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Distribution and Some Morphological Characters of the Wild Rice in the Central India (II)

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Introduction

During the period from December in 1978 to January in 1979, the writer was sent to India for collection of the wild and cultivated rice 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.

On the distribution of wild rice in central India, some reports have already been published[1,4]. The central India denoted here is as follows; southern part of West Bengal, southern part of Bihar, Orissa, Andhra Pradesh and Madhya Pradesh. Though these areas are condisered to be a region of the secondary centers for origin of rice, accumulation of complete date on these aspects is far from being perfect. Watt[7] reported that rice evolved in peninsular India. Nair *et al.*[6] advanced also some phytogeographical evidence in support of considering peninsular India and particularly some of the Malabar coast as the center of the origin of rice, basing on the occurrence of as many as five wild taxa, the presence of the high varietal diversity, and also the wide occurrence of several dominant genes in local rice varieties. It is important to keep in mind that natural habitats of wild rice are disappearing due to the man-made environments year by year, and that the wild rices mayserve as reservoirs of germplasm for cultivated rices.

Taking these facts into account, the present series was made to accomplish the works which are going to clarify the distribution and ecotypic differentiation of wild rice in the central India. In the previous paper[2], the habitat and the record of morphological characters of the unhusked and husked grains of wild rice were described. In the present report, variation ranges in 12 characters and some mutual relations were mainly described, in order to confirm the morphological characters of grains and as well as to make clear the ecotypic differentiations of those grains. The records on the comparison of the unhusked and the husked grains, consideration on the distribution of wild rice in the whole India, will be reported in the separate articles.

Materials and Methods

Eleven strains of wild rice were collected in this collection-trip, and they were used for morphological investigations. Their collection number, collection date, district and habitat were mentioned in Table 1. Thirty grains were used for the measurement of each strain. The whole data referring to the 12 characters were illustrated by the maximum, the minimum and the average values in the whole grains. Inquiries were done to fix the variation ranges for 12 characters, *i.e.*, 1 and 7 — length (mm), 2 and 8 — width (mm), 3 and 9 — thickness (mm), 4 and 10 — ratio of length to width (%), 5 and 11 — ratio of length to thickness (%), 6 and 12 — ratio of width to

Table 1. Distribution and habitat of wild rice collected in West Bengal (=W. B.), Orissa and Madhya Pradesh (=M. P.), India

Collection No.	Species	Date	Place	Detailed locality, habitat and remarks
W1	**p**	Dec. 20	Baripada	E 17 km north from Baripada, Orissa. Road-side ditch, 20 m × 100 m. Large population.
W2	**p**	Dec. 20	Baripada	E 20 km south from Baripada, Orissa. Growing in edge of pond, 500 m × 300 m. Large population.
W3	**p**	Dec. 21	Konarak	E 8 km north from Konarak, Orissa. Swamp. Large population. Dune. south from here.
W4	**p**	Dec. 21	Konarak	W 31 km north from Konarak, Orissa. Road-side ditch, clearly separated from paddy field by an embankment.
W5	**s**	Dec. 27	Raipur	N 11 km east from Raipur, M. P. Edge of large pond, dia. 200 m. *O. perennis* growing beyond the pond.
W6	**s**	Dec. 27	Sohela	S 15 km west from Sohela, M. P. Edge of large pond, dia. 200 m.
W7	**p**	Dec. 27	Sambalpur	S 15 km west from Sambalpur, Orissa. Edge of large pond, 100 m × 150 m.
W8	**s**	Jan. 10	Calcutta	— 13 km south from Diamond Harbour, W. B. Road-side ditch.
W9	**s**	Jan. 10	Calcutta	— 37 km south from Diamond Harbour, W. B. Road-side ditch.
W10	**s**	Jan. 11	Calcutta	— 12 km east from Baruipur, W. B. Road-side ditch.
W11	**s**	Jan. 11	Calcutta	— 18 km west from Canning and 11 km east from Baruipur, W. B. Road-side ditch. Native name "Ora", "Gola" or "Jhola".

Abbreviations: **s**; *Oryza sativa* var. *spontanea* ROSCHEV., **p**; *Oryza perennis* MOENCH, m; meter or meters, km; kilometer or kilometers, N, E, S and W; north, east, south and west side of main road, respectively

thickness (%). Characters from No. 1 to No. 6 and No. 7 to No. 12 were concerned almost the unhusked and the husked grains, respectively. The whole data were cited from the previous paper[2].

To make clear the relations between the respective two characters of the unhusked and the husked grains, correlation coefficient and linear regression between them were calculated through the whole characters.

In the present paper, the following abbreviations were used, *i.e.*, L (length), W (width), T (thickness), L/W (ratio of length to width), L/T (ratio of length to thickness), W/T (ratio of width to thickness), c.c. (correlation coefficient), l.r. (linear regression) and s.d. (standard deviations).

Results

PART I. Ranges among the respective characters

1. Length in unhusked grains

Maximum: The results are given in Table 2. In this table, the maximum, the minimum and their ranges are shown. The longest (10.10 mm) was obtained in No. 5, followed by No. 9 (8.90 mm)

Table 2. Ranges of unhusked grains in the strain level; length (mm), width (mm), thickness (mm), ratio of length to width (%), ratio of length to thickness (%) and ratio of width to thickness (%)

Strain	Length			Width			Thickness			Length/Width			Length/Thickness			Width/Thickness		
No.	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range
1	8.40	7.15	1.25	2.75	2.30	0.45	1.95	1.65	0.30	3.40	2.75	0.65	4.69	3.95	0.74	1.53	1.21	0.32
2	8.70	7.20	1.50	2.70	2.50	0.20	2.05	1.80	0.25	3.35	2.81	0.54	4.83	3.79	1.04	1.50	1.24	0.26
3	8.20	6.80	1.40	2.90	2.15	0.75	1.80	1.30	0.50	3.16	2.60	0.56	5.82	4.19	1.63	2.04	1.56	0.48
4	8.25	7.00	1.25	2.20	1.90	0.30	1.70	1.30	0.40	4.34	3.23	1.11	5.69	4.50	1.19	1.54	1.12	0.42
5	10.10	8.55	1.55	3.50	2.70	0.80	1.95	1.65	0.30	3.37	2.44	0.93	5.53	4.51	1.02	1.94	1.46	0.48
6	8.60	7.95	0.65	2.65	2.20	0.45	1.85	1.60	0.25	3.82	3.15	0.67	5.13	4.56	0.57	1.53	1.26	0.27
7	8.40	6.90	1.50	2.50	1.95	0.55	1.85	1.40	0.45	3.74	2.96	0.78	5.89	4.03	1.86	1.79	1.16	0.63
8	8.45	7.25	1.20	2.90	2.40	0.50	2.05	1.70	0.35	3.20	2.75	0.45	4.85	3.90	0.95	1.59	1.27	0.32
9	8.90	8.00	0.90	3.05	2.60	0.45	1.95	1.40	0.55	3.36	2.76	0.60	5.93	4.51	1.42	2.00	1.41	0.59
10	8.40	7.65	0.75	2.65	2.20	0.45	1.95	1.55	0.40	3.75	3.00	0.75	5.03	4.13	0.90	1.53	1.16	0.37
11	8.70	7.80	0.90	2.95	2.55	0.40	1.95	1.65	0.30	3.16	2.69	0.47	4.79	4.16	0.63	1.64	1.38	0.26

and Nos. 2 and 11 (8.70 mm). It may be noted that the value was peculiarly large in No. 5. The shortest (8.20 mm) was noted in No. 3, followed by No. 4 (8.25 mm). Average and its s.d. through the whole strains were found to be 8.65±0.53.

Minimum: The longest (8.55 mm) was obtained in No. 5, which was the same as in case of the maximum, followed by No. 9 (8.00 mm) and No. 6 (7.95 mm). The shortest (6.80 mm) was noted in No. 3, which was also the same as in case of the maximum, followed by No. 7 (6.90 mm) and No. 4 (7.00 mm). Average and its s.d. through the whole strains were found to be 7.48±0.55.

Range: The largest (1.55 mm) was obtained in No. 5, which was the same as in cases of the maximum and the minimum, followed by Nos. 2 and 7 (1.50 mm). The smallest (0.65 mm) was noted in No. 6, followed by No. 10 (0.75 mm). Average and its s.d. through the whole strains were found to be 1.17±0.32.

2. Width in unhusked grains

Maximum: The widest (3.50 mm) was obtained in No. 5, which was the same as in cases of 3 characters of length, followed by No. 9 (3.05 mm) and No. 11 (2.95 mm). It may be noted that the value was peculiarly large in No. 5, which was also the same as in case of length. The narrowest (2.20 mm) was noted in No. 4, followed by No. 7 (2.50 mm) and Nos. 6 and 10 (2.65 mm). Average and its s.d. through the whole strains were found to be 2.80±0.33.

Minimum: The widest (2.70 mm) was obtained in No. 5, which was the same as in cases of the former 4 characters, followed by No. 9 (2.60 mm) and No. 11 (2.55 mm). The narrowest (1.90 mm) was noted in No. 4, which was the same as in case of the maximum, followed by No. 7 (1.95 mm) and No. 3 (2.15 mm). Average and its s.d. through the whole strains were found to be 2.31±0.26.

Range: The largest (0.80 mm) was obtained in No. 5, which was the same as in cases of the former 5 characters, followed by No. 3 (0.75 mm) and No. 7 (0.55 mm). The smallest (0.20 mm) was noted in No. 2, followed by No. 4 (0.30 mm) and No. 11 (0.40 mm). Average and its s.d. through the whole strains were found to be 0.48±0.17.

3. Thickness in unhusked grains

Maximum: The thickest (2.05 mm) was obtained in Nos. 2 and 8. The thinnest (1.70 mm) was noted in No. 4, which was the same as in cases of the maximum and the minimum of width, followed by No. 3 (1.80 mm). Average and its s.d. through the whole strains were found to be 1.91±0.11.

Minimum: The thickest (1.80 mm) was obtained in No. 2, followed by No. 8 (1.70 mm). The thinnest (1.30 mm) was noted in Nos. 3 and 4. Average and its s.d. through the whole strains were found to be 1.55±0.17.

Range: The largest (0.55 mm) was obtained in No. 9, followed by No. 3 (0.50 mm) and No. 7 (0.45 mm). The smallest (0.25 mm) was noted in Nos. 2 and 6. Average and its s.d. through the whole strains were found to be 0.37±0.10.

4. Ratio of length to width (L/W) in unhusked grains

Maximum: The largest (4.34) was obtained in No. 4, followed by No. 6 (3.82) and No. 10 (3.75). It may be noted that the value was peculiarly large in No. 4. The smallest (3.16) was noted in Nos. 3 and 11, followed by No. 8 (3.20). Average and its s.d. through the whole strains were found to be 3.51±0.36.

Minimum: The largest (3.23) was obtained in No. 4, which was the same as in case of the maximum, followed by No. 6 (3.15) and No. 10 (3.00). These orders of strains were also the same as in case

of the maximum. The smallest (2.44) was noted in No. 5, followed by No. 3 (2.60) and No. 11 (2.69). Average and its s.d. through the whole strains were found to be 2.83±0.24.

Range: The largest (1.11) was obtained in No. 4, which was the same as in cases of the maximum and the minimum, followed by No. 5 (0.93) and No. 7 (0.78). The smallest (0.45) was noted in No. 8, followed by No. 11 (0.47) and No. 2 (0.54). Average and its s.d. through the whole strains were found to be 0.68±0.20.

5. Ratio of length to thickness (L/T) in unhusked grains

Maximum: The largest (5.93) was obtained in No. 9, which was the same as in case of the range of thickness, followed by No. 7 (5.89) and No. 3 (5.82). The smallest (4.69) was noted in No. 1, followed by No. 11 (4.79) and No. 2 (4.83). Average and its s.d. through the whole strains were found to be 5.29±0.49.

Minimum: The largest (4.56) was obtained in No. 6, followed by No. 9 (4.51) and No. 4 (4.50). The smallest (3.79) was noted in No. 2, which was the same as in case of the range of width, followed by No. 8 (3.90) and No. 1 (3.95). Average and its s.d. through the whole strains were found to be 4.20±0.28.

Range: The largest (1.86) was obtained in No. 7, followed by No. 3 (1.63) and No. 9 (1.42). The smallest (0.57) was noted in No. 6, which was the same as in case of the range of length, followed by No. 11 (0.63) and No. 1 (0.74). Average and its s.d. through the whole strains were found to be 1.09±0.40.

6. Ratio of width to thickness (W/T) in unhusked grains

Maximum: The largest (2.04) was obtained in No. 3, followed by No. 9 (2.00) and No. 5 (1.94). The smallest (1.50) was noted in No. 2, which was the same as in cases of the range of width and the minimum of L/T, followed by Nos. 1, 6 and 10 (1.53). Average and its s.d. through the whole strains were found to be 1.69±0.21.

Minimum: The largest (1.56) was obtained in No. 3, which was the same as in case of the maximum of W/T, followed by No. 5 (1.46) and No. 9 (1.41). The smallest (1.12) was noted in No. 4, which was the same as in cases of the maximum and the minimum of width and thickness, followed by Nos. 7 and 10 (1.16). Average and its s.d. through the whole strains were found to be 1.29±0.14.

Range: The largest (0.63) was obtained in No. 7, which was the same as in case of the range of L/T, followed by No. 9 (0.59) and No. 3 (0.48). The smallest (0.26) was noted in Nos. 2 and 11, followed by Nos. 1 and 8 (0.32). Average and its s.d. through the whole strains were found to be 0.40±0.13.

7. Length in husked grains

Maximum: The results are given in Table 3. In this table, the maximum, the minimum and their ranges are shown. The longest (6.55 mm) was obtained in No. 5, which was the same as in case of the unhusked grains, followed by No. 9 (6.40 mm) and No. 10 (6.15 mm). The shortest (5.60 mm) was noted in No. 4, followed by No. 3 (5.70 mm) and No. 2 (5.85 mm). Average and its s.d. through the whole strains were found to be 6.01±0.29.

Minimum: The longest (5.70 mm) was obtained in Nos. 5 and 9, followed by No. 11 (5.50 mm). The shortest (4.50 mm) was noted in No. 3, which was the same as in case of the unhusked grains, followed by No. 7 (4.70 mm) and No. 4 (5.00 mm). These orders of strains were found to be the same as in case of the unhusked grains. Average and its s.d. through the whole strains were found

Table 3. Ranges of husked grains in the strain level; length (mm), width (mm), thickness (mm), ratio of length to width (%), ratio of length to thickness (%) and ratio of width to thickness (%)

Strain	Length			Width			Thickness			Length/Width			Length/Thickness			Width/Thickness		
No.	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range	Max.	Min.	Range
1	5.90	5.10	0.80	2.45	1.90	0.55	1.75	1.40	0.35	2.95	2.20	0.75	3.93	3.04	0.89	1.61	1.12	0.49
2	5.85	5.20	0.65	2.35	2.10	0.25	1.80	1.60	0.20	2.79	2.35	0.44	3.66	2.92	0.74	1.47	1.17	0.30
3	5.70	4.50	1.20	2.10	1.40	0.70	1.60	1.00	0.60	3.24	2.38	0.86	5.45	3.13	2.32	1.90	1.25	0.65
4	5.60	5.00	0.60	1.80	1.60	0.20	1.40	1.05	0.35	3.57	2.81	0.76	5.00	3.61	1.39	1.57	1.14	0.43
5	6.55	5.70	0.85	3.00	2.20	0.80	1.75	1.50	0.25	2.82	1.93	0.89	4.13	3.35	0.78	1.88	1.26	0.62
6	6.10	5.30	0.80	2.05	1.75	0.30	1.65	1.30	0.35	3.22	2.83	0.39	4.46	3.46	1.00	1.50	1.16	0.34
7	5.85	4.70	1.15	2.30	1.70	0.60	1.65	1.00	0.65	3.08	2.17	0.91	5.50	3.13	2.37	2.20	1.15	1.05
8	6.05	5.20	0.85	2.30	1.80	0.50	1.80	1.50	0.30	3.00	2.30	0.70	3.87	3.11	0.76	1.47	1.11	0.36
9	6.40	5.70	0.70	2.50	2.00	0.50	1.70	1.20	0.50	3 05	2.48	0.57	4.77	3.63	1.14	1.92	1.25	0.67
10	6.15	5.20	0.95	2.25	1.80	0.45	1.70	1.35	0.35	3.22	2.50	0.72	4.29	3.27	1.02	1.42	1.12	0.30
11	5.90	5.50	0.40	2.35	2.00	0.35	1.70	1.50	0.20	2.85	2.44	0.41	3.69	3.29	0.40	1.47	1.21	0.26

to be 5.19±0.37.

Range: The largest (1.20 mm) was obtained in No. 3, followed by No. 7 (1.15 mm) and No. 10 (0.95 mm). It may be noted that the values were peculiarly large in Nos. 3 and 7. The smallest (0.40 mm) was noted in No. 11, followed by No. 4 (0.60 mm) and No. 2 (0.65 mm). It may be noted that the value was peculiarly small in No. 11. Average and its s.d. through the whole strains were found to be 0.81±0.23.

8. Width in husked grains

Maximum: The widest (3.00 mm) was obtained in No. 5, which was the same as in cases of 3 characters of length in the unhusked grains, the maximum of width in the unhusked grains and the maximum of length in the husked grains, followed by No. 9 (2.50 mm) and No. 1 (2.45 mm). It may be noted that the value was peculiarly in No. 5. The narrowest (1.80 mm) was noted in No. 4, which was the same as in cases of the maximum of width in the unhusked grains and the maximum of length in the husked grains, followed by No. 6 (2.05 mm) and No. 3 (2.10 mm). Average and its s.d. through the whole strains were found to be 2.31±0.30.

Minimum: The widest (2.20 mm) was obtained in No. 5, which was the same as in cases of the 3 characters of length in the unhusked grains, the maximum and the minimum of width in the unhusked grains, and the maximum of length and width in the husked grains, followed by No. 2 (2.10 mm) and Nos. 9 and 11 (2.00 mm). The narrowest (1.40 mm) was noted in No. 3, which was the same as in cases of the maximum and the minimum of length in the unhusked grains, and the minimum of length in the husked grains, followed by No. 4 (1.60 mm) and No. 7 (1.70 mm). Average and its s.d. through the whole strains were found to be 1.84±0.23.

Range: The largest (0.80 mm) was obtained in No. 5, which was the same as in cases of the 10 characters mentioned above, followed by No. 3 (0.70 mm) and No. 7 (0.60 mm). These orders of strains were found to be the same as in case of the unhusked grains. The smallest (0.20 mm) was noted in No. 4, which was the same as in cases of the maximum and the minimum of width in the unhusked grains, and the maximum of length and width in the husked grains, followed by No. 2 (0.25 mm) and No. 6 (0.30 mm). Average and its s.d. through the whole strains were found to be 0.47±0.19.

9. Thickness in husked grains

Maximum: The thickest (1.80 mm) was obtained in Nos. 2 and 8, which was the same as in case of the unhusked grains, followed by Nos. 1 and 5 (1.75 mm). The thinnest (1.40 mm) was noted in No. 4, which was the same as in case of the unhusked grains and other 4 characters, followed by No. 3 (1.60 mm). These orders of strains were found to be the same as in case of the unhusked grains. Average and its s.d. through the whole strains were found to be 1.68±0.11.

Minimum: The thickest (1.60 mm) was obtained in No. 2, which was the same as in cases of the maximum and the minimum of thickness in the unhusked grains, and the maximum of thickness in the husked grains, followed by Nos. 5, 8 and 11 (1.50 mm). The thinnest (1.00 mm) was noted in Nos. 3 and 7, followed by No. 4 (1.05 mm). Average and its s.d. through the whole strains were found to be 1.31±0.22.

Range: The largest (0.65 mm) was obtained in No. 7, followed by No. 3 (0.60 mm) and No. 9 (0.50 mm). The smallest (0.20 mm) was noted in Nos. 2 and 11, followed by No. 5 (0.25 mm). Average and its s.d. through the whole strains were found to be 0.37±0.15.

10. Ratio of length to width (L/W) in husked grains

Maximum: The largest (3.57) was obtained in No. 4, which was the same as in case of the unhusked grains, followed by No. 3 (3.24) and Nos. 6 and 10 (3.22). It may be noted that the value was peculiarly large in No. 4. The smallest (2.79) was noted in No. 2, followed by No. 5 (2.82) and No. 11 (2.85). Average and its s.d. through the whole strains were found to be 3.07 ± 0.23.

Minimum: The largest (2.83) was obtained in No. 6, followed by No. 4 (2.81) and No. 10 (2.50). It may be noted that the values were peculiarly large in Nos. 4 and 6. The smallest (1.93) was noted in No. 5, which was the same as in case of the unhusked grains, followed by No. 7 (2.17) and No. 1 (2.20). Average and its s.d. through the whole strains were found to be 2.40 ± 0.26.

Range: The largest (0.91) was obtained in No. 7, which was the same as in case of thickness in the husked grains, followed by No. 5 (0.89) and No. 3 (0.86). The smallest (0.41) was noted in No. 11, which was the same as in cases of the range of length in the husked grains and the maximum of L/W in the unhusked grains. Average and its s.d. through the whole strains were found to be 0.67 ± 0.19.

11. Ratio of length to thickness (L/T) in husked grains

Maximum: The largest (5.50) was obtained in No. 7, which was the same as in cases of the ranges of thickness and L/W in the husked grains, followed by No. 3 (5.45) and No. 4 (5.00). The smallest (3.66) was noted in No. 2, which was the same as in case of the maximum of L/W in the husked grains, followed by No. 11 (3.69) and No. 8 (3.87). Average and its s.d. through the whole strains were found to be 4.43 ± 0.67.

Minimum: The largest (3.63) was obtained in No. 9, which was the same as in cases of the range of thickness in the unhusked grains, the maximum of L/T of the unhusked grains and the minimum of length in the husked grains, followed by No. 4 (3.61) and No. 6 (3.46). The smallest (2.92) was noted in No. 2, which was the same as in cases of the maximum of L/W and L/T in the husked grains, followed by No. 1 (3.04) and No. 8 (3.11). Average and its s.d. through the whole strains were found to be 3.27 ± 0.23.

Range: The largest (2.37) was obtained in No. 7, which was the same as in cases of the unhusked grains, the range of L/W and the maximum of L/T in the husked grains, followed by No. 3 (2.32) and No. 4 (1.39). These orders of strains were found to be the same as in case of the maximum of this character. The smallest (0.40) was noted in No. 11, which was the same as in case of the range of L/W in the husked grains, followed by No. 2 (0.74) and No. 8 (0.76). Average and its s.d. through the whole strains were found to be 1.17 ± 0.64.

12. Ratio of width to thickness (W/T) in husked grains

Maximum: The largest (2.20) was obtained in No. 7, which was the same as in cases of the range of L/W, the maximum and the range of L/T in the husked grains, followed by No. 9 (1.92) and No. 3 (1.90). The smallest (1.42) was noted in No. 10, followed by Nos. 2, 8 and 11 (1.47). Average and its s.d. through the whole strains were found to be 1.67 ± 0.26.

Minimum: The largest (1.26) was obtained in No. 5, followed by Nos. 3 and 9 (1.25). The smallest (1.11) was noted in No. 8, followed by Nos. 1 and 10 (1.12). Average and its s.d. through the whole strains were found to be 1.18 ± 0.06.

Range: The largest (1.05) was obtained in No. 7, which was the same as in cases of the unhusked grains, the ranges of L/W and L/T, followed by No. 9 (0.67) and No. 3 (0.65). It may be noted that the value was peculiarly large in No. 7, which was the same phenomenon in case of theun husked

grains. The smallest (0.26) was noted in No. 11, which was also the same as in cases of the unhusked grains, the ranges of L/W and L/T, followed by Nos. 2 and 10 (0.30). Average and its s.d. through the whole strains were found to be 0.50 ± 0.24.

Part II. Relations between the two respective characters

1. Length and width in unhusked grains

C.c. and l.r. of width on length in the same strains were calculated, and are shown in Table 4.

Table 4. Correlation coefficient and linear regression of the three components; width in unhusked grain on length in unhusked grain, thickness in unhusked grain on length in unhusked grain, thickness in unhusked grain on width in unhusked grain

Strain No.	Length and Width		Length and Thickness		Width and Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.0646	—	0.5446**	Y=0.726X+0.846	−0.0239	—
2	0.3442	—	0.0107	—	0.0741	—
3	0.5567**	Y=0.300X+0.376	0.4023*	Y=0.184X+0.130	0.7234***	Y=0.613X−0.102
4	0.6858***	Y=0.344X−0.464	0.7091***	Y=0.278X−0.537	0.8624***	Y=0.675X+0.132
5	0.0190	—	0.3868*	Y=0.103X+0.903	0.0000	—
6	0.2111	—	0.6284***	Y=0.282X−0.618	0.2905	—
7	0.3866*	Y=0.142X+1.149	0.0453	—	−0.0572	—
8	0.4947**	Y=0.155X+1.404	0.3462	—	0.0626	—
9	0.2374	—	0.1672	—	−0.4125*	Y=−0.591X+3.354
10	0.1296	—	0.4144*	Y=0.177X+0.360	0.1778	—
11	0.3082	—	0.1511	—	0.1609	—

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

One, 2, 1 and 7 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.7348 to the degree of freedom of 9, which is significant at 5% level. Generally speaking, the longer is the length, the wider is the width. L.r. of length on width was calculated as follows; $Y=1.278X-6.720$, where Y and X indicate length and width, respectively. This formula indicates that the length becomes 1.278 mm longer, by becoming 1 unit wider the width (0 points, 8.28 mm in length and 2.48 mm in width, respectively).

2. Length and thickness in unhusked grains

Two, 1, 3 and 5 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.3564, showing no significance even at 5% level.

3. Width and thickness in unhusked grains

Two, 1 and 8 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.4674, showing no significance even at 5% level.

4. L/W and L/T in unhusked grains

C.c. and l.r. of L/T on L/W in the same strains were calculated, and are shown in Table 5. Three, 1 and 7 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.2542, showing no significance even at 5% level.

Table 5. Correlation coefficient and linear regression of the three components; ratio of length to thickness (abbreviated as L/T, and so forth) in unhusked grain on L/W in unhusked grain, W/T in unhusked grain on L/W in unhusked grain, W/T in unhusked grain on L/T in unhusked grain

Strain No.	L/W and L/T		L/W and W/T		L/T and W/T	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.2944	—	−0.7392***	Y=−0.346X+2.446	0.4039*	Y=0.184X+0.595
2	0.6623***	Y=1.098X+0.741	−0.0210	—	0.5922***	Y=0.145X+0.751
3	0.6391***	Y=1.720X+0.074	−0.0091	—	0.7622***	Y=0.207X+0.709
4	0.6921***	Y=1.018X+1.225	−0.2902	—	0.4857**	Y=0.097X+0.897
5	0.2184	—	−0.7122***	Y=−0.469X+3.059	0.5250**	Y=0.242X+0.432
6	0.1042	—	−0.6950***	Y=−0.359X+2.638	0.6398***	Y=0.262X+0.127
7	0.0530	—	−0.4655**	Y=−0.319X+2.456	0.8202***	Y=0.254X+0.190
8	0.2390	—	−0.5470**	Y=−0.341X+2.463	0.6801***	Y=0.260X+0.316
9	−0.3199	—	−0.6430***	Y=−0.911X+4.499	0.9305***	Y=0.373X−0.232
10	0.1583	—	−0.6540***	Y=−0.338X+2.486	0.6402***	Y=0.253X+0.222
11	0.4103*	Y=0.657X+2.480	−0.5202**	Y=−0.299X+2.383	0.5634**	Y=0.202X+0.615

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

5. L/W and W/T in unhusked grains

Five, 3 and 3 strains showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.5831, showing no significance even at 5% level.

6. L/T and W/T in unhusked grains

Seven, 3 and 1 strain showed significances at 0.1%, 1% and 5% levels, respectively. In other words, the whole strains used showed significances, which were clearly different phenomenon in those of the former 5 relations. In the whole strains, c.c. was +0.6308 to the degree of freedom of 9, which is significant at 5% level. Generally speaking, the larger is the L/T, the larger is the

W/T. L.r. of L/T on W/T was calculated as follows; $Y=0.629X+2.589$, where Y and X indicate L/T and W/T, respectively. This formula indicates that L/T becomes 0.629 larger, by becoming 1 unit larger the W/T (0 points, 4.63 in L/T and 1.54 in W/T, respectively).

7. Length and width in husked grains

C.c. and l.r. of width on length in the same strains were calculated, and are shown in Table 6. One, 1, 2 and 7 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.7087 to the degree of freedom of 9, which is significant at 5% level. Generally speaking, the longer is the length, the wider is the width. L.r. of length on width was calculated as follows; $Y=0.927X-0.929$, where Y and X indicate length and width, respectively. This formula indicates that the length becomes 0.927 mm longer, by becoming 1 unit wider the width (0 points, 5.68 mm in length and 2.08 mm in width, respectively).

Table 6. Correlation coefficient and linear regression of the three components; width in husked grain on length in husked grain, thickness in husked grain on length in husked grain, thickness in husked grain on width in husked grain

Strain No.	Length and Width		Length and Thickness		Width and Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	−0.1732	—	0.3709*	Y=0.186X+0.595	−0.2245	—
2	0.0490	—	0.0068	—	−0.1519	—
3	0.4508*	Y=0.294X+0.317	0.3352	—	0.7375***	Y= 0.814X−0.246
4	0.8621***	Y=0.460X−0.727	0.8358***	Y=0.408X−0.852	0.9157***	Y= 0.839X−0.117
5	0.0342	—	0.3196	—	−0.1252	—
6	0.5023**	Y=0.198X+0.760	0.1537	—	0.1926	—
7	0.2099	—	0.1803	—	−0.1826	—
8	0.3922*	Y=0.220X+0.904	0.2335	—	−0.0432	—
9	0.2076	—	0.1988	—	−0.3765*	Y=−0.593X+2.789
10	0.2084	—	0.4265*	Y=0.170X+0.583	0.3054	—
11	0.3005	—	0.1371	—	0.0377	—

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

8. Length and thickness in husked grains

One, 2 and 8 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.4600, showing no significance even at 5% level.

9. Width and thickness in husked grains

Two, 1 and 8 strains showed significances at 0.1% and 5% levels and no significance even at

5% level, respectively. In the whole strains, c.c. was +0.7713 to the degree of freedom of 9, which is significant at 1% level. Generally speaking, the wider is the width, the thicker is the thickness. L.r. of width on thickness was calculated as follows; $Y=0.665X-0.999$, where Y and X indicate width and thickness, respectively. This formula indicates that the width becomes 0.665 mm wider, by becoming 1 unit thicker the thickness (0 points, 2.08 mm in width and 1.48 mm in thickness, respectively).

10. L/W and L/T in husked grains

C.c. and l.r. of L/T on L/W in the same strains were calculated, and are shown in Table 7. Two, 3 and 6 strains showed significances at 0.1% and 5% levels and no significances even at 5% level, respectively. In the whole strains, c.c. was +0.6769 to the degree of freedom of 9, which is significant at 5% level. Generally speaking, the larger is the L/W, the larger is the L/T. L.r. of L/W on L/T was calculated as follows; $Y=0.445X-2.101$, where Y and X indicate L/W and L/T, respectively. This formula indicates that the L/W becomes 0.445 larger, by becoming 1 unit larger the L/T (0 points, 2.83 in L/W and 3.73 in L/T, respectively).

Table 7. Correlation coefficient and linear regression of the three components; ratio of length to thickness (abbreviated as L/T, and so forth) in husked grain on L/W in husked grain, W/T in husked grain on L/W in husked grain, W/T in husked grain on L/T in husked grain

Strain No.	L/W and L/T		L/W and W/T		L/T and W/T	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	−0.1523	—	−0.7558***	Y=−0.520X+2.665	0.7254***	Y=0.425X−0.077
2	0.3933*	Y=0.598X+1.698	−0.3967*	Y=−0.240X+1.877	0.6851***	Y=0.273X+0.394
3	0.6567***	Y=1.567X−0.253	0.0687	—	0.7958***	Y=0.217X+0.568
4	0.6490***	Y=1.114X+0.553	−0.0226	—	0.7249***	Y=0.169X+0.627
5	0.1200	—	−0.7897***	Y=−0.583X+2.965	0.4980**	Y=0.326X+0.295
6	0.2133	—	−0.2639	—	0.8849***	Y=0.295X+0.135
7	−0.1552	—	−0.5354**	Y=−0.659X+3.249	0.9147***	Y=0.397X−0.137
8	0.0492	—	−0.7600***	Y=−0.450X+2.504	0.4869**	Y=0.269X+0.394
9	−0.3750*	Y=−1.197X+7.359	−0.6711***	Y=−0.984X+4.192	0.9376***	Y=0.431X−0.267
10	0.3645*	Y=0.459X+2.386	−0.5532**	Y=−0.254X+2.021	0.5454**	Y=0.199X+0.558
11	0.1818	—	−0.6834***	Y=−0.438X+2.511	0.5902***	Y=0.308X+0.294

***, **, *; significant at 0.1%, 1% and 5% levels, respectively. d.f.=28.

11. L/W and W/T in husked grains

Five, 2, 1 and 3 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.2434, showing no significance even at 5% level.

12. L/T and W/T in husked grains

Eight and 3 strains showed significances at 0.1% and 1% levels, respectively. In other words, the whole strains used showed significances. This phenomonon was the same as in case of the unhusked grains. In the whole strains, c.c. was +0.5418, showing no significance even at 5% level.

Discussion

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

1. According to the tripartite classification noted by Matsuo[5], the whole strains used here were belonging to C type, *i.e.*, *indica* group or slender group. On the contrary, wild rice distributed in northeastern India[3] showed relatively large variations in both length and width. The strains collected in the Ganga Plains can be divided into two groups in accordance with these classification, type B and type C, and were widely distributed in the respective character-range[4]. These findings proposed quite an interesting problem concerning the strain or variety differentiations of wild rice species.

2. Though the values were peculiarly large or small in the unhusked grains in some cases, the values were, in general, looked upon as the standard level in the husked grains in the same strains. For example, strain No. 5 showed a peculiarly large value (1.55 mm) in range of L in the unhusked grains, but showed nearly the middle value (0.85 mm) in range of L in the husked grains. Strain No. 6 showed a peculiarly small value (0.65 mm) in range of L in the unhusked grains, but showed nearly the middle value (0.80 mm) in range of L in the husked grains.

On the other hand, though the values were looked upon as the standard level in the unhusked grains in some strains, the values were peculiarly large or small in the husked grains in the same strains. For example, strain No. 7 showed nearly the middle value (0.45 mm) in range of T in the unhusked grains, but showed peculiarly large value (0.65 mm) in range of T in the husked grains. Strain No. 11 showed nearly the middle value (0.90 mm) in range of L in the unhusked grains, but showed the peculiarly small value (0.40 mm) in range of L in the husked grains. These phenomena, in which the reversed results and remarkable facts were ascertained, may partly be due to the grain fullness, and to the strain specificity.

3. In view of species specificities, the following facts may appreciably be drawn from the data obtained in this experiment. In general, the extremely large values in the respective characters were found in *O. sativa* var. *spontanea*, but the extremely small values in the respective characters were found in *O. perennis*. It was noticeable that No. 5 showed extremely large values in several characters. This findings proposed also quite an interesting problem concerning the species differentiations and distinction between the 2 species.

4. In the minimum of length, the shortests (6.80 mm in the unhusked grains and 4.50 mm in the husked grains) were obtained in No. 3, followed by No. 7 (6.90 mm and 4.70 mm in the same order, and so forth) and No. 4 (7.00 mm and 5.00 mm). These orders of strains were fixed to be the same as both in the unhusked and in the husked grains. These phenomena were found in the other 3 cases through the whole characters, *i.e.*, No. 5 (0.80 mm and 0.80 mm), No. 3 (0.75 mm and 0.70 mm) and No. 7 (0.55 mm and 0.60 mm) in the range of the width; No. 4 (1.70 mm and 1.40 mm), No. 3 (1.80 mm and 1.60 mm) and Nos. 6 and 7 (1.85 mm and 1.65 mm) in the maximum of thickness; No. 7 (1.86 and 2.37), No. 3 (1.63 and 2.32) and No. 9 (1.42 and 1.14) in the range of L/T.

In the unhusked grains, the widests (3.50 mm in the maximum and 2.70 in the minimum) were obtained in No. 5, followed by No. 9 (3.05 mm and 2.60 mm in the same order, and so forth) and No. 11 (2.95 mm and 2.55 mm). These orders of strains were fixed to be the same as both in the maximum and in the minimum. These phenomena were found only in another case through the whole characters, *i.e.*, No. 4 (4.34 and 3.23), No. 6 (3.82 and 3.15) and No. 10 (3.75 and 3.00) in L/W of the unhusked grains. It may be concluded that these strains and characters were almost stable in view of genetic background.

5. The value (3.16) shown by strain No. 3 in the maximum of L/W in the unhusked grains was ascertained to be the smallest one in this character. On the other hand, the value (3.24) shown by strain No. 3 in the maximum of L/W in the husked grains was noted to be nearly the largest in this character. These unstabilities may be looked upon as one of the specificities of *O. perennis*, perennial plants.

6. Correlation coefficients of the respective characters in the strain level were fixed to be significant in 70/132 cases, *i.e.*, 53.0% of those. But these in the whole strains were fixed to be significant in 5/12 cases, *i.e.*, 41.7% of these. In detail, however, some strain characteristics were found. Significant correlations in the strain level were accounted as follows in the order from character No. 1 to No. 12; 4 strains (36.4%), 6 (54.6%), 3 (27.6%), 4 (36.4%), 8 (72.7%), 11 (100.0%), 4 (36.4%), 3 (27.3%), 3 (27.3%), 5 (45.5%), 8 (72.7%) and 11 (100.0%), respectively. It may be noticed that the values were peculiarly large in combination with Nos. 6 and 12. Average value and its s.d. through the whole combinations were found to be 5.83 ± 2.85.

In the character groups, significant correlations in the strain level were accounted as follows in the order of group I (combination Nos. 1 to 3), group II (combination Nos. 4 to 6), group III (combination Nos. 7 to 9) and group IV (combination Nos. 10 to 12); 13/33 (39.4%), 23/33 (69.7%), 10/33 (30.3%) and 24/33 (72.7%), respectively. From those data, it might be said that the combinations of 4–6 and 10–12, *i.e.*, ratio characters, showed more significant strains than those of the remaining 2 combinations, *i.e.*, practical characters.

On the other hand, 1 strain (No. 4), 1 (No. 3), 2 (Nos. 9 and 10), 2 (Nos. 1 and 8) and 5 (Nos. 2, 5, 6, 7 and 11) showed significant correlations with 10 (83.3%), 9 (75.0%), 7 (58.3%), 6 (50.0%) and 5 (41.7%), respectively. It may be noted that strain No. 4 showed significances in 10/12 combinations, *i.e.*, 83.3% of the whole. Average value and its s.d. through the whole strains were found to be 6.36 ± 1.67.

7. Negative correlations were found in strain level on some characters, though positive correlations were found in the whole strains on the same characters. Three, 1, 1, 6 and 3 strains showed negative correlations between W and T, L/W and L/T in the unhusked grains, L and W, W and T, L/W and L/T in the husked grains, respectively. However, the whole combinations mentioned above showed positive correlations in all the cases. These discrepancies may not be fully explained at this time. It was noticeable that 2 of 3, *i.e.*, between W and T, L/W and L/T, relations were the same both in the unhusked and the husked grains. It may duely be attributed to the action of genes concerned.

8. Relations between L/W and W/T, between L/T and W/T, especially the latter case, concerning both in the unhusked and in the husked grains, showed very high significances. These traits were of stable genetic background.

9. In some strains, significant relations were shown in the unhusked grains but not in the husked grains. These phenomena were found in 6 cases on strain level through the whole cases. The reversed results were found in 4 cases on the strain level.

In relation between L/T and W/T, significant correlations were shown through the all strains both in the unhusked and in the husked grains. However, significant correlations were shown in the unhusked grains but not shown in the husked grains. As the analyses and conclusions have left several points in question, further analyses are to be performed sincerely.

Summary

During the period from December in 1978 to January in 1979, the writer was sent to India for collecting the wild and the cultivated rices. Eleven strains of wild rice, *i.e.*, *Oryza sativa* var. *spontanea* ROSCHEV. and *O. perennis* MOENCH, were collected in the central India, *i.e.*, southern part of West Bengal, southern part of Bihar, Orissa, Andhra Pradesh and Madhya Pradesh. Succeeding to the previous paper, some morphological characters of grains were analyzed and described in the present paper. The main results obtained during this study were summarized as follows:

Ranges shown by 12 characters, *i.e.*, length, width, thickness, L/W, L/T and W/T in the unhusked and in the husked grains, were calculated in view of the maximum, the minimum and the pure ranges of them. Basing on the data obtained in these characters, several patterns were found as strain- or species-specificities.

Concerning correlation coefficients among the 12 character-combinations, 70/132, *i.e.*, 53.0% of the combinations showed significant relations through the whole ones. It may be noted that combinations between L/T and W/T both in the unhusked and in the husked grains showed significant relations through the whole strains. Average value and its s.d. through the whole combinations were found to be 5.83 ± 2.85. In strain level, average and its s.d. through the whole strains were found to be 6.36 ± 1.67. It may be noted that strain No. 4 showed significances in 10/12, *i.e.*, 83.3%.

Ecotypic differentiations were discussed basing on the values ascertained in 12 characters, 12 correlation-combinations and geographical locations.

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