

Distribution and Grain Morphology of Wild Rice Collected in Bangladesh, 1994

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Introduction

On the distribution of wild rice in Bangladesh, some reports have been published^{1, 3, 10, 12)}. Although Bangladesh has been considered to be one of the most important distribution areas of the wild rice in the world, accumulations of completely analysed data on several aspects are far from being perfect. Taking these facts into account, the present study was made to ascertain exactly the geographical distribution and ecotypic differentiations of the wild rice in Bangladesh.

The writers made research trip to northeastern part of Bangladesh during the period from November 17 to 20 in 1994. In the present paper, the habitat and record of the morphological characters of plant, unhusked and husked grains of wild rice collected in 1994 were described. The methodologies conducted in this paper will be fixed as one of the fundamental analyses for strain differentiations.

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Materials and Methods

During the trip, the locality, habitat and detailed informations of wild rice were recorded. The locality was detected, using the apparatus "SONY PYXIS Global Positioning System". Habitat records included light, water, soil and other environmental conditions. Sometimes, informations from local farmers were also recorded. Morphological characters of the plant were measured on the whole of the organs. Habitat relationship between the wild and the cultivated rice species (*Oryza sativa* L.) was detected in detail in view of the mutual locations, *i.e.*, allopatrical and/or sympatrical statuses.

Specimens were collected in the four sites. The materials collected in the Sites 2, 3 and 4 were divided into 3, 6 and 3 strains, respectively, basing on the diversities found in several morphological characters. Consequently, 13 strains were obtained and detected.

Those were sown and harvested at the experimental field of Kagoshima University in 1995, because only a few of the respective seeds were collected at the native places as the matured grains available for the experiment.

Thirty matured grains were used for measuring each strain. Measurements were done at

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length (abbreviated as L), width (W) and thickness (T) of the respective grains, centering at the most eminent section of the respective characters, using a "Kori Seiki" dial caliper. Calculations were done for the ratios of length to width (abbreviated as L/W), of length to thickness (L/T) and of width to thickness (W/T). The accumulations of whole data referring to the all characters were done to unhusked (UHG) (Table 2) and husked (HG) (Table 3) grains, and illustrated by the average values in the whole grains. Comparative values were illustrated by the ratios of the values fixed in the husked to the values fixed in the unhusked grains in the respective characters (CV) (Table 4). The following six characters of the unhusked and the husked grains were illustrated by the area (= length x width) and volume (= length x width x thickness) for the unhusked and the husked grains, and by the area and volume quotients (= ratio of the value of husked to the value of unhusked grains) (Table 5, AV). Grain weights (UHG, HG and CV) were also measured, using balance "A & A, ER-182A" (Table 6, GW). Nextly, correlation coefficients between the respective two characters were measured for 52 combinations (Tables 7 and 8).

To make clear the relationships among practical values, standard deviations and variation ranges at the strain level, six relations were calculated, *i.e.*, those between practical values and other practical values, standard deviations and other standard deviations, variation ranges and other variation ranges (Table 9), practical values and its standard deviations, practical values and its variation ranges, standard deviations and its variation ranges (Table 10), respectively.

Finally, to make clear the relations and possessions between the present materials and the other strains collected in the neighbouring areas, comparisons were made using the data obtained in the present experiment and in the previous papers⁴⁻⁷⁾, on the six grain characters of the unhusked grains (Table 11).

Results and Discussion

1. Abstract of distribution and habitat of the wild *Oryza* species

The localities concerned in this trip were the northeastern part of Bangladesh, *i.e.*, Sylhet and Sunamganj Districts. Geographical localities of the distribution areas of the wild rice collected were briefly illustrated in Fig.1. In this figure, route of the trip and the growing areas of the wild rice are given. A numeral in the figure shows the collection-site-number used in Table 1.

Specimens collected have the following characters; plant 150cm long, leaf blade 73 to 45cm long, 13mm wide, ligule 15mm long. Panicle 40cm long, slightly spreading at maturity. Spikelet 9.1 to 5.9mm long, 3.1 to 2.0mm wide, 2.2 to 1.3mm thick, 4.2 to 2.4 in ratio of length to width, 6.4 to 3.2 in ratio of length to thickness, 1.7 to 1.1 in ratio of width to thickness, 28.5 to 13.2mg in weight. Husked grain 7.1 to 4.8mm long, 2.6 to 1.7mm wide, 2.0 to 1.2mm thick, 3.8 to 2.2 in ratio of length to width, 5.4 to 2.9 in ratio of length to thickness, 1.8 to 1.1 in ratio of width to thickness, 21.6 to 9.0mg in weight. Glume surface with distinctly crosswise intersection rows of small tubercles. Empty glume 3mm long. Awn 78 to 4mm long, with white, black and pink colors. Grain dark to plain brown.

Based on the data obtained here, the present materials of wild rice collected were detected to be *Oryza sativa* var. *spontanea* ROSCHEV.

Populations of the specimens were found in many districts. They were found in a swampy

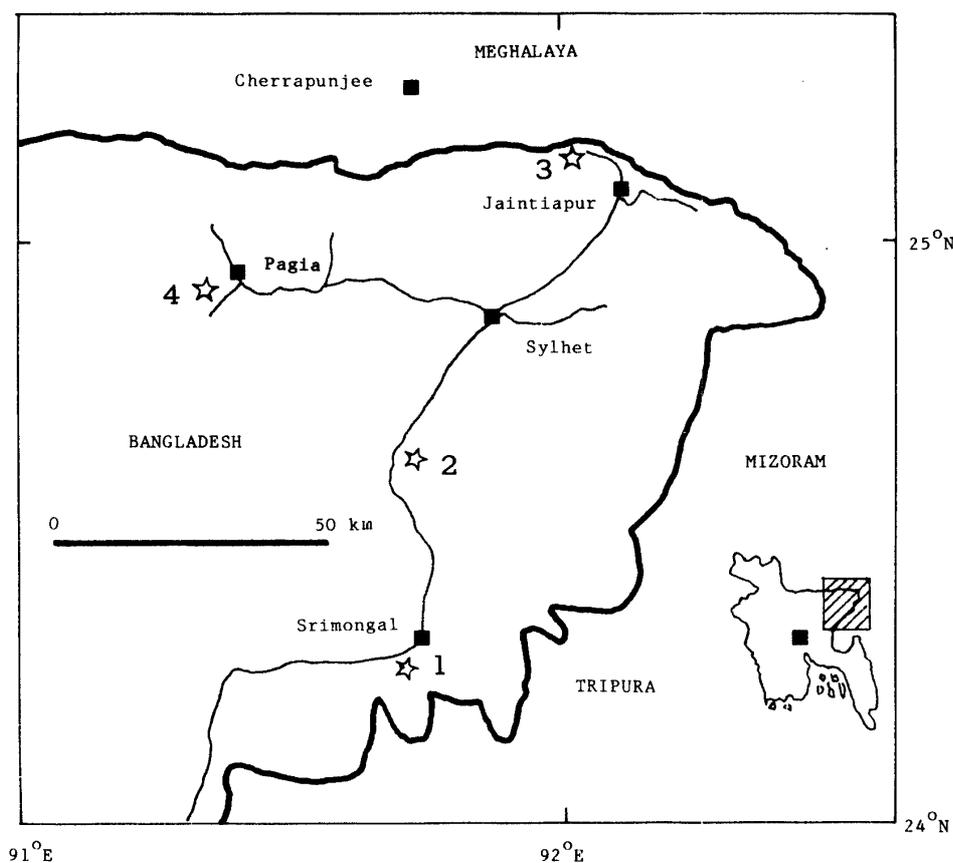


Fig. 1. Map showing localities where the wild rice in Bangladesh were collected and observed in 1994. Solid line; route of trip, number; collection site number.

area, road-side ditch, edge of pond, paddy field and grassland.

Distribution status of the wild rices collected are listed up in Table 1. In spite of their growth on the same site, distinct ecotypic differentiations were easily found, and they were divided into several numbers of the strains. In the table, site number, strain number, accession number in Kagoshima University, date of collection, detailed locality and some information of habitat were described.

Natural habitats of the collected materials concerned in the text are exhibited in Fig.2 for the whole of the strains. Although some conclusions on the distribution are going to be drawn after the experiments made with the use of the materials collected from the several view-points, the outlines of habitats of distribution, of environmental and geotopographical conditions have mainly been described. In brief, they had a creeping growth in the pond, swamp, embankment, small pond, irrigation canal, small stream, and slightly shaded sections. They were growing sometimes adjacent to the cultivated rice field, with or without separation-embankment, and grew sporadically or thickly, mainly allopatrically with each other.

2. Unhusked grains (abbreviated as UHG)

The detailed results obtained from the unhusked grains are given in Table 2. Lengths (abbreviated as L) for the individual grain level ranged from 9.10 mm (strain No. W4) to 5.90mm (W10). In the strain level, the longest (8.75mm) and the shortest (6.77mm) were obtained in W4 and W10, respectively. Average and its standard deviations (abbreviated as

Table 1. Distribution and habitat of wild rice collected in Bangladesh in 1994. Abbreviations: m; meter or meters, km; kilometer or kilometers, *N, E, S, W*; north, east, south and west sides of main road, respectively

Site No.	Strain No.	Accession No.	Date, place, detailed locality, habitat and remarks
1	W1	2201	November 17, Srimongal, 24° 18' 04" 9N, 91° 42' 32" 6E. <i>E</i> , 3km south from Srimongal. Swampy area, 20m x 100m, and road side ditch. Growing only along edge, sporadically, together with water hyacinth. Neighbouring cultivated rice field.
2	W2 ~ W4	2202 ~ 2204	November 17, Srimongal, 24° 39' 40" 1N, 91° 42' 46" 9E. <i>E</i> , 30km north from Srimongal. Pond, 20m x 200m. Growing dominantly with water hyacinth in whole area. Got between paddy fields in both sides. Growing allopatrically with cultivated rice, and growing sporadically only along edge of pond. Differentiated to three strains.
3	W5 ~ W10	2205 ~ 2210	November 18, Jaintiapur, 25° 10' 36" 8N, 92° 02' 55" 9E. <i>N</i> , 24km northwest from Jaintiapur. Near of Meghalaya, Assam, India. Swampy area, 30m x 20m, located in grassland and waste land, grazed by cows. Together with plants of <i>Leersia</i> sp., <i>Hygroryza</i> sp. Growing sporadically mainly along edge. Differentiated to six strains.
4	W11 ~ W13	2211 ~ 2213	November 19, Pagia, 24° 55' 48" 0N, 91° 21' 13" 7E. <i>W</i> , 8km south from Pagia. Waste land, neighbouring swamp, 200m x 50m, paddy field and upland cultivated field. Growing sporadically and thickly together with the cultivated rice of escaped types. Opposite side of main road. Differentiated to three strains.

s.d.) in the whole strains were found to be 7.85 ± 0.50 . Widths (*W*) for the individual grain level ranged from 3.05mm (*W*9) to 1.95mm (*W*2). In the strain level, the widest (2.75mm) and the narrowest (2.35mm) were obtained in *W*9 and *W*12, respectively. Average and its s.d. in the whole strains were found to be 2.61 ± 0.28 . Thicknesses (*T*) for the individual grain level ranged from 2.15mm (*W*11) to 1.30mm (*W*2). In the strain level, the thickest (1.95mm) and the thinnest (1.62mm) were obtained in *W*9 and *W*2, respectively, in which the former was the same as in case of *W*. Average and its s.d. in the whole strains were found to be 1.80 ± 0.09 .

In comparison with the two components, *i.e.*, *L* and *W* of UHG, the following tendencies were made clear, as illustrated in Fig.3-A. In the figure, the respective strains were plotted in accordance with the respective values in both the characters. Strains *W*11, *W*12 and *W*13 collected in the Site 4, showed long *L* and narrow *W*, *i.e.*, slender type. Strains *W*2 ~ *W*4 in the Site 2 showed relatively long *L*. Strains *W*5 ~ *W*10 in the Site 3 showed large variations both in *L* and *W*.

Ratios of length to width (abbreviated as *L/W*) for the individual grain level ranged from 4.15 (*W*2) to 2.36 (*W*10). In the strain level, the largest (3.53) and the smallest (2.75) were obtained in *W*4 and *W*10, respectively, which were the same as in case of *L*. Average and

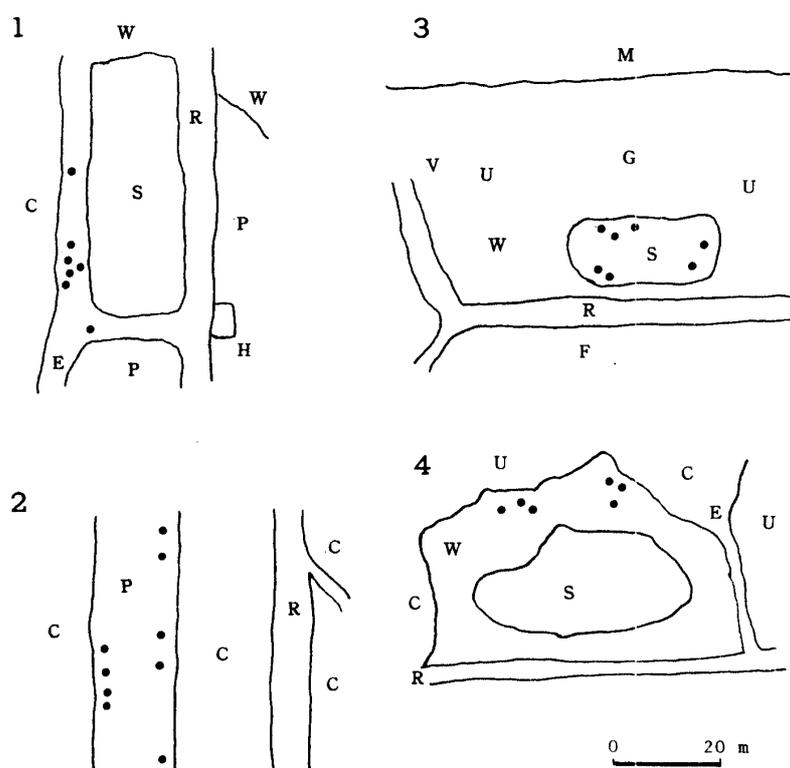


Fig. 2. Sketch maps of habitats of wild rice population. Circle dot [●] shows wild rice, C; cultivated paddy field, P; pond or small water pool, R; road, V; river or small stream, S; swamp, E; embankment, F; forest, W; waste land, G; grass land, H; house, U; cultivated upland field, M; mountain. Code numbers used in the figure correspond to the site numbers which were used in Table 1 and Fig.1.

Table 2. Six morphological characters of the unhusked grains collected in Bangladesh in 1994

Accession No.	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
2201	7.00±0.46	2.54±0.15	1.78±0.09	2.77±0.20	3.94±0.32	1.43±0.12
2202	8.00±0.37	2.36±0.16	1.62±0.12	3.40±0.27	4.95±0.45	1.46±0.14
2203	8.22±0.32	2.67±0.14	1.80±0.18	3.09±0.22	4.48±0.21	1.46±0.10
2204	8.75±0.25	2.49±0.11	1.77±0.09	3.53±0.20	4.97±0.29	1.41±0.09
2205	7.91±0.29	2.55±0.18	1.88±0.08	3.09±0.27	4.21±0.26	1.35±0.10
2206	7.85±0.30	2.56±0.14	1.89±0.10	3.07±0.20	4.17±0.23	1.36±0.10
2207	7.68±0.39	2.63±0.16	1.86±0.09	2.93±0.20	4.14±0.23	1.42±0.09
2208	7.64±0.30	2.70±0.15	1.85±0.09	2.81±0.20	4.14±0.22	1.46±0.10
2209	8.02±0.33	2.75±0.13	1.95±0.08	2.93±0.18	4.12±0.18	1.41±0.08
2210	6.77±0.41	2.47±0.16	1.82±0.08	2.75±0.20	3.74±0.23	1.37±0.11
2211	8.25±0.42	2.49±0.17	1.77±0.17	3.34±0.26	4.69±0.42	1.41±0.11
2212	7.76±0.31	2.35±0.15	1.72±0.10	3.31±0.23	4.54±0.35	1.38±0.10
2213	8.26±0.35	2.39±0.12	1.68±0.09	3.46±0.18	4.94±0.35	1.43±0.09
Average	7.85±0.50	2.61±0.28	1.80±0.09	3.11±0.26	4.39±0.39	1.41±0.04

its s.d. in the whole strains were found to be 3.11 ± 0.26 . Ratios of length to thickness (L/T) for the individual grain level ranged from 6.35 (W2) to 3.16 (W10). In the strain level, the

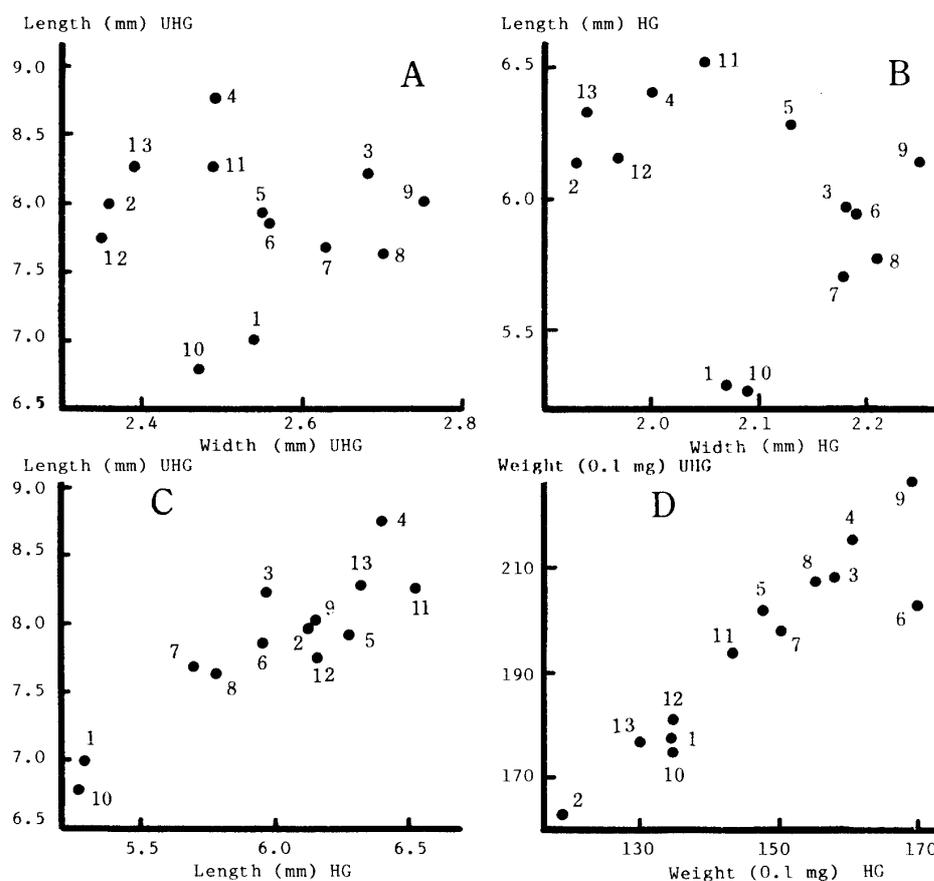


Fig. 3. Relations between the respective two characters of unhusked (UHG) and husked (HG) grains based on the average values of each strain. A --- length (UHG, vertical axis) and width (UHG, abscissa), B --- length (HG) and width (HG), C --- length (UHG) and length (HG), D --- weight (UHG) and weight (HG). Code numbers used in the figure correspond to the strain numbers (except W mark) which were used in the tables.

largest (4.97) and the smallest (3.74) were obtained in W4 and W10, respectively, which were the same as in cases of L and L/W. Average and its s.d. in the whole strains were found to be 4.39 ± 0.39 . Ratios of the width to thickness (W/T) for the individual grain level ranged from 1.70 (W1) to 1.10 (W5). In the strain level, the largest (1.46) and the smallest (1.35) were obtained in W2, W3 and W8, and W5, respectively. Average and its s.d. in the whole strains were found to be 1.41 ± 0.04 . It showed relatively small variations.

The standard deviations of each strain were noted as 0.35 ± 0.06 , 0.15 ± 0.02 , 0.11 ± 0.03 , 0.22 ± 0.03 , 0.29 ± 0.08 and 0.10 ± 0.02 in L, W, T, L/W, L/T and W/T, respectively, illustrated in average and its s.d. in the respective characters.

3. Husked grains (HG)

The results of the husked grains are given in Table 3. Ls for the individual grain level ranged from 7.10mm (W13) to 4.75mm (W1). In the strain level, the longest (6.52mm) and the shortest (5.27mm) were obtained in W11 and W10, respectively, in which the latter was the same as in case of UHG. Average and its s.d. in the whole strains were found to be 5.99 ± 0.38 . Ws for the individual grain level ranged from 2.55mm (W8) to 1.65 mm (W2). In the strain level, the widest (2.25mm) and the narrowest (1.93mm) were obtained in W9 and W2, re-

Table 3. Six morphological characters of the husked grains collected in Bangladesh in 1994

Accession No.	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
2201	5.29±0.28	2.07±0.16	1.56±0.07	2.58±0.21	3.41±0.27	1.33±0.10
2202	6.13±0.30	1.93±0.12	1.42±0.09	3.18±0.20	4.35±0.34	1.37±0.12
2203	5.97±0.14	2.18±0.15	1.59±0.08	2.75±0.20	3.77±0.19	1.38±0.12
2204	6.40±0.30	2.00±0.13	1.53±0.09	3.21±0.26	4.19±0.29	1.31±0.11
2205	6.28±0.26	2.13±0.14	1.63±0.07	2.97±0.25	3.87±0.25	1.31±0.10
2206	5.95±0.27	2.19±0.15	1.60±0.12	2.75±0.21	3.73±0.27	1.37±0.14
2207	5.70±0.29	2.18±0.17	1.59±0.11	2.63±0.24	3.59±0.27	1.38±0.15
2208	5.78±0.25	2.21±0.15	1.61±0.09	2.63±0.21	3.62±0.24	1.38±0.14
2209	6.14±0.31	2.25±0.14	1.67±0.11	2.74±0.20	3.69±0.29	1.35±0.13
2210	5.27±0.31	2.09±0.14	1.54±0.08	2.53±0.25	3.40±0.21	1.36±0.11
2211	6.52±0.34	2.05±0.13	1.51±0.18	3.19±0.23	4.38±0.48	1.38±0.13
2212	6.15±0.35	1.97±0.11	1.44±0.09	3.14±0.22	4.29±0.33	1.37±0.09
2213	6.32±0.35	1.94±0.09	1.40±0.11	3.26±0.26	4.55±0.36	1.40±0.13
Average	5.99±0.38	2.09±0.10	1.55±0.08	2.89±0.26	3.91±0.38	1.36±0.03

spectively, in which the former was the same as in case of UHG. Average and its s.d. in the whole strains were found to be 2.09 ± 0.10 . Ts for the individual grain level ranged from 1.95mm (W11) to 1.20mm (W2, W11, W12, W13). In the strain level, the thickest (1.67mm) and the thinnest (1.40mm) were obtained in W9 and W13, respectively, in which the former was the same as in cases of W and T of UHG and W of HG. Average and its s.d. in the whole strains were found to be 1.55 ± 0.08 .

In comparison with the two components, *i.e.*, L and W of HG, the following tendencies were made clear, as illustrated in Fig. 3-B. In this figure the respective strains were plotted in accordance with the respective values in both the characters. Strains W11~W13 in Site 4 showed relatively long L and narrow W, *i.e.*, slender type. Strains W5~W10 in Site 3 showed large variations in both of L and W. In comparison with UHG and HG in view of L (Fig. 3-C), nearly the same tendencies were ascertained.

L/W for individual grain level ranged from 3.77 (W2, W13) to 2.15 (W1). In the strain level, the largest (3.26) and the smallest (2.53) were obtained in W13 and W10, respectively, in which the latter was the same as in case of UHG. Average and its s.d. in the whole strains were found to be 2.89 ± 0.26 . L/T for the individual grain level ranged from 5.42 (W2, W13) to 2.94 (W1). In the strain level, the largest (4.55) and the smallest (3.40) were obtained in W13 and W10, respectively, in which the former and the latter were the same as in cases of L/W of HG, and of L and L/W of UHG and of HG and L/T of UHG, respectively. Average and its s.d. in the whole strains were found to be 3.91 ± 0.38 . W/T for the individual grain level ranged from 1.75 (W7) to 1.11 (W9, W10). In the strain level, the largest (1.40) and the smallest (1.31) were obtained in W13 and W5, respectively, in which the former and the latter were the same as in cases L/W and L/T of HG, and of W/T of UHG, respectively. Average and its s.d. in the whole strains were found to be 1.36 ± 0.03 .

The standard deviations of each strain were noted as 0.29 ± 0.05 , 0.14 ± 0.02 , 0.10 ± 0.03 , 0.23 ± 0.02 , 0.29 ± 0.07 and 0.12 ± 0.02 in L, W, T, L/W, L/T and W/T, respectively, illustrated in average and its s.d. in the respective characters.

Table 4. Six morphological characters of the unhusked and the husked grains illustrated by the ratio of value in the husked to value in the unhusked grains in the respective characters

Accession No.	Length	Width	Thickness	L/W	L/T	W/T
2201	0.76±0.05	0.81±0.06	0.87±0.03	0.94±0.10	0.87±0.06	0.94±0.09
2202	0.77±0.04	0.82±0.05	0.88±0.04	0.93±0.07	0.88±0.07	0.94±0.09
2203	0.73±0.03	0.82±0.06	0.86±0.03	0.90±0.08	0.84±0.04	0.95±0.07
2204	0.73±0.03	0.81±0.05	0.87±0.03	0.91±0.06	0.84±0.05	0.93±0.06
2205	0.80±0.03	0.84±0.06	0.87±0.03	0.95±0.10	0.92±0.05	0.97±0.08
2206	0.76±0.04	0.86±0.05	0.85±0.04	0.90±0.07	0.89±0.06	1.01±0.09
2207	0.74±0.04	0.83±0.06	0.86±0.04	0.90±0.08	0.87±0.06	0.97±0.08
2208	0.76±0.02	0.82±0.06	0.87±0.03	0.93±0.07	0.88±0.04	0.95±0.07
2209	0.77±0.04	0.82±0.05	0.86±0.05	0.94±0.07	0.90±0.08	0.96±0.08
2210	0.78±0.05	0.85±0.05	0.85±0.03	0.92±0.08	0.91±0.07	1.00±0.07
2211	0.79±0.03	0.83±0.04	0.85±0.04	0.96±0.06	0.93±0.05	0.98±0.07
2212	0.79±0.04	0.84±0.05	0.84±0.04	0.95±0.07	0.95±0.06	1.00±0.07
2213	0.77±0.06	0.82±0.04	0.83±0.05	0.95±0.07	0.92±0.09	0.98±0.07
Average	0.77±0.02	0.83±0.02	0.86±0.01	0.93±0.02	0.89±0.03	0.97±0.03

4. Comparative values (CV)

The detailed results of the comparative values are given in Table 4. Ls for the individual grain level ranged from 0.90 (W5, W13) to 0.65 (W9). In the strain level, the largest (0.80) and the smallest (0.73) were obtained in W5, and W3 and W4, respectively. Average and its s.d. in the whole strains were found to be 0.77 ± 0.02 . Ws for the individual grain level ranged from 0.94 (W1) to 0.62 (W5). In the strain level, the largest (0.86) and the smallest (0.81) were obtained in W6, and W1 and W4, respectively. Average and its s.d. in the whole strains were found to be 0.83 ± 0.02 . Ts for the individual grain level ranged from 0.92 (W2, W4, W5, W6, W8) to 0.71 (W13). In the strain level, the largest (0.88) and the smallest (0.83) were obtained in W2 and W13, respectively, in which the latter was the same as in case of T of HG. Average and its s.d. in the whole strains were found to be 0.86 ± 0.01 .

L/W for the individual grain level ranged from 1.27 (W5) to 0.77 (W6). In the strain level, the largest (0.96) and the smallest (0.90) were obtained in W11, and W3, W6 and W7, respectively, in which the former was the same as in case of L of HG. Average and its s.d. in the whole strains were found to be 0.93 ± 0.02 . L/T for the individual grain level ranged from 1.12 (W12) to 0.70 (W13). In the strain level, the largest (0.95) and the smallest (0.84) were obtained in W12, and W3 and W4, respectively. Average and its s.d. in the whole strains were found to be 0.89 ± 0.03 . W/T for the individual grain level ranged from 1.18 (W2) to 0.75 (W5). In the strain level, the largest (1.01) and the smallest (0.93) were obtained in W6 and W4, respectively, in which the former was the same as in case of W of CV. Average and its s.d. in the whole strains were found to be 0.97 ± 0.03 .

The standard deviations of each strain were noted as 0.04 ± 0.01 , 0.05 ± 0.01 , 0.04 ± 0.01 , 0.08 ± 0.01 , 0.06 ± 0.01 and 0.08 ± 0.01 in L, W, T, L/W, L/T and W/T, respectively, illustrated in average and its s.d. in the respective characters.

5. Area and volume items (AV)

The detailed results of the area and volume items are given in Table 5. Areas in UHG for

Table 5. Six morphological 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 (= ratio of value of the husked to value of the unhusked grains)

Accession No.	Unhusked		Husked		Quotient	
	Area (mm ²)	Volume (mm ³)	Area (mm ²)	Volume (mm ³)	Area	Volume
2201	17.78±1.85	31.69±3.53	10.93±1.07	17.03±1.89	0.62±0.06	0.54±0.06
2202	18.91±1.67	30.57±3.66	11.77±1.24	16.69±2.30	0.63±0.06	0.55±0.06
2203	21.71±1.69	39.93±4.23	12.99±0.98	20.62±1.86	0.61±0.06	0.52±0.06
2204	21.78±1.08	38.52±2.97	12.82±1.03	19.66±2.07	0.59±0.05	0.51±0.05
2205	20.11±1.45	37.89±3.32	13.38±0.97	21.76±1.83	0.67±0.05	0.58±0.05
2206	20.12±1.38	37.95±3.39	13.02±1.13	20.87±2.50	0.65±0.06	0.53±0.10
2207	20.17±1.78	37.55±4.51	12.41±1.14	19.76±2.24	0.62±0.05	0.53±0.05
2208	20.63±1.63	38.19±3.89	12.79±1.08	20.51±1.81	0.62±0.05	0.54±0.05
2209	22.01±1.41	42.90±3.86	13.84±1.25	23.15±2.84	0.63±0.06	0.54±0.05
2210	16.77±1.73	30.47±3.72	11.02±0.92	17.01±1.87	0.67±0.06	0.56±0.06
2211	20.54±1.82	36.64±6.27	13.38±1.20	20.29±3.74	0.65±0.04	0.56±0.05
2212	18.28±1.49	31.39±3.71	12.10±1.06	17.45±2.18	0.66±0.05	0.56±0.05
2213	19.65±1.62	32.93±3.38	12.28±0.82	17.19±1.93	0.63±0.06	0.53±0.06
Average	19.88±1.53	35.89±3.86	12.52±0.85	19.38±2.02	0.64±0.02	0.54±0.02

the individual grain level ranged from 25.20 mm² (W9) to 13.20 mm² (W10). In the strain level, the widest (22.01mm²) and the narrowest (16.77mm²) were obtained in W9 and W10, respectively, in which the former and the latter were the same as in cases of W and T of UHG and HG, and of L, L/W and L/T of UHG and HG, respectively. Average and its s.d. in the whole strains were found to be 19.88±1.53. Volumes in UHG for the individual grain level ranged from 52.70 mm³ (W11) to 22.92mm³ (W2). In the strain level, the largest (42.90mm³) and the smallest (30.47mm³) were obtained in W9 and W10, respectively, which were quite the same as just in the former character. Average and its s.d. in the whole strains were found to be 35.89±3.86.

Areas in HG for the individual grain level ranged from 16.75mm² (W9) to 8.55mm² (W1). In the strain level, the widest (13.84mm²) and the narrowest (10.93mm²) were obtained in W9 and W1, respectively, in which the former and the latter were the same as in cases of W and T of UHG and HG and of areas and volumes of UHG, and of W of CV, respectively. Average and its s.d. in the whole strains were found to be 12.52±0.85. Volumes in HG for the individual grain level ranged from 30.15mm³ (W9) to 10.62mm³ (W2). In the strain level, the largest (23.15mm³) and the smallest (16.69mm³) were obtained in W9 and W2, respectively, in which the former and the latter were the same as in the cases of W, T and areas of UHG and HG and of volume of UHG, and of T of UHG and of W of HG, respectively. Average and its s.d. in the whole strains were found to be 19.38±2.02.

Quotients in areas for the individual grain level ranged from 0.88 (W3) to 0.46 (W4). In the strain level, the largest (0.67) and the smallest (0.59) were obtained in W5 and W10, and W4, respectively, in which the former and the latter were the same as in cases of L of CV and of W/T of CV, respectively. Average and its s.d. in the whole strains were found to be 0.64±0.02. Quotients in volumes for the individual grain level ranges from 0.74 (W3) to 0.38

(W10). In the strain level, the largest (0.58) and the smallest (0.51) were obtained in W5 and W4, respectively, in which the latter was the same as just in case of the former character. Average and its s.d. in the whole strains were found to be 0.54 ± 0.02 .

The standard deviations of each strain were noted as 1.59 ± 0.21 , 3.88 ± 0.79 , 1.07 ± 0.12 , 2.24 ± 0.52 , 0.06 ± 0.01 and 0.06 ± 0.01 in area in UHG, volume in UHG, area in HG, volume in HG, quotient of area and quotient of volume, respectively, illustrated in average and its s.d. in the respective characters.

6. Weight items (GW)

The detailed results of the weight characters are given in Table 6. Weights in UHG for the individual grain level ranged from 28.5mg (W11) to 13.2mg (W11). In the strain level, the heaviest (22.69mg) and the lightest (16.26mg) were obtained in W9 and W2, respectively, in which the former and the latter were the same as in cases of W and T of UHG and HG and of areas and volumes of UHG and HG, and of T of UHG, of W of HG and of volume of HG, respectively. Average and its s.d. in the whole strains were found to be 19.45 ± 1.79 . Weights in HG for the individual grain level ranged from 21.6mg (W11) to 9.0mg (W2). In the strain level, the heaviest (17.03mg) and the lightest (11.91mg) were obtained in W6 and W2, respectively, in which the former and the latter were the same as in the cases of W and W/T of CV, and of T of UHG, of W of HG, of volume of HG and of weight in UHG, respectively. Average and its s.d. in the whole strains were found to be 14.67 ± 1.53 . Quotients in weight for the individual grain level ranged from 0.82 (W12) to 0.67 (W4, W9). In the strain level, the largest (0.77) and the smallest (0.73) were obtained in W6 and W10, and W2, respectively, in which the latter was the same as in the cases of T of UHG, of W of HG, of volume of HG and of weights of UHG and HG. Average and its s.d. in the whole strains were found to be 0.75 ± 0.01 .

In comparison with two components, *i.e.*, weights in UHG and HG, the following tenden-

Table 6. Three grain weight characters in view of practical value and pure range, *i.e.*, unhusked (UHG), husked (HG) and ratio of the value in husked to value in unhusked grains (HG/UHG), illustrated by 0.1 mg

Accession No.	Practical value			Range		
	UHG	HG	HG/UHG	UHG	HG	HG/UHG
2201	176.80 ± 15.81	133.67 ± 12.49	0.76 ± 0.02	58	47	0.08
2202	162.60 ± 21.13	119.13 ± 17.36	0.73 ± 0.03	80	75	0.09
2203	208.10 ± 11.62	158.43 ± 8.56	0.76 ± 0.02	55	40	0.06
2204	214.90 ± 15.64	160.83 ± 14.49	0.75 ± 0.02	76	67	0.11
2205	202.73 ± 15.03	147.07 ± 17.95	0.74 ± 0.02	61	46	0.08
2206	202.33 ± 13.80	170.27 ± 10.76	0.77 ± 0.02	50	42	0.06
2207	198.17 ± 18.59	150.00 ± 13.81	0.76 ± 0.02	70	61	0.09
2208	207.90 ± 14.32	155.27 ± 10.75	0.75 ± 0.02	59	48	0.08
2209	226.90 ± 20.05	169.77 ± 17.99	0.75 ± 0.03	84	84	0.11
2210	175.30 ± 12.50	134.27 ± 10.64	0.77 ± 0.02	60	48	0.09
2211	194.70 ± 33.64	143.87 ± 26.47	0.74 ± 0.03	153	111	0.12
2212	181.33 ± 18.22	134.27 ± 14.80	0.74 ± 0.02	71	62	0.13
2213	176.67 ± 16.67	130.33 ± 14.63	0.74 ± 0.02	81	68	0.09
Average	194.50 ± 17.90	146.71 ± 15.25	0.75 ± 0.01	74	62	0.09

cies were made clear, as illustrated in Fig. 3-D. In the figure, the respective strains were plotted in accordance with the respective values in both the characters. Strains W11~W13 in Site 4 showed relatively light weight in both UHG and HG. Strains W2~W4 in Site 2 and W5~W10 in Site 3 showed very large intra-site diversities.

The standard deviations of each strain were noted as 1.75 ± 0.54 , 1.47 ± 0.45 and 0.02 ± 0.00 in weights in UHG, in weights in HG and in quotients in weight, respectively, illustrated in average and its s.d. in the respective characters.

7. Relationships between the respective two characters

i] *Relationships of grain morphology (character-combination Nos.1~27 in Table 7)*

As shown in Table 7, correlation coefficients (abbreviated as c.c.) of the respective character-combinations in the strain level were fixed to be significant in 192 cases out of 351 combinations (=13 strains x 27 character-combinations) of the whole cases (=54.7%). In detail, some characteristics were found. Significant correlations in the strain level were accounted as follows in the order of the combination numbers from 1 to 27; 3, 3, 2; 8, 11, 10; 1, 2, 2; 6, 12, 11; 0, 0, 0; 10, 11, 7; 7, 10, 13; 9, 10, 12; 7, 12 and 13 strains, respectively. Average value and its s.d. through the whole combinations were found to be 7.11 ± 4.42 .

The whole combinations were divided into 2 groups, i.e., group I (combination Nos. 1~18) and group II (Nos.19~27). Significant correlations were accounted as 42.3% (=99/234) and 79.5% (=93/117) in group I (the lower group) and group II (the higher group), respectively. Their averages and their s.ds. through the whole combinations within the groups were found to

Table 7. Summed up data showing correlation coefficients in the 27 character-combinations

Combination No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Character Nos.	1	1	2	4	4	5	11	11	12	14	14	15	21	21	22	24	24	25	1	2	3	4	5	6	31	32	35	
	2	3	3	5	6	6	12	13	13	15	16	16	22	23	23	25	26	26	11	12	13	14	15	16	33	34	36	
Accession No.	2201	*			***	***				**	**	*				***	***				***	***		**	**	***	***	
	2202				***	***	*			**	***						**		**	***	***	***	***	***	***	***	***	***
	2203		**		*	***				***	***					**	***		*		***	***	***	***		*	***	
	2204				*	**	**			***	***	*				**	***		*		***	***	***	***	***	***	***	***
	2205				**	***				***	***					**	***		*		**	*	***	*			***	
	2206				***	**				***	***					*	***	*		*	***		**	**		***	***	***
	2207		*		*	***	*			***	***					**	***		*	***	***	*	***	***	***	***	***	***
	2208	*			*	***				***	***					**	***		*	***	***	***	***	***	***	***	***	***
	2209		**		*	***				***	***					**	***		***	***	***	***	**	**		***	***	***
	2210				***	**				***	***					**	**	*		***	***	***	***	***	***	*	***	***
	2211			***	***	***		*	***	**	***					**	***	***	***	***	***	***	***	***	***	***	***	***
	2212			*	*	***			*	***	*	**				***	**	***	***	***	**	**	**	***	***	***	***	***
	2213	*			*	***		*		***	***					***				***	***	***	***	***	***	*	***	***
Whole			***	***	***			***	***	***					**	***	***	***	***	***	***	***	***	***	***	***	***	

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 area (=33/31), 36 - quotient of volume (=34/32)

d.f.; 28 and 11 in strain level and the whole, respectively
 ***, **, *; significant at 0.1%, 1% and 5% levels, respectively

be 16.50 ± 12.39 and 31.00 ± 0.82 in groups I and II, respectively. Moreover, group I were redivided into 6 sub-groups as follows; sub-group I (combination Nos.1~3), sub-2 (Nos.4~6), sub-3 (Nos.7~9), sub-4 (Nos.10~12), sub-5 (Nos.13~15) and sub-6 (Nos.16~18). Significant correlations were accounted as follows in the order from sub-1 to sub-6; 20.5% (=8/39), 74.4% (=29/39), 12.8% (=5/39), 74.4% (=29/39), 0.0% (=0/39) and 71.8% (=28/39), respectively. It was ascertained that subs-2, -4 and -6, *i.e.*, ratio columns, showed the more higher significances [73.5% (=86/117)] in comparison with those of subs-1, -3 and -5 [11.1% (=13/117)]. Those differences found might be looked upon as specificities of character and/or character-combination. Those averages and their s.ds. through the whole combinations within the sub-groups were found to be 28.67 ± 0.47 and 12.44 ± 11.79 in the higher and in the lower sub-groups, respectively.

The respective strains showed significant correlations as follows in the order from strain W1 to W13; 13, 15, 13, 16, 12, 13, 17, 16, 13, 14, 18, 20 and 12, respectively. It was noticeable that the strains W12 and W5 showed significances in 20/27 combinations (=74.1% in the whole character-combinations) and 12/27 combinations (=44.4%), respectively. One, 1, 1, 2, 1, 1, 4 and 2 strains showed significances in 20, 18, 17, 16, 15, 14, 13 and 12 character-combinations, respectively. Average value and its s.d. through the whole strains were found to be 14.77 ± 2.39 .

Significant correlations were analysed in the positive or the negative statuses as well as in the degrees of the respective statuses. Significant correlations were accounted as follows in the order of 0.1% levels (positive, negative and the whole), of 1% levels (positive, negative and the whole) and of 5% levels (positive, negative and the whole); 76 (=36.9%), 23 (=12.0%), 99 (=51.6%); 46 (=24.0%), 8 (=4.2%), 54 (=28.1%); 36 (=18.8%), 3 (=1.6%), 39 (=20.3%).

It might be a noticeable phenomenon that about the half (51.6%) of them showed significant correlations at 0.1% level. It might have meant an instance of those biological actions, which were extremely called "all or nothing", *i.e.*, going from one extreme to another. However, the value was clearly lower than those of the cultivated species^{8,9}. This meant a difference brought forth owing to taxonomic status. In a stricter sense, those characters were looked upon as being in possession of a stable state, and they were exhibited independently on the other characters. The positive and the negative combinations in the total were accounted as 158 combinations (=82.3%) and 34 combinations (=17.7%), respectively. Nearly the same patterns were found in the cases of the cultivated strains collected in Madura, Indonesia⁸ and Fiji⁹. Negative significances were found only in the combination Nos.5, 11 and 17 (combinations between L/W and W/T).

ii] *Relationships of grain weight (character-combination Nos.28~52 in Table 8)*

As shown in Table 8, c.c. of the respective character-combinations in the strain level were fixed to be significant in 119 cases out of 325 combinations (=13 strains x 25 character-combinations) of the whole cases (=36.6%). In detail, some characteristics were found. Significant correlations in the strain level were accounted as follows in the order of the combination numbers from 28 to 52; 13; 9, 5, 9; 0, 2, 5; 8, 6, 8; 0, 0, 2; 2, 3, 0; 1, 1, 1; 8, 11, 11, 12, 0 and 2 strains, respectively. It may be noticed that the values were particularly larger in the combination numbers 28, 48, 49 and 50. Average and its s.d. through the whole combinations were found to be 4.76 ± 4.27 .

The whole combinations were divided into 3 groups, *i.e.*, group III (combination No.28, the

Table 8. Summed-up data showing correlation coefficients in the 25 character-combinations

Combination No.	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Character Nos.	7	7	7	7	7	7	7	17	17	17	17	17	17	27	27	27	27	27	27	7	7	17	17	27	27
	17	1	2	3	4	5	6	11	12	13	14	15	16	21	22	23	24	25	26	31	32	33	34	35	36
Accession No.	2201	***	***	***			*			*										***	***	*	**		
	2202	***	*	*	**				*	*	***									***	***	**	***		
	2203	***	**		*				***		*				*		*	**			*	**	*		
	2204	***			**			*	*	**					*						**	**	***	**	**
	2205	***		**				*						*							*				
	2206	***	*		**																*	***		*	
	2207	***	***	***				*	*	*											***	***	**	*	
	2208	***	**						***						*	**		**			*	**	*	**	
	2209	***			***				***	*	*										*	***	***	***	**
	2210	***	*		**						***											**	**	***	
	2211	***	***	***	***		**	*	*	**	***			***							***	***	**	***	
	2212	***	*		*		**		*	*													**	**	
	2213	***			*			**	**	**				**								*	**	**	
Whole	***		**	**				**	**							*				***	***	**	***		

Character numbers; 7, 17, 27 grain weight, 7 (UHG), 17 (HG), 27 (quotient of grain weight = 17 / 7). Others are the same as shown in Table 7.

d.f.; 28 and 11 in strain level and the whole, respectively

***, **, *; significant at 0.1%, 1% and 5% levels, respectively

high group), group IV (Nos.29~31, 35~37, 47~48, 49~50, the medium) and group V (Nos.32~34, 38~40, 41~43, 44~46, 51~52, the low). Significant correlations were accounted as 100.0% (=13/13), 66.9% (=87/130) and 10.4% (=19/182) in groups III, IV and V, respectively. Those averages and their s.ds. through the whole combinations within the groups were found to be 13.00 ± 0.00 , 21.75 ± 1.64 and 3.80 ± 1.94 in groups III, IV and V, respectively. Those differences found might be looked upon as specificities of character and/or character-combinations.

The respective strains showed significant correlations as follows in the order from strain W1 to W13; 9, 11, 11, 10, 5, 6, 10, 10, 10, 7, 14, 8 and 8, respectively. It was noticeable that strains W11 and W5 showed significances in 14/25 combinations (=56.0% in the whole character-combinations) and 5/25 combinations (=20.0%), respectively. One, 2, 4, 1, 2, 1, 1 and 1 strains showed significances in 14, 11, 10, 9, 8, 7, 6 and 5 character-combinations, respectively. Average value and its s.d. through the whole strains were found to be 9.15 ± 2.28 .

Significant correlations were analysed in the positive or the negative statuses as well as in the degrees of the respective statuses. Significant correlations were accounted as follows in the order of 0.1% levels (positive, negative and the whole), of 1% levels (positive, negative and the whole) and of 5% levels (positive, negative and the whole); 43 (=36.1%), 1 (=0.8%), 44 (=37.0%); 30 (=25.2%), 4 (=3.4%), 34 (=28.6%); 37 (=31.1%), 4 (=3.4%), 41 (=34.5%).

It might be a noticeable phenomenon that about one third each of those showed significant combinations at 0.1%, 1% and 5% levels. That was ascertained to be quite different from those in the former chapter, and looked upon as the respective character-specificities.

The positive and the negative combinations in the total were accounted as 110 combinations (=92.4%) and 9 combinations (=7.6%), respectively. It was clearly found that the former value (=92.4%) was larger than those in the former chapter.

iii] *Relations among practical value, standard deviations and variation range*

The mutual relationships in view of the three major components were accounted, and are given in Table 9, in which the items concerning grain morphology and grain weight are shown in the left and right half columns, respectively.

<Grain morphology group>

In the practical-value-combinations (A), 11, 2 and 14 character-combinations showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the s.d.-value-combinations (B), 2, 5 and 20 character-combinations showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the range-value-combi-

Table 9. Correlation coefficient of the former character (Y) on the latter character (X) for 52 combinations; practical value (left), s.d. (center) and range (right)

Combination	Practical value	S.d.	Range	Combination	Practical value	S.d.	Range
1 · 2	-0.0311	0.4127	0.1886	7 · 1	0.4343	0.3760	0.3427
1 · 3	-0.4083	0.1471	0.3422	7 · 2	0.7888**	0.2938	0.3613
2 · 3	0.8241***	0.1460	0.4608	7 · 3	0.7589**	0.4028	0.6314*
4 · 5	0.9593***	0.5772*	0.5527	7 · 4	-0.1297	0.4331	0.4160
4 · 6	0.0690	0.6005*	0.3921	7 · 5	-0.1356	0.6261**	0.5528
5 · 6	0.3432	0.6403*	0.5149	7 · 6	-0.0763	0.1825	-0.1211
11 · 12	-0.3077	-0.5657*	-0.6352*	17 · 11	0.1435	0.5503	0.3908
11 · 13	-0.2549	0.4075	0.2806	17 · 12	0.7719**	-0.3203	-0.4474
12 · 13	0.9383***	-0.1521	-0.1967	17 · 13	0.7754**	0.6648*	0.8014***
14 · 15	0.9764***	0.1188	0.2549	17 · 14	-0.3141	0.1325	0.0564
14 · 16	0.0260	-0.1314	-0.1735	17 · 15	-0.3529	0.8471***	0.7861**
15 · 16	0.2387	0.0859	-0.0121	17 · 16	-0.1808	-0.0154	0.0804
21 · 22	0.4464	-0.2354	0.0375	27 · 21	-0.4343	-0.0958	0.1933
21 · 23	-0.2649	0.4554	0.2151	27 · 22	0.3562	-0.4436	-0.0811
22 · 23	-0.4024	-0.6239*	-0.3594	27 · 23	-0.0872	0.4866	0.2820
24 · 25	0.7479**	-0.0894	0.1372	27 · 24	-0.6800*	-0.3926	-0.1495
24 · 26	0.0880	0.4585	0.4550	27 · 25	-0.3815	0.2582	0.2152
25 · 26	0.6991**	0.2357	0.0343	27 · 26	0.2658	0.2282	-0.3941
1 · 11	0.9007***	0.2314	0.4416	7 · 31	0.8462***	0.2655	0.3309
2 · 12	0.5529	0.2994	-0.1440	7 · 32	0.9641***	0.7754**	0.7649**
3 · 13	0.9447***	0.4298	0.6889**	17 · 33	0.7161**	0.4405	0.2322
4 · 14	0.9655***	-0.0893	0.1614	17 · 34	0.8602***	0.7842**	0.8518***
5 · 15	0.9222***	0.7756**	0.8147***	27 · 35	-0.0404	-0.1107	-0.6628*
6 · 16	0.4006	-0.2781	-0.6190*	27 · 36	-0.3533	-0.1823	-0.2311
31 · 33	0.8816***	0.0305	-0.1744	7 · 17	0.9338***	0.9179***	0.9435***
32 · 34	0.9502***	0.7496**	0.6603*				
35 · 36	0.8597***	0.4985	0.7727**				

Character numbers are the same as mentioned in Tables 7 and 8.

d.f.; 11

***, **, *; significant at 0.1%, 1% and 5% levels, respectively

nations (C), 1, 2, 3 and 21 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the three character-combinations mentioned above (D), 12, 6, 8 and 55 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. Four columns were regulated, under the condition that the calculation was to be made by means of the significances in disregard of significant levels, fixed in other viewpoints. Significant combinations were accounted as 13/27 cases (=48.2%), 7/27 cases (=25.9%), 6/27 cases (=22.2%) and 26/81 cases (=32.1%) in columns A, B, C and D, respectively. Moreover, 2, 4, 12 and 9 character-combinations showed significances in 3, 2, 1 and 0 columns, respectively. Average and its s.d. through the whole cases were found to be 0.96 ± 0.88 . It was a remarkable phenomenon that character-combination Nos.5·15 and 32·34 showed the higher frequencies.

< Grain weight group >

In A, 4, 5, 1 and 15 the character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In B, 2, 3, 1 and 19 the character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In C, 3, 2, 2 and 18 the character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In D, 9, 10, 4 and 52 the character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. Significant combinations were accounted as 10/25 cases (=40.0%), 6/25 cases (24.0%), 7/25 cases (28.0%) and 23/75 cases (=30.7%) in columns A, B, C and D, respectively. Moreover, 4, 2, 7 and 12 character-combinations showed significances in 3, 2, 1 and 0 columns, respectively. Average and its s.d. through the whole cases were found to be 0.92 ± 1.09 , in which the latter value was remarkably large.

< Both character-groups >

In A, 15, 7, 1 and 29 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In B, 2, 5, 6 and 39 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In C, 4, 4, 5 and 39 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In D, 21, 16, 12 and 107 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. Significant combinations were accounted as 23/52 cases (=44.2%), 13/52 cases (=25.0%), 13/52 cases (=25.0%) and 49/156 cases (=31.4%) in A, B, C and D, respectively. Moreover, 6, 6, 19 and 21 character-combinations showed significances in 3, 2, 1 and 0 columns, respectively. Average and its s.d. through the whole cases were found to be 0.94 ± 0.98 .

In comparison with the respective groups and columns, the following facts were ascertained. Column A showed a significant level about twice larger than those of B and C columns showed in total groups. Columns A and B showed the higher significant level than those of C column showed in grain morphology group. However, the total data (D) of the both groups were fixed to be nearly of the same grades. Standard deviations in three columns (0.88, 1.09 and 0.98) were found to be relatively of large values.

The other mutual relationships in view of the respective three major components were calculated, and are shown in Table 10. In the relations between the practical values and their s.d.s. (E), 1, 3 and 23 characters showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the relations between the practical values and their variation

Table 10. Correlation coefficient of the former character (Y) on the latter character (X) for 27 characters; practical value on its s.d. (left), practical value on its range (center), and s.d. on its range (right)

Char-acter	Practical value on its s.d.	Practical value on its range	S.d. on range	Char-acter	Practical value on its s.d.	Practical value on its range	S.d. on range
1	-0.5986*	-0.2613	0.5289	21	0.1432	0.3710	0.6555*
2	-0.0552	-0.2459	0.8384***	22	-0.1164	-0.1375	-0.0111
3	0.2791	-0.6837**	0.6747*	23	-0.5224	-0.6949**	0.5878*
4	0.3306	0.3814	0.8986***	24	0.0473	0.3414	0.6601*
5	0.6553*	0.5829*	0.9699***	25	0.3723	0.3538	0.9345***
6	0.2386	-0.4027	0.6655*	26	0.0287	-0.3725	0.7198**
11	0.2342	0.0049	0.8753***	31	-0.4658	-0.2030	0.8053***
12	0.3765	0.5552*	0.8470***	32	0.1356	0.1368	0.9440***
13	-0.1187	-0.3177	0.9469***	33	0.2943	0.1659	0.8293***
14	0.3149	0.2544	0.1303	34	0.3181	0.2354	0.9538***
15	0.7469**	0.7513**	0.9020***	35	-0.0930	0.0234	0.6720*
16	0.5745*	0.4979	0.8776***	36	-0.2324	0.0712	0.1147
				7	-0.0833	0.1652	0.9537***
				17	-0.1755	-0.1319	0.8833***
				27	-0.4889	-0.5068	0.4077

Character numbers are the same as shown in Tables 7 and 8.

d.f.; 11

***, **, *; significant at 0.1%, 1% and 5% levels, respectively

ranges (F), 3, 2 and 22 characters showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the relations between the s.ds. and their variation ranges (G), 15, 1, 6 and 5 characters showed significances at 0.1%, 1% and 5% levels, and no significance even at 5% level, respectively. In the three relations mentioned above (H), 15, 5, 11 and 50 characters showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. Significant relations were calculated as 4/27 cases (=14.8%), 5/27 cases (=18.5%), 22/27 cases (=81.5%) and 31/81 cases (=38.3%) in E, F, G and H, respectively. Moreover, 2, 4, 17 and 4 characters showed significances in 3, 2, 1 and 0 columns, respectively. Average and its s.d. through the whole columns were found to be 1.15 ± 0.76 . It was noticeable that character Nos.5 and 15 showed higher frequencies. It was also clearly ascertained that the column G showed higher significant status than E and F columns, and the columns of E and F showed nearly the same significant grades.

8. Comparison of materials collected in neighbouring areas

To clarify the relationships between the present materials and other strains of *Oryza sativa* var. *spontanea* ROSCHEV. collected in the neighbouring areas, comparison was made, using the data obtained in the present experiment and in the previous papers^{4, 7} on the characters of the unhusked grains. In the latter, the following 4 material groups were adopted, i.e., (group-a) 42 strains collected along Ganga Plains during the period from October to December in 1971 (abbreviated as Ganga)⁴, (group-b) 25 strains collected in Ceylon (Sri Lanka) during the period from December in 1971 to January in 1972 (Ceylon)⁵, (group-c) 11 strains collected in Deccan Plateau during the period from December in 1978 to January in 1979

Table 11. Six morphological characters of the unhusked grains collected in Bangladesh in 1994 and the previous four localities, illustrated by the average values of the respective groups

Group	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T	No. of strains
Present	7.85	2.61	1.80	3.11	4.39	1.41	13
Ganga	8.53	2.78	1.83	3.12	4.72	1.52	42
Ceylon	8.84	2.72	1.70	3.30	5.20	1.60	25
Deccan	8.01	2.54	1.73	3.18	4.66	1.48	11
Assam	7.65	2.21	1.70	3.51	4.56	1.31	17

Group marks used are shown in the text.

(Deccan)⁶⁾ and (group-d) 17 strains collected in Assam along Brahmaputra River in January of 1979 (Assam)⁷⁾, all of which were directly collected in the respective areas by the senior author of the present paper. Six morphological characters of the unhusked grains are given in Table 11.

From the data shown in this table, the following facts were ascertained in view of the strain differentiation. i) Values of L, W and T of the present materials were remarkably shorter, wider and thicker than those of the other groups in view of group averages. ii) Values of L/W, L/T and W/T of the present materials were clearly smaller than those of the other groups, especially in L/T value. iii) In comparison with these results obtained here, the present materials might be located in the position implying relatively shorter, wider and thicker statuses of the wild rice species in the Indian-Subcontinent, which have been looked upon as a contrasting position of materials collected in Ceylon.

Summary

Thirteen strains of wild rice were collected in 4 sites in the northeastern part of Bangladesh in 1994. In the present paper, the records of identification of species, habitats and morphological characters were reported. The main results obtained here were summarized as follows.

Basing on the data obtained, those were detected to be *Oryza sativa* var. *spontanea* ROSCHEV.

Twenty seven characters of the unhusked and husked grains and 52 mutual relationships between the respective characters were calculated. In the former, length, width, thickness and weight of the unhusked grains were found to be 7.85 mm, 2.61 mm, 1.80 mm and 19.5 mg in average values, respectively. Those of the husked grains were found to be 5.99 mm, 2.09 mm, 1.55 mm and 14.7 mg in the average values in the same order, respectively. In the latter, 46.0% (=311/676 character and character-combinations) showed significant relationships. It was noted that the strains collected in Site 3 showed very large intra-site diversities.

In comparison with the data obtained in the present and the previous studies in view of the strain differentiation, the following fact was ascertained. The present materials might be located in the position in which they have in grain length relatively shorter, in width wider

and in thickness thicker statuses of the wild rice in the Indian-Subcontinent.

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