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On Distribution and Morphology of Cultivated Rice in Nigeria

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Introduction

During the periods of November in 1984 and October in 1985, the writers were sent to Nigeria for collecting the wild and cultivated rices under the project, "Studies on the Distribution and Ecotypic Differentiation of Wild and Cultivated Rice Species in Africa", supported by a Grant from the Ministry of Education, Science and Culture of the Japanese Government. In these opportunities, cultivated rices distributed in Nigeria were studied.

On the distribution of cultivated rice in Nigeria, some reports have already been published[1,3,4]. In these trips, various types of cultivated rice, distributed and under the cultivation, were collected in Nigeria. In this report, only the habitat and record of morphological characters of unhusked grains of the cultivated rice collected in Nigeria were described. Based on the analyses of the data obtained in the further morphological characters, varietal variations are going to be informed in the following papers.

The writers are most grateful to the government officials in Nigeria. Thanks are also due to the following persons; Dr. E. H. HARTMANS, Dr. N. Q. NG, Dr. M. YAMAUCHI, Prof. M. O. ADENIJI, Prof. J. K. EGUNJOBI, Dr. E. O. OSISANYA, Mr. V. O. SAGUA, Dr. B. B. WUDIRI, Mr. S. MOHAMMED.

Abstract of distribution and habitat of cultivated rice

Geographical distributions and habitats of cultivated rice collected in Nigeria were briefly illustrated in Fig. 1, in which the routes of trip and the collection-sites of seed samples are given, too.

I. *Oryza sativa* L.

Seed samples of the species were collected from the following districts; Tegina, Kagara, Zaria, Badeggi, Birnin Kebbi, Kende, Sokoto, Rabah, Talta, Maradun, Pambeguma and Outurcupo. Those were found in rainfed paddy fields, swamps, deep water paddy fields, river flood plains, road-side ditches, ponds and upland fields.

II. *Oryza glaberrima* STEUD.

Seed samples of the species were collected from the following districts; Tegina, Kagara, Zaria, Ngala, Badeggi, Jega, Rafingiwa, Kende, Arugungu, Sokoto, Rabah, Goronyo, Talta, Pambeguma and Lafia. Those were found in rainfed paddy fields, road-side depressions, irrigated paddy fields, deep water paddy fields, river flood plains, swamps and road-side

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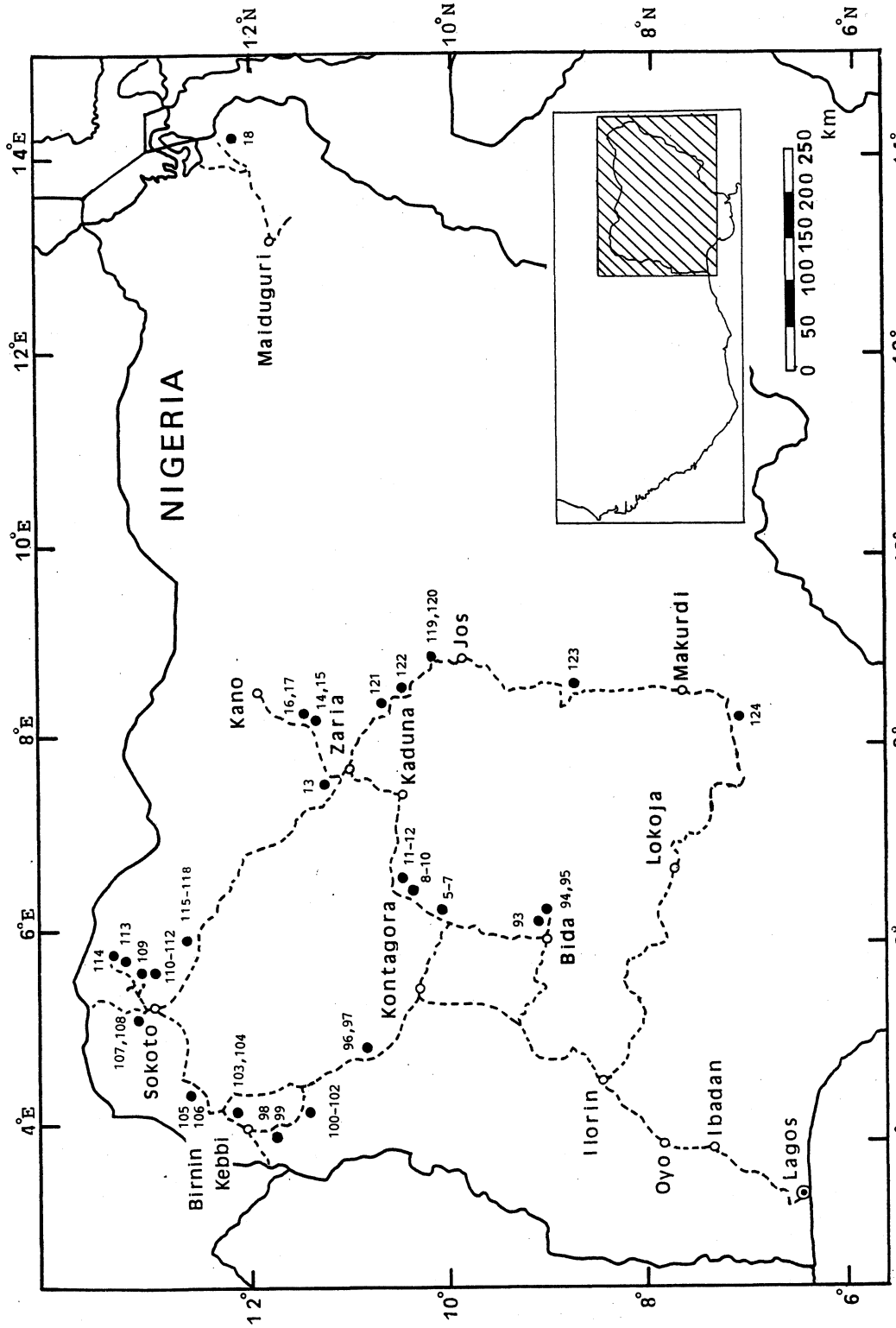

Fig. 1. Map showing several localities where the cultivated rices were collected in Nigeria. Dotted lines; routes of observations, filled circles; collection areas, open circles; main towns. Code-numbers used in the figure are corresponding to the strain number used in the tables.

Table 1. Distribution and habitat of cultivated rice collected in Nigeria, in 1984 and 1985. Abbreviations: **S**; *Oryza sativa* L., **G**; *Oryza glaberrima* STEUD., *km*; kilometers, *m*; meters, respectively.

Strain No.	Species	Collecting date	Place, habitat and remarks
In 1984			
5	S	Nov. 6	Samples of Nos. **5**～**7** mixed-growing in rainfed paddy field in Tegina.
6	S	Nov. 6	
7	G	Nov. 6	
8	S	Nov. 6	Samples of Nos. **8**～**10** mixed-growing in rainfed paddy field in Kagara.
9	S	Nov. 6	
10	G	Nov. 6	
11	S	Nov. 6	Nos. **11** and **12** mixed-growing in rainfed paddy field in Kagara.
12	G	Nov. 6	
13	G	Nov. 7	Zaria. Road-side depression.
14	G	Nov. 7	60 *km* north of Zaria to Kano. Road-side depression.
15	G	Nov. 7	The same habitat as No. **14**.
16	G	Nov. 7	64 *km* north of Zaria to Kano. Road-side depression.
17	G	Nov. 7	The same habitat as No. **16**.
18	G	Nov. 9	Ngala. Irrigated paddy field of South East Chad Irrigation Project.
In 1985			
93	S	Oct. 1	Badeggi. Road-side swamp.
94	G	Oct. 1	Nos. **94** and **95** mixed-growing in deep water paddy field of National Cereals Research Station in Badeggi.
95	S	Oct. 1	
96	G	Oct. 2	Nos. **96** and **97** mixed-growing in field of river flood plain, 70 *km* south of Jega to Kontagora.
97	S	Oct. 2	
98	G	Oct. 3	Rafingiwa Village between Bunza and Kende. Irrigated paddy field adjacent to pond.
99	G	Oct. 3	The same place as No. **98**. Embankment of irrigation canal.
100	G	Oct. 3	Kende. Depression in river flood plain.
101	S	Oct. 3	The same habitat as No. **100**.
102	S	Oct. 3	The same habitat as Nos. **100** and **101**.
103	S	Oct. 4	Birnin Kebbi. River flood plain. Mixed-growing with *O. glaberrima* in the river.
104	S	Oct. 4	The same place as No. **103**.
105	G	Oct. 4	Nos. **105** and **106** mixed-growing in field of river flood plain in Arugungu.
106	S	Oct. 4	
107	G	Oct. 4	Sokoto. River flood plain.
108	G	Oct. 4	The same habitat as No. **107**.
109	S	Oct. 5	Rabah. Road-side ditch.
110	S	Oct. 5	Rabah. River flood plain. Growing along the river.
111	S	Oct. 5	The same habitat as No. **110**.
112	G	Oct. 5	The same place as Nos. **110** and **111**. Growing in the river.
113	G	Oct. 5	Goronyo. Road-side dried up swamp.
114	G	Oct. 5	Goronyo. Road-side dried up swamp.
115	S	Oct. 6	Samples of Nos. **115**～**118** mixed-growing in paddy field, 3 *m* below the road in Talta.
116	G	Oct. 6	
117	G	Oct. 6	
118	G	Oct. 6	
119	S	Oct. 6	14 *km* south of Maradun. Road-side swamp.
120	G	Oct. 6	The same habitat as No. **119**.
121	S	Oct. 7	18 *km* south east of Pambeguma. Pond.
122	G	Oct. 7	48 *km* south east of Pambeguma. Pond.
123	G	Oct. 8	Lafia. Road-side ditch.
124	S	Oct. 10	Outurcupo. Upland field.

ditches.

Distributions of cultivated rices collected were listed up in Table 1. In this table, the strain number, the species name, the date of collection, the locality and some informations of the habitat were described.

Some morphological characters of unhusked grains

Twenty strains of *O. sativa* and 26 strains of *O. glaberrima* were collected in these trips and those were used for morphological investigations of unhusked grains. One strain of *O. glaberrima* was removed from the investigations, because of the utter immaturities of it's grains.

Table 2. Some morphological characters of unhusked grains of *O. sativa* collected in Nigeria

Strain[1] No.	Length (L) (*mm*)	Width (W) (*mm*)	Thickness (T) (*mm*)	L/W	L/T	W/T
5	10.42±0.50[2]	2.84±0.12	2.08±0.12	3.68±0.28	5.01±0.26	1.37±0.07
6	9.21±0.27	2.81±0.08	2.02±0.07	3.29±0.14	4.57±0.13	1.40±0.07
8	8.41±0.24	2.98±0.05	2.00±0.06	2.83±0.09	4.21±0.13	1.49±0.04
9	9.56±0.23	2.87±0.08	2.01±0.06	3.33±0.11	4.75±0.14	1.43±0.06
11	9.46±0.32	3.29±0.09	2.19±0.07	2.88±0.14	4.34±0.19	1.51±0.07
93	9.62±0.24	2.81±0.08	2.00±0.04	3.43±0.13	4.82±0.11	1.41±0.05
95	9.06±0.32	3.71±0.10	2.32±0.07	2.44±0.10	3.91±0.18	1.60±0.08
97	8.21±0.20	3.61±0.07	2.36±0.07	2.28±0.06	3.48±0.12	1.53±0.05
101	9.12±0.17	2.82±0.09	2.00±0.07	3.24±0.11	4.56±0.17	1.41±0.06
102	8.78±0.21	3.26±0.10	2.04±0.04	2.69±0.09	4.31±0.10	1.60±0.05
103	8.74±0.31	3.52±0.09	2.28±0.10	2.49±0.11	3.84±0.22	1.55±0.09
104	9.33±0.28	3.66±0.06	2.20±0.07	2.55±0.09	4.24±0.16	1.66±0.06
106	8.94±0.20	3.77±0.11	2.48±0.09	2.37±0.08	3.61±0.11	1.52±0.08
109	9.56±0.27	3.57±0.10	2.14±0.07	2.68±0.11	4.48±0.19	1.67±0.09
110	8.97±0.26	3.64±0.10	2.41±0.08	2.47±0.09	3.73±0.14	1.51±0.07
111	8.98±0.17	3.50±0.09	2.13±0.08	2.57±0.09	4.23±0.16	1.65±0.07
115	9.03±0.28	3.65±0.12	2.31±0.07	2.48±0.11	3.92±0.16	1.58±0.08
119	8.60±0.25	3.06±0.11	2.15±0.07	2.82±0.16	4.01±0.14	1.43±0.07
121	8.90±0.26	3.53±0.10	2.14±0.05	2.52±0.11	4.17±0.18	1.65±0.06
124	9.38±0.26	3.44±0.09	2.16±0.07	2.73±0.08	4.34±0.14	1.59±0.05
Grand[3] mean	9.11±0.48	3.32±0.34	2.17±0.14	2.78±0.39	4.23±0.40	1.53±0.09

1) Nos. 5~11 were collected in 1984 and Nos. 93~124 in 1985, respectively.
2) Mean of 20 grains and standard deviation.
3) Mean of means in the respective strains (n=20) and standard deviation.

Investigations were done for length, width and thickness of unhusked grains, using 20 grains of each strain. Measurements were done at the largest position of the respective characters. Moreover, of the unhusked grains, calculations were done on the ratios of the following components, namely, 'length to width', 'length to thickness', and 'width to thickness', using average values of the respective characters.

I. *O. sativa*

The results are given in Table 2. Lengths of grains were observed to be between 8.21 *mm* and 10.42 *mm*. The shortest grain was obtained in strain No. 97. The longest grain was obtained in No. 5. Average value was found to be 9.11 *mm*. The standard deviations of each strain, *i. e.*, showing intra-strain variation, were noted to be between 0.17 and 0.50.

Widths of grains were observed to be between 2.81 *mm* and 3.77 *mm*. The narrowest grains were obtained in Nos. 6 and 93. The widest grain was obtained in No. 106. Average value was found to be 3.32 *mm*. The standard deviations of each strain were noted to be between 0.05 and 0.12.

Thicknesses of grains were observed to be between 2.00 *mm* and 2.48 *mm*. The thinnest grains were obtained in Nos. 8, 93 and 101. The thickest grain was obtained in No. 106. Average value was found to be 2.17 *mm*. The standard deviations of each strain were noted to be between 0.04 and 0.12.

To make clear the relationships of the three components, *i. e.*, length and width, length and thickness, and width and thickness of unhusked grains, correlation coefficients were calculated. The correlation coefficient between length and width of unhusked grains was ascertained to be -0.34 showing no significant correlation even at 5 % level. The correlation coefficient between length and thickness of unhusked grains ascertained to be -0.31 showing no significant correlation even at 5 % level. The correlation coefficient between width and thickness of unhusked grains was ascertained to be 0.84 showing significant correlation among them at 0.1 % level. This relation indicated that the wider was the grain-width, the thicker was the grain-thickness.

Ratios of grain-length to grain-width of unhusked grains were observed to be between 2.28 and 3.68. The smallest value was obtained in No. 97. The largest value was obtained in No. 5. Average value was found to be 2.78. The standard deviation of the whole strains, *i. e.*, showing inter-strain variation, was 0.39.

Ratios of grain-length to grain-thickness of unhusked grains were observed to be between 3.48 and 5.01. The smallest value was obtained in No. 97. The largest value was obtained in No. 5. Average value was found to be 4.23. The standard deviation of the whole strains was 0.40.

Ratios of grain-width to grain-thickness of unhusked grains were observed to be between 1.37 and 1.67. The smallest value was obtained in No. 5. The largest value was obtained in No. 109. Average value was found to be 1.53. Standard deviation of the whole strains was 0.09.

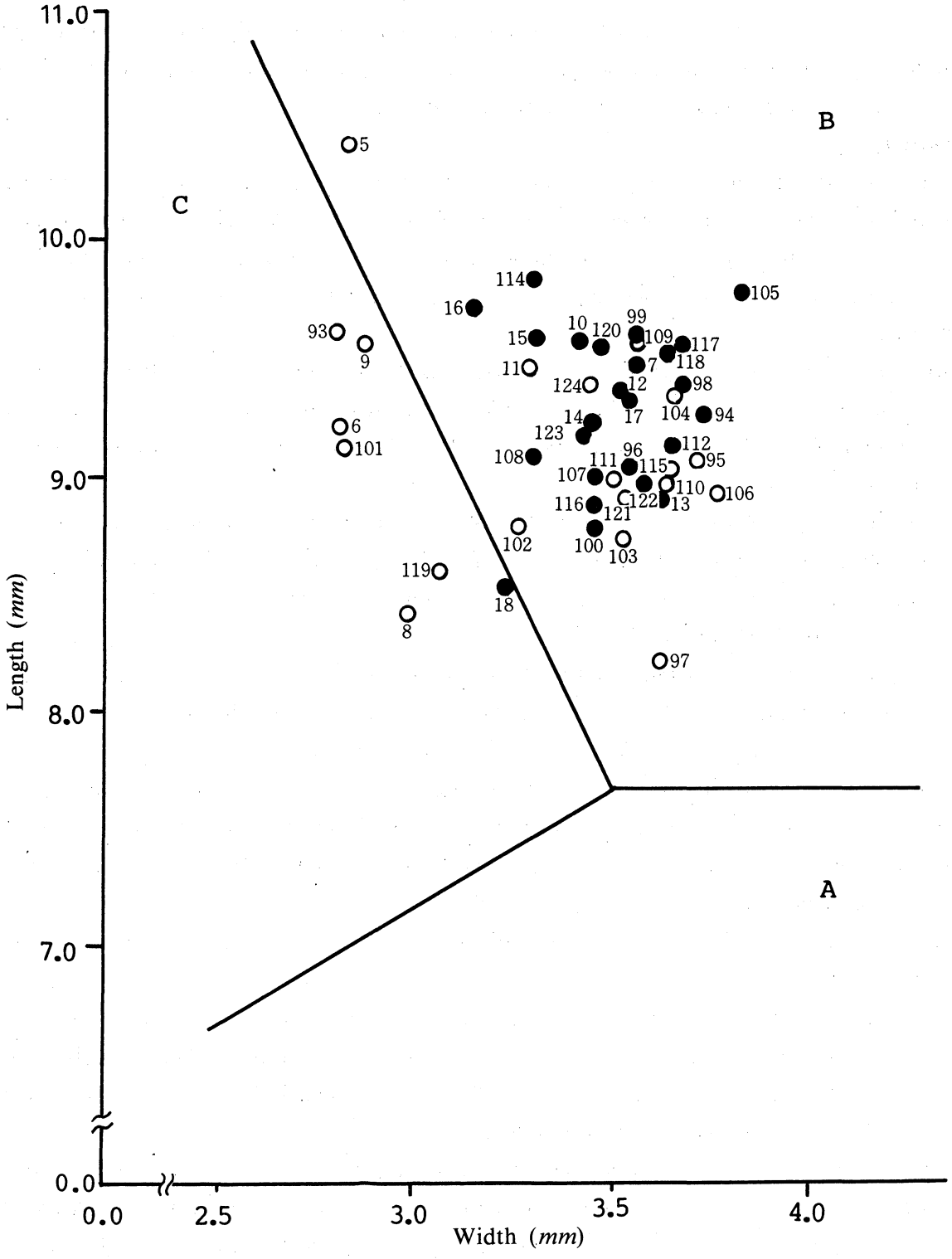

Fig. 2. Classification of grain type of unhusked grains in cultivated rice collected in Nigeria according to the tripartite classification by Matsuo[2]. Vertical axis; length of grain, abscissa; width of grain, open circle; *Oryza sativa* L., filled circle; *O. glaberrima* STEUD., respectively. Code-numbers used in the figure are corresponding to the strain number used in Tables 2 and 4.

Table 3. Number of strains and average values of length and width of unhusked grains in *O. sativa* belonging to the respective grain types

Grain[1] type	No. of strains	Length (*mm*)	Width (*mm*)
B	14	9.13±0.49	3.50±0.23
C	6	9.09±0.45	2.89±0.10

1) For explanation, refer to Fig. 2.

As shown in Fig. 2, based on the data obtained concerning the grain-length and grain-width of unhusked grains, the whole strains of *O. sativa* used were classified into two grain types, *i. e.*, B (large type) and C (slender type), according to the tripartite classification by Matsuo[2]. In this figure, code-numbers used are corresponding to the strain number used in Table 1. Fourteen strains of those belonged to the B type and 6 strains to the C type, respectively. As shown in Table 3, average values of grain-length were found to be 9.13 *mm* in 14 strains belonging to the B type and 9.09 *mm* in 6 strains to the C type, respectively. Average values of grain-width were found to be 3.50 *mm* in the B type and 2.89 *mm* in the C type, respectively. Strains belonging to the C type were remarkably narrow in view of grain-width. In grain-length, standard deviations of the whole strains belonging to the B and C types, *i. e.*, showing inter-strain variations, were 0.49 and 0.45, respectively. In grain-width, standard deviations of the whole strains belonging to the B and the C types were 0.23 and 0.10, respectively.

II. *O. glaberrima*

The results are given in Table 4. Lengths of grains were observed to be between 8.54 *mm* and 9.84 *mm*. The shortest grain was obtained in No. 18. The longest grain was obtained in No. 114. Average value was found to be 9.29 *mm*. The standard deviations of each strain, *i. e.*, showing intra-strain variation, were noted to be between 0.16 and 0.39.

Widths of grains were observed to be between 3.15 *mm* and 3.83 *mm*. The narrowest grain was obtained in No. 16. The widest grain was obtained in No. 105. Average value was found to be 3.50 *mm*. The standard deviations of each strain were noted to be between 0.06 and 0.16.

Thicknesses of grains were observed to be between 1.92 *mm* and 2.26 *mm*. The thinnest grain was obtained in No. 18. The thickest grain was obtained in No. 105. Average value was found to be 2.12 *mm*. The standard deviations of each strain were noted to be between 0.04 and 0.13.

To make clear the relationships of the three components, *i. e.*, length and width, length and thickness, and width and thickness of unhusked grains, correlation coefficients were calculated. The correlation coefficient between length and width of unhusked grains was

Table 4. Some morphological characters of unhusked grains of *O. glaberrima* collected in Nigeria

Strain[1] No.	Length (L) (*mm*)	Width (W) (*mm*)	Thickness (T) (*mm*)	L/W	L/T	W/T
7	9.47±0.21[2]	3.56±0.11	2.13±0.06	2.66±0.10	4.46±0.11	1.68±0.06
10	9.58±0.21	3.41±0.10	2.05±0.04	2.81±0.08	4.67±0.11	1.66±0.06
12	9.36±0.24	3.52±0.13	2.15±0.07	2.67±0.11	4.36±0.18	1.64±0.08
13	8.89±0.22	3.62±0.09	2.16±0.07	2.46±0.09	4.12±0.09	1.68±0.07
14	9.23±0.28	3.45±0.16	2.09±0.08	2.69±0.16	4.42±0.19	1.65±0.12
15	9.60±0.39	3.31±0.15	2.22±0.13	2.91±0.16	4.33±0.28	1.50±0.12
16	9.71±0.27	3.15±0.15	1.96±0.06	3.09±0.12	4.95±0.12	1.60±0.06
17	9.32±0.24	3.54±0.10	2.09±0.06	2.64±0.06	4.46±0.19	1.69±0.08
18	8.54±0.26	3.23±0.13	1.92±0.07	2.65±0.12	4.46±0.21	1.69±0.09
94	9.25±0.24	3.73±0.07	2.21±0.06	2.49±0.05	4.18±0.08	1.69±0.05
96	9.03±0.16	3.54±0.06	2.21±0.08	2.55±0.07	4.09±0.12	1.61±0.07
98	9.38±0.19	3.68±0.06	2.24±0.07	2.55±0.05	4.19±0.14	1.64±0.06
99	9.59±0.25	3.56±0.09	2.19±0.05	2.70±0.08	4.39±0.16	1.63±0.06
100	8.79±0.19	3.45±0.11	2.04±0.06	2.55±0.07	4.31±0.10	1.69±0.06
105	9.77±0.19	3.83±0.11	2.26±0.05	2.55±0.07	4.32±0.11	1.70±0.07
107	8.99±0.20	3.45±0.09	2.07±0.06	2.67±0.08	4.36±0.14	1.67±0.05
108	9.08±0.17	3.30±0.12	2.05±0.05	2.76±0.13	4.44±0.12	1.61±0.07
112	9.12±0.26	3.65±0.15	2.15±0.07	2.50±0.11	4.24±0.17	1.70±0.11
114	9.84±0.28	3.31±0.13	2.06±0.06	2.98±0.16	4.77±0.11	1.61±0.09
116	8.87±0.31	3.45±0.09	2.10±0.06	2.57±0.08	4.23±0.12	1.65±0.05
117	9.55±0.27	3.68±0.13	2.12±0.09	2.60±0.11	4.52±0.17	1.74±0.11
118	9.52±0.30	3.64±0.13	2.16±0.08	2.62±0.10	4.40±0.13	1.69±0.08
120	9.55±0.27	3.47±0.13	2.08±0.08	2.76±0.11	4.60±0.16	1.67±0.08
122	8.97±0.18	3.58±0.09	2.16±0.07	2.51±0.09	4.17±0.13	1.66±0.07
123	9.17±0.20	3.42±0.09	2.04±0.04	2.68±0.10	4.49±0.09	1.68±0.05
Grand[3] mean	9.29±0.33	3.50±0.16	2.12±0.08	2.67±0.15	4.40±0.32	1.66±0.08

1) Nos. 7~18 were collected in 1984 and Nos. 94~123 in 1985, respectively.
2) Mean of 20 grains and standard deviation.
3) Mean of means in the respective strains (n=25) and standard deviation.

ascertained to be 0.11 showing no significant correlation even at 5 % level. The correlation coefficient between length and thickness of unhusked grains was ascertained to be 0.28 showing no significant correlation even at 5 % level. The correlation coefficient between width and thickness of unhusked grains was ascertained to be 0.77 showing significant correlation among them at 0.1 % level. This relation indicated that the wider was the grain-width, the thicker was the grain-thickness.

Ratios of grain-length to grain-width were observed to be between 2.46 and 3.09.

Table 5. Number of strains and average values of length and width of unhusked grains in *O. glaberrima* belonging to the respective grain types

Grain[1)] type	No. of strains	Length (*mm*)	Width (*mm*)
B	24	9.32±0.30	3.51±0.15
C	1	8.54±0.00	3.23±0.00

1) For explanation, refer to Fig. 2.

The smallest value was obtained in No. 13. The largest value was obtained in No. 16. Average value was found to be 2.67. The standard deviation of the whole strains, *i. e.*, showing inter-strain variation, was 0.15.

Ratios of grain-length to grain-thickness were observed to be between 4.09 and 4.95. The smallest value was obtained in No. 96. The largest value was obtained in No. 16. Average value was found to be 4.40. The standard deviation of the whole strains was 0.32.

Ratios of grain-width to grain-thickness were observed to be between 1.50 and 1.74. The smallest value was obtained in No. 15. The largest value was obtained in No. 117. Average value was found to be 1.66. The standard deviation of the whole strains was 0.08.

As shown in Fig. 2, based on the data obtained concerning the grain-length and grain-width of unhusked grains, the whole strains of *O. glaberrima* used were classified into two grain types, *i. e.*, B and C types. Twenty-four strains of them belonged to the B type and 1 strain to the C type, respectively. As shown in Table 5, average values of grain-length were found to be 9.32 *mm* in 24 strains belonging to the B type and 8.54 *mm* in one strain to the C type, respectively. Average values of grain-width were found to be 3.51 *mm* in the B type and 3.23 *mm* in the C type, respectively. Strains belonging to the C type were relatively narrow in view of grain-width and strains belonging to the B type remarkably long in view of grain-length. In grain-length, standard deviation of the whole strains belonging to the B type, *i. e.*, showing inter-strain variation, was 0.30. In grain-width, standard deviation of the whole strains belonging to the B type was 0.15.

Summary

During the trips of November in 1984 and of October in 1985 in Nigeria, 46 strains of cultivated rice, *i. e.*, 20 strains of *O. sativa* and 26 strains of *O. glaberrima*, were collected. Their localities and habitats were reported (Table 1). Locality names are as follows; Tegina, Kagara, Zaria, Ngala, Badeggi, Bunza, Kende, Birnin Kebbi, Arugungu, Sokoto,

Rabah, Goronyo, Talta, Maradun, Pambeguma, Lafia and Outurcupo.

In the whole strains of *O. sativa* collected, average values of length, width and thickness of unhusked grains were 9.11 *mm,* 3.32 *mm* and 2.17 *mm,* respectively. Of unhusked grains, correlation coefficients between length and width, length and thickness, and width and thickness were −0.34, −0.31 and 0.84, respectively. Of unhusked grains, ratios of length to width, of length to thickness and of width to thickness were 2.78, 4.23 and 1.53, in average values, respectively.

Using grain-length and grain-width, the whole strains of *O. sativa* used were classified into two grain types. Fourteen strains belonged to the B type and 6 strains to the C type, respectively.

In *O. glaberrima,* of 26 strains twenty-five were used for morphological investigations of unhusked grains. Average values of length, width and thickness of unhusked grains were 9.29 *mm,* 3.50 *mm* and 2.12 *mm,* respectively. Of unhusked grains, correlation coefficients between length and width, length and thickness, and width and thickness were 0.11, 0.28 and 0.77, respectively. Of unhusked grains, ratios of length to width, of length to thickness and of width to thickness were 2.67, 4.40 and 1.66, respectively.

Using grain-length and grain-width, the whole strains of *O. glaberrima* used were classified into two grain types. Twenty-four strains belonged to the B type and 1 strain to the C type, respectively.

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摘　　要

ナイジェリアにおける栽培稲の分布と形態

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1984 年 11 月と 1985 年 10 月にナイジェリアにおいて栽培稲の分布と生態について調査を行ない，*Oryza sativa* 20 系統，*Oryza glaberrima* 26 系統を採集した。それらの分布と生息地の生態条件を Table 1 に示した。

O. sativa の全系統と *O. glaberrima* の 25 系統を用いた籾の形態調査の結果，籾の長さ，幅，および厚さの系統間平均は，*O. sativa* では 9.11，3.32，2.17 *mm* であり，*O. glaberrima* では 9.29，3.50，

2.12 *mm* であった。これらの形質間の相関は，両種とも籾幅と籾厚に高い相関係数が得られ，籾幅の広い系統ほど厚くなる傾向が認められた。長幅比，長厚比，幅厚比の系統間平均は，*O. sativa* で 2.78，4.23，1.53 であり，*O. glaberrima* では 2.67，4.40，1.66 であった。籾型の分類より *O. sativa* では，14 系統がB型，6 系統がC型に，*O. glaberrima* では 24 系統がB型，1 系統がC型にそれぞれ分類された。

今後，さらに多くの形態的特性の分析をもとにナイジェリアを含むアフリカ地域における栽培稲の品種分化を検討する。

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