On the Wild Rice, *Oryza breviligulata* CHEV. et ROEHR., Collected in Ivory Coast

Tadao C. KATAYAMA*

Abstract

One strain of wild rice species, *Oryza breviligulata* CHEV. et ROEHR., was found at Sobara, Ivory Coast, and collected. In the present paper, the records on morphological characters of those seeds were reported.

Twenty-four characters of the unhusked and husked grains and 27 mutual relationships between the respective 2 characters were calculated. In the former, length, width and thickness of the unhusked grains were found to be 10.23 mm, 2.72 mm and 1.65 mm in average values, respectively. Those of the husked grains were found to be 7.73 mm, 2.30 mm and 1.46 mm in average values, respectively. In the latter, 11, 3, 2 and 11 character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively.

In comparison with the data obtained in the present and the previous studies using materials from other African countries, the following facts were ascertained. The present strain would be located in the position as relatively longer length, narrower width and thinner thickness of this species of annual wild rice, *Oryza breviligulata* in African countries and relatives of Asian countries. Moreover, it was concluded that the present strain had a long history in the present niche.

Key words: Wild rice, *Oryza breviligulata*, Ivory Coast, Ecotypic differentiation.

Introduction

Due to the great importance of rice as food stuff, a large amount of work on rice from different viewpoints has been reported. However, on many points more extensive investigations are required in order to solve the interesting but highly complex problem of its origin and the history of transformations from a wild state into the cultivated crop plant of our time. The research done on this problem by a wide range of workers will contribute to the improvement of rice in the future.

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* 鹿児島大学農学部附属農場 片山忠夫
Experimental Farm, Faculty of Agriculture, Kagoshima University, Kagoshima, JAPAN 890

Distribution and taxonomical report on various *Oryza* species in African countries have been published by some workers (BEZANÇON, 1982; GUILLAUMENT and ADJANOHOUN, 1971; IRAT-ORSTOM, 1978; KATAYAMA, 1987a; STEELE and SHARMA, 1977). Though Africa has been considered to be one of the most important distribution areas of wild rice in the world, accumulation of complete data on these aspects is far from being perfect. One strain of wild rice of Ivory Coast was collected. In the present paper, the records of morphological characters were briefly reported. Some consideration on situation of this strain in the whole of African countries was also discussed. This data might be of assistance to research on the origin and genetic analyses of rice.

Materials and Methods

Plants belonging to the wild species of rice were found during the trip on October 31, 1984. The locality and habitat were recorded in detail. The seeds were collected and used for morphological investigations.

Twenty grains were used for the measurement. Measurements were done for length, width and thickness of the unhusked and the husked grains at the largest points of the respective characters. Calculations were done for determining the ratios of length to width, of length to thickness, and of width to thickness, for comparative values on morphological characters of unhusked and husked grains. Moreover, the following characters of the unhusked and the husked grains were illustrated by the area (= length × width) and volume (= length × width × thickness) for both the unhusked and the husked grains, and the area and volume quotients (= ratio of value of husked to value of unhusked grains).

The correlations between practical values of unhusked and husked grains and the linear regressions between them were also calculated in the whole character-combinations measured by comparing them.

To make clear the relations between the present and other strains collected in other African countries, comparison was made using the data in the present and the previous papers (KATAYAMA, 1987a) on the characters of the unhusked grains.

Results and Discussion

I. Locality and habitat

The wild rice was found at 2 kilometers southwest from Sobara, Yaossédougou, about 8°15'N, 4°15'W, Ivory Coast. The pond is located in northeast side of the main road. Wild rice was found in the pond which has about 100 meter in diameter, and 30 cm in depth.

The wild rice was sporadically found only at edge and central regions of the pond, but not found in other areas. In other words, the distributing area of wild rice was strictly limited. The highest plant showed 40 cm. There are grassy and waste lands in the other side of the road (southwest side). There are no cultivated rice field, and upland fields are found in here and there, in which corn and pearl millet are dominant crop species.

Ⅱ. Grain morphology

1. Practical values

Table 1. Morphological characters of the unhusked and the husked grains

	Character	No.	Average and its standard deviations		Character		No.	Average and its standard deviations
Unhusked	Length	1	10.23±0.37 mm	Comparison	Length		21	0.76±0.02
	Width	2	2.72±0.06 mm		Width		22	0.84±0.01
	Thickness	3	1.65±0.06 mm		Thickness		23	0.88±0.02
	Length/Width	4	3.76±0.15		Length/Width		24	0.90±0.02
	Length/Thickness	5	6.20±0.27		Length/Thickness		25	0.86±0.02
	Width/Thickness	6	1.65±0.07		Width/Thickness		26	0.96±0.02
Husked	Length	11	7.73±0.20 mm	Area & Volume	Unhusked	Area	31	27.82±1.03 mm^2
	Width	12	2.30±0.06 mm			Volume	32	45.99±2.94 mm^3
	Thickness	13	1.46±0.06 mm		Husked	Area	33	17.74±0.66 mm^2
	Length/Width	14	3.37±0.11			Volume	34	25.83±1.70 mm^3
	Length/Thickness	15	5.32±0.18		Quotient	Area	35	0.64±0.02
	Width/Thickness	16	1.58±0.08			Volume	36	0.56±0.02

Quotient; Husked/Unhusked
Area; length × width, Volume; length × width × thickness

Unhusked grain (Character Nos. 1 to 6 in Table 1)

The results are given in the left-upper column of Table 1. Grains showed the following characteristics; 9.80 to 11.20 mm long, 2.60 to 2.85 mm wide, 1.55 to 1.75 mm thick, 3.54 to 4.07 in ratio of length to width, 5.83 to 6.97 in ratio of length to thickness, and 1.47 to 1.78 in ratio of width to thickness.

Husked grain (Character Nos. 11 to 16)

The results are given in the left-lower column of Table 1. Grains showed the following characteristics; 7.40 to 8.15 mm long, 2.20 to 2.40 mm wide, 1.35 to 1.55 mm thick, 3.21 to 3.62 in ratio of length to width, 5.03 to 5.78 in ratio of length to thickness, and 1.45 to 1.71 in ratio of width to thickness.

Comparison (Character Nos. 21 to 26)

The results are given in the right-upper column of Table 1. Grains showed the following characteristics; 0.72 to 0.78 in length, 0.82 to 0.87 in width, 0.85 to 0.91 in thickness, 0.85 to 0.94 in ratio of length to width, 0.82 to 0.90 in ratio of length to thickness, and 0.90 to 1.00 in ratio of width to thickness.

Comparative studies of data obtained in the previous characters have been looked upon as one of the most important characters for ecotypic differentiations in view of evolution. This character means biologically or agronomically the "grain fullness" in its capacity (KATAYAMA and KURODA, 1974). In evolutional and agronomical viewpoints, it may be said that the larger is the ratio of husked to unhusked grains in the respective characters, the more advanced is the evolutional state of the respective strains. Values of length, width and thickness in wild rice species were clearly found to be smaller than these of cultivated rice species (KATAYAMA, 1978).

Averages and ranges of variation became larger in the order of length, width and thickness of grains. In other words, grain length showed the lowest value but most stable in view of the grain fullness, and was not affected by any environmental conditions. On the contrary, grain thickness showed the highest value but was unstable in view of the grain fullness. Grain width showed intermediate value in the practical value. Such tendency was already found to be the same in cultivated rice grains (KATAYAMA, 1976; KATAYAMA, 1978), and wild species in India (KATAYAMA and KURODA, 1974) and in Indonesia (KATAYAMA, 1984), and to be the different result in wild rice in Ethiopia (KATAYAMA, 1987b). In general, the order found in length, width and thickness of practical values and variation ranges are constant in the genus *Oryza*, regardless of species status.

Area and Volume (Character Nos. 31 to 36)

The results are given in the right-lower column of Table 1. Grains showed the following characteristics; 25.97 to 30.80 mm^2 in area of unhusked grain, 41.55 to 53.90 mm^3 in volume of unhusked grain, 16.65 to 19.15 mm^2 in area of husked grain, 23.31 to 29.69 mm^3 in volume of husked grain, 0.60 to 0.67 in quotient of areas and 0.52 to 0.59 in quotient of volumes.

2. Relations between the respective 2 characters

Unhusked grain (Character-combinations 1 & 2 to 5 & 6)

To make clear the 3 relationships between length and width, length and thickness, width and thickness, as 3 components, *i.e.*, ratios of length to width (abbreviated as L/W in Table 2) and of length to thickness (L/T), of length to width (L/W) and of width to thickness (W/T), of length to thickness (L/T) and of width to thickness (W/T), correlation coefficients and linear regressions between them were calculated, and are shown in the first column of Table 2. One, 1 and 4 character-combinations showed significances at 1% and 5% levels and no significance even at 5% level, respectively. For example, from the data obtained in character-combination 5 and 6, it may be said that the larger is the L/T of the unhusked grains, the larger is W/T of the unhusked grains. This tendency was also found to be true for cultivated and wild strains in the several areas of the world. Linear regression shows that the L/T becomes 0.153 larger, when the W/T becomes larger by 1 degree.

Husked grain (Character-combinations 11 & 12 to 15 & 16)

The 6 character-combinations of the husked grains as the same those of the unhusked grains were calculated, and are shown in the second column of Table 2. Two, 1 and 3 character-combinations showed significances at 0.1% and 1% levels and no significance even at 5% level, respectively. For example, from the data obtained in character-combination 11 and 13, it may be said that the longer is the length of the husked grains, the thicker is the thickness of the husked grains. Linear regression shows that the length becomes 0.186 mm longer, when the width becomes thicker by 1 degree.

This tendency was also found to be quite the same as that of the cultivated strains collected in the several tropical and subtropical areas.

In comparison with the data obtained in the unhusked and husked grains, the following facts could be said. Two character-combinations, *i.e.*, L/W and W/T and L/T and W/T, were significant both in the unhusked and husked grains. In the whole, 5/12 character-combinations, *i.e.*, 41.7% of the whole, showed significances. In the previous data concerning the wild rice

Table 2. Correlation coefficient and linear regression of the former character (Y) on the latter character (X) for 27 character-combinations

	Character combination	Nos.	Correlation coefficient	Linear regression
Unhusked	Length and Width	1 & 2	0.1755	—
	Length and Thickness	1 & 3	0.2850	—
	Width and Thickness	2 & 3	−0.0081	—
	L/W and L/T	4 & 5	0.4377	—
	L/W and W/T	4 & 6	−0.4760*	Y=−0.228X+2.506
	L/T and W/T	5 & 6	0.5805**	Y=0.153X+0.702
Husked	Length and Width	11 & 12	0.1286	—
	Length and Thickness	11 & 13	0.6135**	Y=0.186X+0.005
	Width and Thickness	12 & 13	−0.1051	—
	L/W and L/T	14 & 15	−0.1427	—
	L/W and W/T	14 & 16	−0.7364***	Y=−0.529X+3.364
	L/T and W/T	15 & 16	0.7739***	Y=0.344X−0.249
Quotient	Length and Width	21 & 22	0.0904	—
	Length and Thickness	21 & 23	0.0434	—
	Width and Thickness	22 & 23	−0.1991	—
	L/W and L/T	24 & 25	0.5738**	Y=0.580X+0.340
	L/W and W/T	24 & 26	−0.4078	—
	L/T and W/T	25 & 26	0.4980*	Y=0.513X+0.517
Comparison	Length	1 & 11	0.8112***	Y=0.434X+3.295
	Width	2 & 12	0.8518***	Y=0.726X+0.321
	Thickness	3 & 13	0.9139***	Y=0.914X−0.133
	L/W	4 & 14	0.7832***	Y=0.582X+1.181
	L/T	5 & 15	0.7926***	Y=0.525X+2.065
	W/T	6 & 16	0.9078***	Y=1.000X−0.071
Ratio	Area	31 & 33	0.8452***	Y=0.430X+5.790
	Volume	32 & 34	0.8992***	Y=0.522X+1.840
	Quotient	35 & 36	0.7722***	Y=0.768X+0.071

L/W; Length/Width, L/T; Length/Thickness, W/T; Width/Thickness, Area; length × width, Volume; length × width × thickness, Quotient; Husked/Unhusked
***, **, *; significant at 0.1%, 1% and 5% levels, respectively
d.f.= 18

species, 5/12, 3/12 and 11/12 character-combinations, *i.e.*, 41.7%, 25.0% and 91.7%, showed significances in *O. sativa* var. *spontanea* of Indonesia (KATAYAMA, 1984), *O. officinalis* of Indonesia (KATAYAMA, 1986), *O. longistaminata* of Ethiopia (KATAYAMA, 1987b), respectively. It may be concluded that the present materials showed low significant correlations and unstable status.

Quotient (Character-combinations 21 & 22 to 25 & 26)

The 6 character-combinations of the quotients as the same those of the unhusked and husked grains were calculated, and are shown in the third column of Table 2. One, 1 and 4 character-combinations showed significances at 1% and 5% levels and no significance even at 5% level, respectively. For example, from the data obtained in character-combination 25 and 26, it may be said that larger is the quotient of L/T, the larger is the quotient of W/T. Linear

regression shows that the quotient of L/T becomes 0.513 larger, when the quotient of W/T becomes larger by 1 degree.

In comparison with the data obtained in the unhusked, husked and quotient, the following facts could be said. One character-combination, *i.e.*, L/T and W/T, was significant and constant in the 3 columns. This tendency was found to be quite the same that of the previous wild species (KATAYAMA, 1984, 1986, 1987b). It is assumed that these character-combinations are looked upon as the stable status in view of the genetic background. One (L/W and W/T), 2 (length and thickness, L/W and L/T) and 2 (length and width, width and thickness) character-combinations were significant in 2, 1 and 0 columns, respectively. In comparison with the previous character-combination (L/T and W/T), the 5 character-combinations were thought to be of relatively unstable status.

Comparison (Character-combinations 1 & 11 to 6 & 16)

To make clear the relations between the unhusked and husked grains in view of the 6 characters, correlation coefficients and linear regressions between them were calculated, and are shown in the fourth column of Table 2. All of them showed significances at 0.1% level. This tendency was also found in the cultivated rice in Ambon (KATAYAMA, 1976) and wild rices in Babad (KATAYAMA, 1984). For example, from the data obtained in character-combination 1 and 11, it may be said that the longer is the length of the unhusked grains, the longer is the length of the husked grains. Linear regression shows that the length of unhusked grain becomes 0.434 mm longer, when the length of husked grain becomes longer by 1 degree.

In general, it was already ascertained that almost all of those character-combinations in these columns, and almost of the materials belonging to the genus *Oryza*, including the cultivated rice (KATAYAMA, 1976, and others) and wild rice (KATAYAMA, 1984, and others), showed high significances. So it might be said that the low significances found in the previous materials (KATAYAMA, 1986 and 1987b) were looked upon as peculiar tendency and as a clear specificity of the materials.

Ratio (Character-combinations 31 & 33 to 35 & 36)

To make clear the relations between the unhusked and husked grains with regard to area and volume, correlation coefficients and linear regressions between them were calculated, and are shown in the last column of Table 2. All of them showed significances at 0.1% level. For example, from the data obtained in character-combination 31 and 33, it may be said that the wider is the area of unhusked grains, the wider is the area of husked grains. Linear regression shows that the area of unhusked grain becomes 0.430 mm^2 wider, when the area of husked grain becomes wider by 1 degree.

3. Comparison with the date obtained in the present and the previous materials

To make clear the status of the present material and the relations between the present material and other strains previously collected in other African countries, comparison was made.

In comparison with the present and the previous data concerned with African countries (KATAYAMA, 1990) in view of strain differentiation of *O. breviligulata* (Table 3), the following facts were ascertained. i) Values of 3 characters, *i.e.*, length, ratio of length to width and ratio of length to thickness, showed the largest ones in the whole countries. ii) Values of 2 charac-

Table 3. Six morphological characters of unhusked grains of *Oryza breviligulata* collected in 3 African countries; illustrated by average values of the respective groups. A: Nigeria collected in 1984 (7 strains); B: the same collected in 1985 (17 strains); C: the same collected in both years (24 strains); D: Senegal collected in 1985 in Casamance region (17 strains); E: the same in 1985 in northern region (7 strains); F: the same in both regions (24 strains); G: Ivory Coast collected in 1984 (1 strain); H: the summed-up data of strains collected in 1984 and 1985 in three countries (49 strains). Data of G and the other 7 groups were cited from the present (Table 1) and the previous papers (KATAYAMA, 1990), respectively.

Group	Length (mm)	Width (mm)	Thickness (mm)	L/W	L/T	W/T
A	9.98	3.11	2.03	3.24	4.96	1.53
B	9.29	3.13	1.87	3.00	5.00	1.68
C	9.49	3.13	1.92	3.07	4.99	1.63
D	9.01	2.91	1.77	3.13	5.15	1.65
E	8.64	3.13	1.92	2.77	4.52	1.64
F	8.91	2.98	1.81	3.02	4.97	1.65
G	10.23	2.72	1.65	3.76	6.20	1.65
H	9.22	3.04	1.86	3.06	5.00	1.64

ters, *i.e.*, width and thickness, showed the smallest ones in the whole countries. iii) One character, *i.e.*, ratio of width to thickness, showed nearly the largest one in the whole countries. iv) According to the tripartite classification (MATSUO, 1952), almost grains of the present material belonged to C type, long type and *indica* type. This tendency was found to be the same as in case of *O. sativa* var. *spontanea* of Indonesia (KATAYAMA, 1963). v) In comparison with these results obtained here, the present material should be located in the position relatively longer length, narrower width and thinner thickness of wild rice in the *Oryza breviligulata* and its relatives.

Standard deviations, *i.e.*, intra-population's variations, of 6 characters were ascertained as follows; length (0.90 in A, 0.53 in B, 0.73 in C, 0.70 in D, 0.76 in E, 0.74 in F, 0.37 in G and 0.80 in H groups), width (0.15, 0.29, 0.26, 0.22, 0.10, 0.22, 0.06 and 0.25 in the same order), thickness (0.13, 0.15, 0.16, 0.15, 0.05, 0.15, 0.06 and 0.16 in the same order), L/W (0.41, 0.36, 0.39, 0.40, 0.29, 0.41, 0.15 and 0.41 in the same order), L/T (0.74, 0.50, 0.58, 0.69, 0.46, 0.69, 0.27 and 0.66 in the same order), W/T (0.07, 0.07, 0.10, 0.08, 0.04, 0.07, 0.07 and 0.09 in the same order). Values of length, width, L/W and L/T of the present material (Group G) showed the smallest ones in the whole groups. Values of thickness showed nearly the smallest one in the whole groups. In general, the strain having large and small standard deviations are said to be located in genetically unstable and stable statuses, respectively. So, the present strain is located to the latter one. It is thought that the present strain was looked upon as having a long history after migrating here from another locality or differentiated here.

In the whole data shown in Table 2, 11 (=40.7% of the whole character-combinations), 3 (=11.1%), 2 (=7.4%) and 11 (=40.7%) character-combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In other words, 16 (= 59.3%) character-combinations showed significances.

In the previous data, 1 (=3.7%), 2 (=7.4%), 2 (=7.4%) and 22 (=81.5%) character-

combinations showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively, in case of *O. officinalis*, collected at Tembilahan, Sumatra, Indonesia (KATAYAMA, 1986). On the other hand, 13 (=48.2%) and 16 (=59.3%), 3 (=11.1%) and 1 (=3.7%), 0 (=0.0%) and 3 (11.1%), and 11 (=40.7%) and 7 (=25.9%) character-combinations showed significances at 0.1%, 1% and 5 % levels and no significance even at 5% level, respectively, in case of *O. sativa* var. *spontanea*, collected at Babat, East Java, Indonesia (KATAYAMA, 1984) and in case of *O. longistaminata*, collected at Gondar, Fogera, Ethiopia (KATAYAMA, 1987b).

In comparison with the data obtained in 4 sites, 16 (=59.3%), 20 (=74.1%), 5 (=18.5%) and 16 (=59.3%) character-combinations showed significances in the present, Ethiopia, Sumatra and East Java, respectively. These differences mean the species- and locality-specificities.

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