29	41.35	32.19	9.16	0.65	0.62	0.03	0.61	0.55	0.06
39	29.88	24.00	5.88	75.35	59.28	16.07	18.90	15.12	3.78	42.48	33.64	8.84	0.65	0.59	0.06	0.60	0.54	0.06
40	30.78	25.55	5.23	78.49	60.26	18.23	18.81	15.81	3.00	42.32	33.00	9.32	0.67	0.58	0.09	0.62	0.52	0.10
41	29.67	24.21	5.46	71.33	56.44	14.89	18.00	14.84	3.16	41.40	31.16	10.24	0.64	0.59	0.05	0.59	0.54	0.05
42	29.23	24.18	5.05	70.15	54.41	15.74	18.60	15.60	3.00	40.92	32.40	8.52	0.66	0.62	0.04	0.62	0.56	0.06
43	28.00	24.48	3.52	67.20	54.34	12.86	17.36	15.11	2.25	38.19	31.51	6.68	0.64	0.59	0.05	0.58	0.54	0.04
44	25.52	18.48	7.04	53.59	35.11	18.48	15.98	12.00	3.98	29.56	20.40	9.16	0.67	0.59	0.08	0.60	0.53	0.07
45	31.33	24.37	6.96	70.58	57.12	13.46	18.29	15.60	2.69	40.24	29.61	10.63	0.67	0.56	0.11	0.61	0.47	0.14
46	29.15	24.30	4.85	68.50	55.69	12.81	19.22	16.24	2.98	41.29	32.94	8.35	0.68	0.61	0.07	0.62	0.56	0.06
47	28.35	22.88	5.47	66.62	53.61	13.01	17.96	13.50	4.46	38.61	29.05	9.56	0.65	0.58	0.07	0.60	0.53	0.07
48	30.24	23.93	6.31	77.11	61.02	16.09	18.60	14.56	4.04	43.71	34.02	9.69	0.65	0.56	0.09	0.60	0.50	0.10
49	29.37	23.70	5.67	67.92	54.51	13.41	18.75	15.11	3.64	39.99	31.73	8.26	0.67	0.62	0.05	0.61	0.57	0.04
50	29.75	21.46	8.29	72.89	47.25	25.64	18.27	13.91	4.36	41.11	26.45	14.43	0.68	0.60	0.08	0.62	0.54	0.08
51	28.05	22.96	5.09	61.36	48.22	13.14	17.42	13.92	3.50	34.65	26.45	8.20	0.62	0.58	0.04	0.57	0.52	0.05
52	27.20	22.94	4.26	65.28	50.12	15.16	17.70	14.82	2.88	38.28	29.64	8.64	0.68	0.60	0.08	0.62	0.55	0.07
53	25.79	19.36	6.43	58.03	37.75	20.28	15.84	11.50	4.34	32.47	19.55	12.92	0.64	0.56	0.08	0.58	0.50	0.08
54	25.11	18.28	6.83	53.99	33.82	20.17	14.72	11.51	3.21	28.70	18.99	9.71	0.64	0.59	0.05	0.58	0.53	0.05
55	28.84	21.12	7.72	57.75	42.24	15.51	17.40	13.74	3.66	32.19	24.72	7.47	0.66	0.60	0.06	0.60	0.54	0.06
56	29.70	24.51	5.19	61.74	46.57	15.17	18.01	14.74	3.27	33.06	25.06	8.00	0.63	0.57	0.06	0.57	0.51	0.06
57	31.53	24.38	7.15	67.79	47.54	20.25	18.82	14.41	4.41	35.76	26.53	9.23	0.65	0.59	0.06	0.60	0.53	0.07
58	29.56	23.75	5.81	63.55	45.13	18.42	17.82	14.49	2.79	32.83	24.63	8.20	0.62	0.57	0.05	0.56	0.51	0.05
59	30.49	25.67	4.82	67.28	52.74	14.54	18.63	16.00	2.63	37.88	28.29	9.59	0.66	0.59	0.07	0.59	0.53	0.06
60	30.28	23.10	7.18	72.62	46.20	26.42	18.44	12.75	5.69	40.57	22.95	17.62	0.62	0.55	0.07	0.56	0.49	0.07
61	27.20	20.70	6.50	65.28	46.87	18.41	16.24	12.25	3.99	33.88	25.19	8.69	0.62	0.56	0.06	0.56	0.51	0.05
62	20.80	16.54	4.26	37.07	28.95	8.12	12.21	9.75	2.46	20.20	15.06	5.14	0.63	0.58	0.05	0.56	0.50	0.06
63	29.75	22.57	7.18	69.91	50.16	19.75	17.70	13.75	3.95	38.61	27.66	10.95	0.66	0.58	0.08	0.62	0.53	0.09
64	30.53	22.94	7.59	68.69	49.18	19.51	19.98	14.84	5.05	40.78	28.20	12.58	0.67	0.59	0.08	0.61	0.53	0.08

### 9. Areas in HG

*Maximum* : The widest (23.27 mm<sup>2</sup>) was obtained in No. 31, which was the same as in cases of the maxima and of the minima of area and volume (UHG), followed by No. 36 (21.78 mm<sup>2</sup>) and No. 28 (21.42 mm<sup>2</sup>). These combinations of strains were found to be the same as in cases of the maximum of area and of the minima of area and volume (UHG). Moreover, these orders of strains were found to be the same as in case of the minimum of volume (UHG). The narrowest (12.21 mm<sup>2</sup>) was noted in No. 62, which was the same as in cases of the maxima of T, area and volume (UHG), and of the range of volume (UHG), followed by No. 54 (14.72 mm<sup>2</sup>) and No. 53 (15.84 mm<sup>2</sup>). Average and its s. d. through the whole strains were found to be  $18.13 \pm 1.65$ .

*Minimum* : The widest (18.56 mm<sup>2</sup>) was obtained in No. 31, which was the same as in cases of the maxima of areas (UHG and HG) and volume (UHG), and of the minima of area and volume (UHG), followed by No. 36 (17.83 mm<sup>2</sup>) and No. 46 (16.24 mm<sup>2</sup>). The narrowest (9.62 mm<sup>2</sup>) was noted in No. 9, which was the same as in cases of the minima of area and volume (UHG), followed by No. 62 (9.75 mm<sup>2</sup>) and No. 4 (10.45 mm<sup>2</sup>). Average and its s. d. through the whole strains were found to be  $14.01 \pm 1.74$ .

*Range* : The largest (7.88 mm<sup>2</sup>) was obtained in No. 9, which was the same as in cases of the ranges of area and volume (UHG), followed by No. 4 (7.10 mm<sup>2</sup>) and No. 8 (6.21 mm<sup>2</sup>). The smallest (2.12 mm<sup>2</sup>) was noted in No. 19, followed by No. 43 (2.25 mm<sup>2</sup>) and No. 62 (2.46 mm<sup>2</sup>). Average and its s. d. through the whole strains were found to be  $4.12 \pm 1.13$ .

### 10. Volumes in HG

*Maximum* : The largest (49.44 mm<sup>3</sup>) was obtained in No. 36, followed by No. 31 (48.87 mm<sup>3</sup>) and No. 33 (46.46 mm<sup>3</sup>). The smallest (20.20 mm<sup>3</sup>) was noted in No. 62, which was the same as in cases of the maxima of T, areas (UHG and HG) and volume (UHG), and of the range of volume (UHG), followed by No. 54 (28.70 mm<sup>3</sup>) and No. 44 (29.56 mm<sup>3</sup>). These combinations of strains were found to be the same as in cases of the maxima of area and volume (UHG). Average and its s. d. through the whole strains were found to be  $37.97 \pm 4.92$ .

*Minimum* : The largest (38.38 mm<sup>3</sup>) was obtained in No. 36, which was the same as in case of the maximum of volume (HG), followed by No. 31 (35.82 mm<sup>3</sup>) and Nos. 33 and 48 (34.02 mm<sup>3</sup>). These orders of strains were found to be the same as in case of the maximum of volume (HG). The smallest (15.06 mm<sup>3</sup>) was noted in No. 62, which was the same as in cases of the maxima of T, areas (UHG and HG) and volumes (UHG and HG), and of the range of volume (UHG), followed by No. 9 (15.39 mm<sup>3</sup>) and No. 2 (18.10 mm<sup>3</sup>). Average and its s. d. through the whole strains were found to be  $26.73 \pm 5.04$ .

*Range* : The largest (20.49 mm<sup>3</sup>) was obtained in No. 9, which was the same as in cases of the ranges of areas (UHG and HG) and volume (UHG), followed by No. 4 (19.13 mm<sup>3</sup>) and No. 2 (17.86 mm<sup>3</sup>). The smallest (5.14 mm<sup>3</sup>) was noted in No. 62, which was the same as in cases of the maxima of T, areas (UHG and HG) and volumes (UHG and HG), of the minimum of volume (HG), and of the range of volume (UHG), followed by No. 18 (6.16 mm<sup>3</sup>) and No. 43 (6.68 mm<sup>3</sup>). Average and its s. d. through the whole strains were found to be  $11.25 \pm 3.35$ .

### 11. Quotients in areas

*Maximum* : The largest (0.68) was obtained in Nos. 46, 50 and 52. The smallest (0.59) was noted in Nos. 11, 16 and 27. Average and its s. d. through the whole strains were found to be  $0.64 \pm 0.03$ .

*Minimum* : The largest (0.62) was obtained in Nos. 38, 42 and 49. The smallest (0.50) was noted in Nos. 11 and 15, followed by No. 7 (0.51). Average and its s. d. through the whole strains were found to be  $0.57 \pm 0.03$ .

*Range* : The largest (0.12) was obtained in No. 2, followed by Nos. 3, 14, 15 and 45 (0.11). The smallest (0.03) was noted in No. 38, followed by Nos. 30, 35, 42 and 51 (0.04). Average and its s. d. through the whole strains were found to be  $0.07 \pm 0.02$ .

### 12. Quotients in volumes

*Maximum* : The largest (0.63) was obtained in No. 20, followed by Nos. 40, 42, 46, 50, 52 and 63 (0.62). The smallest (0.53) was noted in Nos. 11, 16 and 27. These orders of strains were found to be the same as in case of the maximum of quotient of areas. Average and its s. d. through the whole strains were found to be  $0.59 \pm 0.03$ .

*Minimum* : The largest (0.57) was obtained in No. 49, followed by Nos. 42 and 46 (0.56). The smallest (0.41) was noted in No. 15, followed by No. 11 (0.44) and Nos. 2, 4, 7, 16, 22 and 45 (0.47). These combinations of strains were found to be the same as in case of the minimum of quotient of areas. Average and its s. d. through the whole strains were found to be  $0.51 \pm 0.03$ .

*Range* : The largest (0.15) was obtained in No. 15, followed by Nos. 2 and 45 (0.14). These combinations of strains were found to be the same as in case of the range of quotient of areas. The smallest (0.03) was noted in No. 35, followed by Nos. 23, 27, 43 and 49 (0.04). Average and its s. d. through the whole strains were found to be  $0.07 \pm 0.03$ .

## Discussion

Basing on the results obtained in the present experiment, the following problems are to be discussed here.

1. Although the values were particularly large or small in some characters, the values were found to be the standard level in other characters in view of the same strains. For example, No. 40 showed the largest value (0.78) in the maximum of L, but showed the middle value (0.89) in the maximum of W. In other case, No. 11 showed the smallest value (0.69) in the maximum of L, but showed the middle value (0.88) in the maximum of W.

On the other hand, although the values were particularly large in some characters, the values were found to be particularly small in other characters in view of the same strains, and *vice versa*. For example, No. 45 showed the largest value (0.95) in the maximum of W, but showed nearly the smallest value (0.85) in the minimum of T. In other case, No. 45 showed nearly the smallest value (0.73) in the maximum of L, but showed the largest value (0.95) in the maximum of W. These phenomena were found in the several combinations.

In view of area and volume characters, it was said, in general, the larger is the value of the maximum, the larger is the values of the minimum and of the range in the respective characters. This tendency was looked upon as the same as one in case of the comparative

characters. However, some disorders were found. For example, No. 36 showed the largest or nearly the largest values (35.34 mm<sup>2</sup>, 84.82 mm<sup>3</sup>, 21.78 mm<sup>2</sup> and 49.44 mm<sup>3</sup>; 27.54 mm<sup>2</sup>, 68.28 mm<sup>3</sup>, 17.83 mm<sup>2</sup> and 38.38 mm<sup>3</sup>) in the maxima and the minima of area (UHG), volume (UHG), area (HG) and volume (HG), respectively, but showed relatively small values (7.80 mm<sup>2</sup>, 16.54 mm<sup>3</sup>, 3.95 mm<sup>2</sup> and 11.06 mm<sup>3</sup>) in the ranges in the same orders, respectively. In other case, No. 9 showed the smallest or nearly the smallest values (15.62 mm<sup>2</sup>, 28.12 mm<sup>3</sup>, 9.62 mm<sup>2</sup> and 15.39 mm<sup>3</sup>) in the minima of area (UHG), volume (UHG), area (HG) and volume (HG), respectively, but showed consistently the largest values (13.18 mm<sup>2</sup>, 35.87 mm<sup>3</sup>, 7.88 mm<sup>2</sup> and 20.49 mm<sup>3</sup>) in the ranges in the same orders, respectively. This tendency was looked upon as strain specificity in these strains.

2. 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, 4 characters (the maxima of L and L/W, the minimum of L/W and the range of W) and 3 characters (the maximum of W/T, the minima of W and W/T) showed the larger and the smaller values than the average of the whole strains, respectively. The remaining 11 characters showed the same as the average of the whole strains.

In area and volume characters, 15 characters (the maxima, the minima and the ranges of areas [UHG and HG], volumes [UHG and HG], the maximum of quotient of volumes, the ranges of quotients of areas and volumes) and 1 character (the minimum of quotient of areas) showed the larger and the smaller values than the average of the whole strains, respectively. Two characters (the maximum of quotient of areas and the minimum of quotient of volumes) showed the same as the average of the whole strains. It was noticeable that all of the characters of area and volume (=12) showed the larger values in Group A than those of the average value through the whole strains.

In type C, the tendency was looked upon as the reversed results of type B.

3. In the larger sets of values, the largests (0.89 in the minimum of W and 0.97 in the minimum of W/T) were obtained in Nos. 46 and 52, followed by No. 64 (0.88 in the minimum of W and 0.96 in the minimum of W/T). These orders of strains were finally illustrated in these two characters as 46=52>64. These phenomena were found in other 7 cases, *i. e.*, ② 16=26=27...Nos. 16, 26 and 27 (0.03 and 0.04) in the smaller sets of the ranges of L and L/T; ③ 31>28>36...No. 31 (37.43 mm<sup>2</sup> and 30.40 mm<sup>2</sup>), No. 28 (35.64 mm<sup>2</sup> and 27.70 mm<sup>2</sup>) and No. 36 (35.34 mm<sup>2</sup> and 27.54 mm<sup>2</sup>) in the larger sets of the maximum and of the minimum of areas (UHG); ④ 62<54<44...No. 62 (20.80 mm<sup>2</sup> and 20.20 mm<sup>3</sup>), No. 54 (25.11 mm<sup>2</sup> and 28.70 mm<sup>3</sup>) and No. 44 (25.52 mm<sup>2</sup> and 29.56 mm<sup>3</sup>) in the smaller sets of the maxima of area (UHG) and volume (HG); ⑤ 9<62<54...No. 9 (15.62 mm<sup>2</sup> and 28.12 mm<sup>3</sup>), No. 62 (16.54 mm<sup>2</sup> and 28.95 mm<sup>3</sup>) and No. 54 (18.28 mm<sup>2</sup> and 33.82 mm<sup>3</sup>) in the smaller sets of the minima of area and volume (UHG); ⑥ 31>36>28...No. 31 (69.66 mm<sup>3</sup> and 23.27 mm<sup>2</sup>), No. 36 (68.28 mm<sup>3</sup> and 21.78 mm<sup>2</sup>) and No. 28 (60.94 mm<sup>3</sup> and 21.42 mm<sup>2</sup>) in the larger sets of the minimum of volume (UHG) and the maximum of area (HG); ⑦ 36>31>33...No. 36 (49.44 mm<sup>3</sup> and 38.38 mm<sup>3</sup>), No. 31 (48.87 mm<sup>3</sup> and 35.82 mm<sup>3</sup>) and No. 33 (46.46 mm<sup>3</sup> and 34.02 mm<sup>3</sup>) in the larger sets of the maximum and the minimum of volume (HG); ⑧ 11=16=27...Nos. 11, 16 and 27 (0.59 and 0.53) in the smaller sets of the maxima of the quotients of areas and volumes. It was noticed that these phenomena were found many cases in area and volume columns than those of the comparative characters. In these

cases, ③, ⑥, ⑦ and ①, ④, ⑤, ⑧ were constituted by only 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 same combinations, which meant the same strain numbers regardless of the orders. Five cases were found, *i. e.*, ① 7·10·15 in the smaller sets...the minima of volume of UHG ( $7=15<10$ ) and of the quotient of volumes ( $7<10<15$ ); ② 28·31·36 in the larger sets...the maximum and the minimum of area of UHG ( $31>28>36$ ), and the minimum of volume of UHG and the maximum of area of HG ( $31>36>28$ ); ③ 44·54·62 in the smaller sets...the maximum of area of UHG ( $62<54<44$ ), the maximum of volume of UHG ( $62<44<54$ ) and the maximum of volume of HG ( $62<54<44$ ); ④ 2·15·45 in the larger sets...the ranges of quotients of areas ( $2>15=45$ ) and of volumes ( $15>2=45$ ); ⑤ 7·11·15 in the smaller sets...the minima of quotients of areas ( $11=15<7$ ) and of volumes ( $15<7=11$ ). It was noted that these phenomena were found many cases in area and volume columns than those of the comparative characters. In those cases, ② and ③ were constituted by only strains belonging to type B and type C, respectively. These phenomenon was not mutually found between the comparative and the area and volume characters.

4. From the data obtained in the previous papers<sup>2,3)</sup> and the present experiment, varietal variations were summed-up in view of the pure-ranges, and are shown in Table 3. In this table, strains showing the relatively large (roman figure in the table) and relatively small (*italic* figure in the table) values were illustrated by Nos. 1, 2 and 3 in 24 characters. It was the first time to adopt these new techniques.

In the larger ranges, the highest frequency (=10) was found in strain No. 8, followed by No. 2 (=9) and No. 9 (=8). The lowest frequency (=0) was noted in 36 strains. One, 1, 0, 3, 2, 0, 3, 1, 6, 12 and 36 strains showed the larger values in 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $1.20\pm 2.08$ . In the smaller ranges, the highest frequency (=10) was found in No. 43, followed by No. 19 (=7) and No. 62 (=6). One, 0, 0, 1, 1, 3, 2, 4, 9, 9 and 34 strains showed the smaller values in 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $1.33\pm 2.02$ . In the whole ranges, the highest frequency (=10) was found in Nos. 8 and 43, followed by No. 2 (=9). Two, 1, 2, 1, 4, 3, 5, 7, 10, 17 and 12 strains showed the total frequencies as 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $2.64\pm 2.59$ . It was reasonably found that the results found in the larger ranges were fixed to be the reversed status from those of the smaller ranges. It was noticeable that the s. d. were remarkably large through the 3 categories mentioned above.

In view of the tripartite classification, the following facts were ascertained. Type B in the larger ranges, 1, 1, 6 and 5 strains showed the larger values in 6, 4, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $1.23\pm 1.72$ . In the smaller ranges, 1, 1 and 11 strains showed the smaller values in 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $0.23\pm 0.58$ . In the whole ranges, 1, 1, 1, 7 and 3 strains showed the total frequencies as 6, 4, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $1.46\pm 1.65$ .

Type C in the larger ranges, 1, 1, 1, 2, 2, 1, 6, 6 and 31 strains showed the larger values

Table 3. Strains showing the relatively large values (roman figure) and the small values (*italic* figure) in 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						L	S	T																											
	1	2	3	4	5	6	11	12	13	14	15	16	21	22	23	24	25	26	31	32	33	34	35	36																														
1																	2																		1	0	1																	
2		2	1					1		1						2	2																	3	1	2	9	0	9															
3																																				2	1	0	1															
4	2						1	1																		3		2	2								6	0	6															
5			3				3				3														2													4	0	4														
7	3						3			2																	3												4	0	4													
8		1					3	1	3	2					1		2		2							2	3												10	0	10													
9		3					2								3		2									1	1	1	1												8	0	8											
10																	1	2																							2	0	2											
11			3																																							1	0	1										
12										2																																	0	1	1									
14		<i>1</i>			3		2								1																											2	3	6										
15			3		1							2				2																										2	1	6	0	6								
17	3																																												1	0	1							
18																											2		2																	0	2	2						
19			3					<i>1</i>		<i>1</i>					<i>1</i>												3	<i>1</i>																		0	7	7						
20																																														1	0	1						
22															1																															2	0	2						
23	1	2	3		2		3		3							<i>1</i>																														2	6	2	8					
24			<i>1</i>																																												0	2	2					
25				2						1							<i>1</i>																															2	1	3				
26															<i>1</i>																																	0	2	2				
27															<i>1</i>																																	2	0	3	3			
28																3																																	1	0	1			
29			<i>1</i>						<i>1</i>			3																																					0	3	3			
30																																																	0	2	2			
32																		2																															1	0	1			
33												3																																						1	0	1		
34																3																																		1	0	1		
35	2		<i>1</i>				<i>1</i>																																									2	1	0	5	5		
36		1																																																1	0	1		
38					2							1																																						1	2	1	3	
40																3																																			1	0	1	
41					2			<i>1</i>			2																																							0	3	3		
42								<i>1</i>																																											0	2	2	
43	2	<i>1</i>		<i>1</i>			2				<i>1</i>																<i>1</i>		2	3																				0	10	10		
44			2						2																																											0	2	2
45					3																																															4	0	4
46																		<i>1</i>																																		1	2	3
48										2																																										0	1	1
49																																																				0	4	4
50				2	2					2	2																																									0	5	5
51		<i>1</i>																																																	0	4	4	
52																																																				0	1	1
53				1							3					3																																				2	1	3

(Continued)

Table 3. (Continued)

Strain No.	Character numbers																		Total								
	Unhusked						Husked						Comparison						Area and Volume						L	S	T
	1	2	3	4	5	6	11	12	13	14	15	16	21	22	23	24	25	26	31	32	33	34	35	36			
54												3													0	1	1
56															1		1								2	0	2
58	1			3	1				2		1														0	5	5
61															1			1							0	2	2
62	1							1											2	1	3	1			0	6	6
63					3																				0	1	1
64															1										0	1	1

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.

in 10, 9, 8, 6, 4, 3, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $1.33 \pm 2.42$ . In the smaller ranges, 1, 1, 1, 3, 2, 4, 8, 8 and 23 strains showed the smaller values in 10, 7, 6, 5, 4, 3, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $1.61 \pm 2.15$ . In the whole ranges, 2, 1, 2, 1, 3, 3, 4, 7, 9, 10 and 9 strains showed the total frequencies as 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 and 0 characters, respectively. Average and its s. d. through the whole characters were found to be  $2.94 \pm 2.70$ .

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

These analysing techniques were used for the first time in this experiment by the author. Further practices should be requested.

5. Basing on the previous<sup>2,3)</sup> and the present experiments, new technique to analyse the varietal variations was adopted. On the strain-average, the maximum, the minimum and their ranges, 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 4. For example, # mark dotted at B line in character number 2 (=width of UHG) in strain average at the large column means that 3 strains showing the largest (strain No. 36=3.62 mm), the second (No. 33=3.60 mm) and the third (No. 31=3.57 mm) were classified to type B. In other example, # mark dotted at M line in character number 1 (=length of UHG) in strain average at the large column means that 3 strains showing relatively large values were found to be mixed with type B and type C, *i. e.*, the largest (strain No. 58=10.34 mm), the second (No. 28=10.28 mm) and the third (No. 14=10.24 mm) belong to type C, type B and type C, respectively.

In the total cases of type B, type C and the mixed one were ascertained as 16 (8.3%), 102 (53.1%) and 74 (38.5%), respectively. Numbers of strains were accounted as 13 (20% in the total) and 51 (80% in the total) in type B and type C, respectively. Accordingly, ratios

Table 4. Characters showing the relatively large and small values in 64 strains; cited from the pure-ranges shown in Table 3. # mark dotted at B line in character number 2 in strain average at the large column means that 3 strains showing the largest (strain No. 36), the second (No. 33) and the third (No. 31) were classified to type B.

Char- acter 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	4	4
2	#				#		#			#				#		#			#		#				2	4	2
3	#				#		#			#				#		#			#		#				2	4	2
4		#				#		#				#		#			#		#		#				0	5	3
5		#				#		#		#			#		#		#		#		#				0	5	3
6			#		#			#		#				#		#			#		#				0	5	3
11			#		#			#		#				#		#			#		#				0	5	3
12			#		#			#		#				#		#			#		#				0	5	3
13	#				#			#		#				#		#			#		#				1	5	2
14		#				#		#				#		#			#		#		#				0	4	4
15		#				#		#		#			#		#		#		#		#			#	0	4	4
16			#		#			#		#				#		#			#		#				0	2	6
21			#			#		#		#				#		#			#		#			#	0	1	7
22		#				#		#		#				#		#			#		#				0	5	3
23		#			#			#		#			#		#		#		#		#				0	3	5
24		#			#			#		#				#		#		#		#					0	5	3
25		#				#		#		#				#		#		#		#			#		0	3	5
26		#				#		#		#				#		#		#		#					0	5	3
31	#				#			#		#				#		#			#		#				3	5	0
32	#				#			#		#				#		#			#		#				3	4	1
33	#				#			#		#				#		#			#		#				2	5	1
34	#				#			#		#				#		#			#		#				3	5	0
35		#				#		#		#				#		#			#		#				0	5	3
36		#				#		#		#				#		#			#		#				0	4	4
L	7	8	9				6	8	10				3	11	10				0	10	14				16	102	74
S				0	13	11				0	18	6				0	13	11				0	21	3			

Character numbers; the same as mentioned in Table 3.

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

from 16 to 102 showed the significant differences in comparison with ratio of 13 to 51 ( $\chi^2$  test). It meant that type B had the tendency of showing 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  $0.66 \pm 1.11$ ,  $4.25 \pm 1.05$  and  $3.08 \pm 1.66$  in type B, type C and the mixed one, respectively. It was noticed that the value of s. d. in type C was found to be very small, though its practical value was very large.

In type B, average and its s. d. through the average, the maximum, the minimum, the range and the total were found to be  $4.00 \pm 2.74$ ,  $0.00 \pm 0.00$  and  $2.00 \pm 2.78$  in the large, the small and the total ones, respectively. In type C, these were found to be in the same order

as  $9.25 \pm 1.30$ ,  $16.25 \pm 3.42$  and  $12.74 \pm 4.35$ , respectively. In the mixed one, these were found in the same order as  $10.75 \pm 1.92$ ,  $7.75 \pm 3.42$  and  $9.25 \pm 3.15$ , respectively. Significant differences were ascertained between the mutual columns in the whole cases. It might be of universal validity for analysing strain differentiations.

It was noticeable that all of s.d. through 4 characters (Nos. 31~34, area and volume items) were classified into type C in both of the large and small columns. It was some incomprehensible results at the present time.

### Summary

In order to confirm the morphological characters of the cultivated rice collected in Burma, variation ranges for 12 characters were investigated following the previous papers. The main results obtained during this study were summarized as follows :

The maximum, the minimum and their ranges of the comparative values of length, width, thickness, L/W, L/T and W/T were ascertained as 0.73, 0.68, 0.06 ; 0.89, 0.82, 0.07 ; 0.93, 0.88, 0.05 ; 0.88, 0.78, 0.10 ; 0.82, 0.74, 0.08 ; 1.00, 0.90, 0.10 in average values, respectively. The maximum, the minimum and their ranges of area (UHG), volume (UHG), area (HG), volume (HG), quotient of areas and quotient of volumes were ascertained as 30.07 mm<sup>2</sup>, 23.27 mm<sup>2</sup>, 6.81 mm<sup>2</sup> ; 68.98 mm<sup>3</sup>, 49.49 mm<sup>3</sup>, 19.61 mm<sup>3</sup> ; 18.13 mm<sup>2</sup>, 14.01 mm<sup>2</sup>, 4.12 mm<sup>2</sup> ; 37.97 mm<sup>3</sup>, 26.73 mm<sup>3</sup>, 11.25 mm<sup>3</sup> ; 0.64, 0.57, 0.07 ; 0.59, 0.51, 0.07 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 classifications, 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" or "combination". These techniques were already fixed to be useful for testing the strain or geographical differentiation 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 the strain-average, the maximum, the minimum and their ranges, an analysing method was newly adopted, and some aspects of type B and type C were ascertained. It might be expected that this newly devised method may have has universal validity for analysing strain differentiations.

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