Some Morphological Characters of the Wild Rice in Indonesia

Akinori NAKAGAMA
(*Laboratory of Crop Science*)
(Received for Publication August 30, 1975)

Introduction

From October to December in 1974, the writer was sent to Malaysia and Indonesia under the project, "Survey on Unused Plants in South East Asia", supported by a Grant from the Ministry of Education, Japan. In this trip, the writer obtained several wild rices, a lot of cultivated rices and many other *Gramineae* and *Leguminosae* plants in cooperation with Mr. K. Ishihata, the team leader, Mr. M. Hayashi and Mr. Sukasdy.

In this report, the records of habitat, of morphological characters of unhusked and husked grains and those concerning the comparison of unhusked and husked grains of wild rices collected in Indonesia, *i.e.*, North Sumatera, South Sumatera and West Kalimantan, have mainly been described. Furthermore some considerations on the ecotypic differentiations of wild rice in the Indonesia have also been described. Morphological comparisons of unhusked and husked grains of the cultivated rices in the Indonesia shall be reported in the separate paper.

Morphological analysis of grain of wild rice was performed by Katayama's methods [3, 4].

The writer is most grateful to Dr. D. S. Sastrapradja (Bogor Botanic Gardens) and Dr. S. Sastrapradja (National Biological Institute, Indonesia), who helped and gave their kind arrangements to accomplish his task. Thanks are due to LIPI office, who helped him greatly with his travelling matters. The writer wishes to express his hearty thanks to Dr. Y. Iwata (Central Research Institute for Agriculture, Indonesia), Dr. H. Mikoshiba and Dr. T. Yamamoto (Tropical Agriculture Research Center, Japan), for their kind suggestions and helps. The writer expresses his hearty thanks to Dr. T. C. Katayama (Kagoshima University), for his continuous guidance and encouragement. His hearty thanks are also due to Drs. M. Kanie, M. Taketomi, M. Ikeda, K. Ueki, T. Oyamada (Kagoshima University), for their guidances and to Experimental Farm members (Kagoshima University) for their kind helps.

Abstract of distribution and habitats of wild *Oryza* species

Twelve strains belonging to two wild *Oryza* species were collected in this trip. Ten strains of them were *Oryza officinalis* and other two strains were *Oryza ridleyi*. Geographical distributions of them were briefly illustrated in Fig. 1. In this figure, route of trip and growing area of the wild rice are given.

General characteristics of the plants collected and the main localities of these hab-

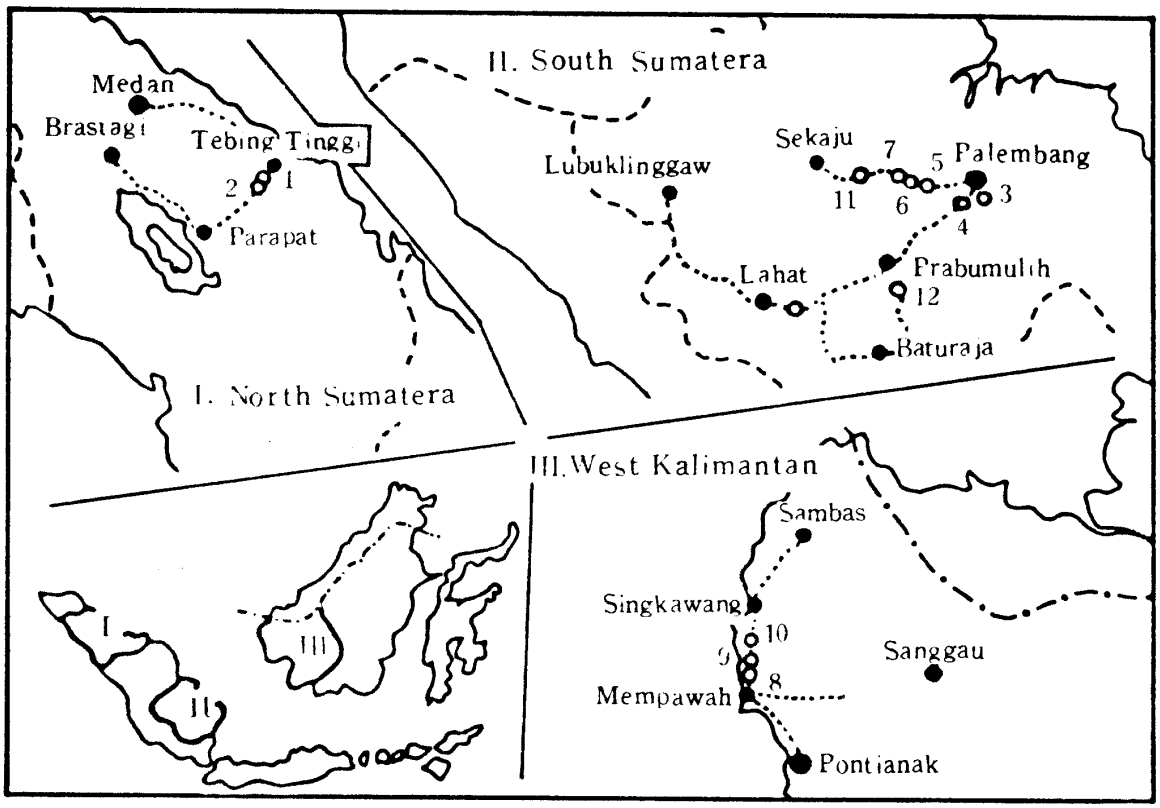


Fig. 1. Map showing several localities concerned in Indonesia. Dotted line : route of observation ; open circle : growing area of the wild rice ; filled circle : main town. Detailed explanation in text.

itats are as follows :

1) *Oryza officinalis* WALL.

Two types, in view of plant height, were observed in this species, *i.e.*, the higher and the lower types.

Higher type specimens collected have the following characteristics ; plant 240 *cm* long, leaf blade 33.0 to 58.6 *cm* long, 2.5 to 3.0 *cm* wide. Panicle 32 *cm* long, widely spreading at maturity. Spikelet easily shedding, 4.3 to 4.7 *mm* long, 2.2 to 2.5 *mm* wide, 1.2 to 1.3 *mm* thick, 1.8 to 2.1 in ratio of length to width, 3.4 to 3.9 in ratio of length to thickness, 1.8 to 1.9 in ratio of width to thickness, awn 5 to 11 *mm* long.

Populations of this type were found in many districts, *i.e.*, Payah Nibung, Lokong Terusan, Kertapati, Betung, Sungai Duri, Sungai Tanjung. They were found on wet waste land near river, along the river-side flooding in rainy season and at the road-side open tank and ditch. They were always adjacent to a human habitation. The local names are "Padi Hutan" and "Padi Ketpat" at Lokong Terusan.

Lower type specimens collected have the following characteristics ; plant 137 *cm* long, leaf blade 25.5 to 54.2 *cm* long, 1.7 to 2.0 *cm* wide. Panicle 25.5 *cm* long, widely spreading at maturity. Spikelet easily shedding, 4.4 to 4.5 *mm* long, 2.1 to 2.3 *mm* wide, 1.1 to 1.2 *mm* thick, 1.9 to 2.2 in ratio of length to width, 3.6 to 4.0 in ratio of length to thickness, 1.9 in ratio of width to thickness, awn 6 to 9 *mm* long.

Populations of this type were observed in Payah Nibung and Sungai Duri. They had the same habitat as that of the former type. Local name is "Padi Pipit".

2) *Oryza ridleyi* HOOK.

Specimens collected have the following characteristics; plant about 170 *cm* long, leaf blade 15.5 to 42.5 *cm* long, 1.4 to 2.1 *cm* wide. Panicle 30 *cm* long, widely spreading at maturity. Spikelet easily shedding, 11.6 to 12.1 *mm* long, 2.3 to 2.5 *mm* wide, 1.4 *mm* thick, 4.8 to 5.2 in ratio of length to width, 8.4 to 8.6 in ratio of length to thickness, 1.6 to 1.8 in ratio of width to thickness, awn about 20 *mm* long.

Populations of the species were found in the following districts, *i.e.*, near Sekaju and near Prabumulih. They were found in swampy and gloomy forest, situated at about 1 *m* below the road.

Table 1. Distribution and habitat of wild rice collected in the Indonesia. Abbreviations: **o**; *Oryza officinalis* WALL., **r**; *Oryza ridleyi* HOOK., *km*; kilometer or kilometers, *m*; meter or meters.

Collected No.	Species	Date	Province	Detailed locality, habitat and remarks
W 1	**o**	Nov. 14	North Sumatera	Payah Nibung, about 50 *km* east from Medan. Road side ditch, about 1 *m* width, adjacent to *Hevea brasiliensis* plantation at east side and paddy field at west side. Growing continuously between 1 *km* from the locality mentioned above to west side. Higher type in view of plant height (*cf.* text). Native name "Padi Hutan".
W 2	**o**	Nov. 14	North Sumatera	Payah Nibung. Road side ditch. Lower type in view of plant height (*cf.* text).
W 3	**o**	Nov. 24	South Sumatera	Lokong Terusan, about 5 *km* south from Palembang. Wet waste land (2 *m*×3 *m*) near river, separated by small road and surrounded by human habitations and small factory of roofing tiles on the other three sides. Growing only 3 plants. Native name "Padi Ketpat".
W 4	**o**	Nov. 24	South Sumatera	Kertapati, about 10 *km* south from Palembang. Road side open tank, 5 *m*×6 *m*.
W 5	**o**	Nov. 25	South Sumatera	Betung, about 65 *km* west from Palembang. Small river side at the back of human habitation, shading by trees. Many plants growing together at both sides of river.
W 6	**o**	Nov. 25	South Sumatera	Betung. River side, flooding in rainy season. Many plants growing together with *Gramineae* grasses.
W 7	**o**	Nov. 25	South Sumatera	Betung. Road side ditch.
W 8	**o**	Dec. 16	West Kalimantan	Sungai Tanjung, about 10 *km* north from Mempawah. Road side ditch, growing only 2 plants.
W 9	**o**	Dec. 16	West Kalimantan	Sungai Duri, about 30 *km* north from Mempawah. Road side open tank, 1.5 *m*×2.0 *m*.
W10	**o**	Dec. 16	West Kalimantan	Sungai Duri. Road side ditch. Growing only 2 plants. Lower type in view of plant height. Native name "Padi Pipit".
W11	**r**	Nov. 25	South Sumatera	About 35 *km* east from Sekaju. Road-side swampy and gloomy forest, situated at 1 *m* below the road. Mostly flowering stage, but collected a few matured grains.
W12	**r**	Nov. 29	South Sumatera	About 30 *km* south from Prabumulih. Same habitat as above. Mostly flowering stage, but collected a few matured grains.

Distributions of wild rices were listed up in Table 1. In this table, collection-number, species-name, date of collection, detailed locality and some information of the habitat were described.

Some morphological characters of unhusked grains of wild-species

Twelve strains of wild rices were collected in this trip, and they were used for morphological investigations of unhusked grain. The results are given in Table 2. In this table, length, width and thickness of unhusked grains, the ratios of length to width, length to thickness and width to thickness were shown. The measurements were done at the largest positions of the respective character.

Lengths of the grain were observed to be between 4.27 and 12.06 *mm*. The shortest grain was obtained as 4.27 *mm* in W3, which was collected in the wet waste land near a river in Lokong Terusan. The longest grain was obtained as 12.06 *mm* in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found to be within 4.65 to 4.70 *mm*. Average value was found to be 5.73 *mm*. The standard deviations of each strain, *i.e.*, showing intra-strain's variation, obtained were 0.22±0.16.

Ten strains of *O. officinalis* belonged to the groups within 4.25 to 4.70 *mm*. One strain of them belonged to the group within 4.25 to 4.30 *mm*, 1 strain within 4.30 to 4.35 *mm*, 1 strain within 4.35 to 4.40 *mm*, 1 strain within 4.45 to 4.50 *mm*, 2 strains within 4.50 to 4.55 *mm*, 1 strain within 4.60 to 4.65 *mm* and 3 strains within 4.65 to 4.70 *mm*, respectively. Two strains of *O. ridleyi* belonged to the groups within 11.55 to 13.00 *mm*. The strains of *O. ridleyi* were remarkably longer than those of *O. officinalis* in view of grain-length. Ten strains of *O. officinalis* may be divided into three groups by the borders in 4.40 to 4.45 *mm* and 4.55 to 4.60 *mm*, *i.e.*, the shorter, the middle and the longer groups. Three strains belonged to the former, 3 strains to the middle and 4 strains to the latter groups, respectively. Relation between geographical positions and these values was not clearly explained.

Table 2. Some morphological characters of unhusked grains of wild species.

Strain No.	Length (*mm*)	Width (*mm*)	Thickness (*mm*)	L/W	L/T	W/T	No. of grains tested
W 1	4.48±0.20	2.08±0.10	1.12±0.05	2.16	4.00	1.86	20
W 2	4.67±0.10	2.23±0.09	1.20±0.03	2.19	3.88	1.86	20
W 3	4.27±0.11	2.35±0.07	1.25±0.14	1.82	3.43	1.89	20
W 4	4.64±0.20	2.32±0.11	1.31±0.01	2.01	3.55	1.78	20
W 5	4.51±0.18	2.27±0.11	1.21±0.04	2.00	3.73	1.88	20
W 6	4.54±0.17	2.31±0.09	1.27±0.04	2.00	3.59	1.83	20
W 7	4.67±0.14	2.27±0.15	1.25±0.08	2.05	3.74	1.83	20
W 8	4.32±0.13	2.36±0.08	1.24±0.02	1.83	3.49	1.91	20
W 9	4.67±0.11	2.45±0.09	1.27±0.03	1.91	3.67	1.93	20
W10	4.37±0.14	2.31±0.08	1.23±0.04	1.90	3.57	1.89	20
W11	11.55±0.52	2.25±0.18	1.38±0.07	5.17	8.42	1.62	20
W12	12.06±0.60	2.50±0.21	1.40±0.09	4.84	8.64	1.79	11

Widths of grain were observed to be between 2.08 and 2.50 *mm*. The narrowest grain was obtained as 2.08 *mm* in W1, which was collected in the road-side ditch in Payah Nibung. The widest grain was obtained as 2.50 *mm* in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found within 2.25 to 2.35 *mm*. Average value was found to be 2.31 *mm*. The standard deviations of each strain, *i.e.*, showing intra-strain's variation, obtained were relatively small, and smaller than that of length, as 0.11 ± 0.04.

Ten strains of *O. officinalis* belonged to the groups within 2.05 to 2.50 *mm* in view of grain-width. One strain of them belonged to the group within 2.05 to 2.10 *mm*, 1 strain within 2.20 to 2.25 *mm*, 2 strains within 2.25 to 2.30 *mm*, 3 strains within 2.30 to 2.35 *mm*, 2 strains within 2.35 to 2.40 *mm* and 1 strain within 2.45 to 2.50 *mm*, respectively. Two strains of *O. ridleyi* belonged to the groups within 2.25 to 2.55 *mm*. Any clear difference between *O. officinalis* and *O. ridleyi*, in view of grain-width, could not be recognized. The strains of *O. officinalis* may be divided into three groups by the borders in 2.10 and 2.40 *mm*, *i.e.*, the narrower, the middle and the wider groups. One strain belonged to the former, 8 strains to the middle and 1 strain to the latter groups, respectively. The grains collected in North Sumatera were relatively narrow in view of grain-width. Further relation between geographical positions and these values was not clearly explained.

Thicknesses of the grain were observed to be between 1.12 and 1.40 *mm*. The thinnest grain was obtained as 1.12 *mm* in W1, which was collected in the road-side ditch in Payah Nibung. The thickest grain was obtained as 1.40 *mm* in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found within 1.20 to 1.30 *mm*. Average value was found to be 1.26 *mm*. The standard deviations of each strain, *i.e.*, showing intra-strain's variation, were relatively small and were remarkably smaller than that of length and width, as 0.05 ± 0.04.

Ten strains of *O. officinalis* belonged to the groups within 1.10 to 1.35 *mm* in view of grain-thickness. One strain of them belonged to the group within 1.10 to 1.15 *mm*, 4 strains within 1.20 to 1.25 *mm*, 4 strains within 1.25 to 1.30 *mm* and 1 strain within 1.30 to 1.35 *mm*, respectively. Two strains of *O. ridleyi* belonged to the groups within 1.35 to 1.45 *mm*. The strains of *O. ridleyi* were remarkably thicker than those of *O. officinalis* in view of grain-thickness. Nine strains of *O. officinalis*, excepting for W1, were observed to be in a very narrow range. W1 was remarkably thinner than the other strains in view of grain-thickness which was same as grain-width. The grains collected in North Sumatera and West Kalimantan were relatively thin in view of grain-thickness. Further relation between geographical positions and these values was not explained.

In comparison with three components, *i.e.*, length, width and thickness of unhusked grain, the following tendency was ascertained clearly. The whole strains of *O. ridleyi* were remarkably larger than those of *O. officinalis* in view of grain-length and grain-thickness. The whole strains of *O. officinalis* could not be recognized to have any clear tendency in comparison with the three components, excepting the relation between grain-width and grain-thickness. W1 and W2 belonged to the relatively smaller group, and W3, W4, W5, W6 and W7 belonged to the middle and the relatively larger groups in view of grain-width and grain-thickness. W1 and W2 were collected in North

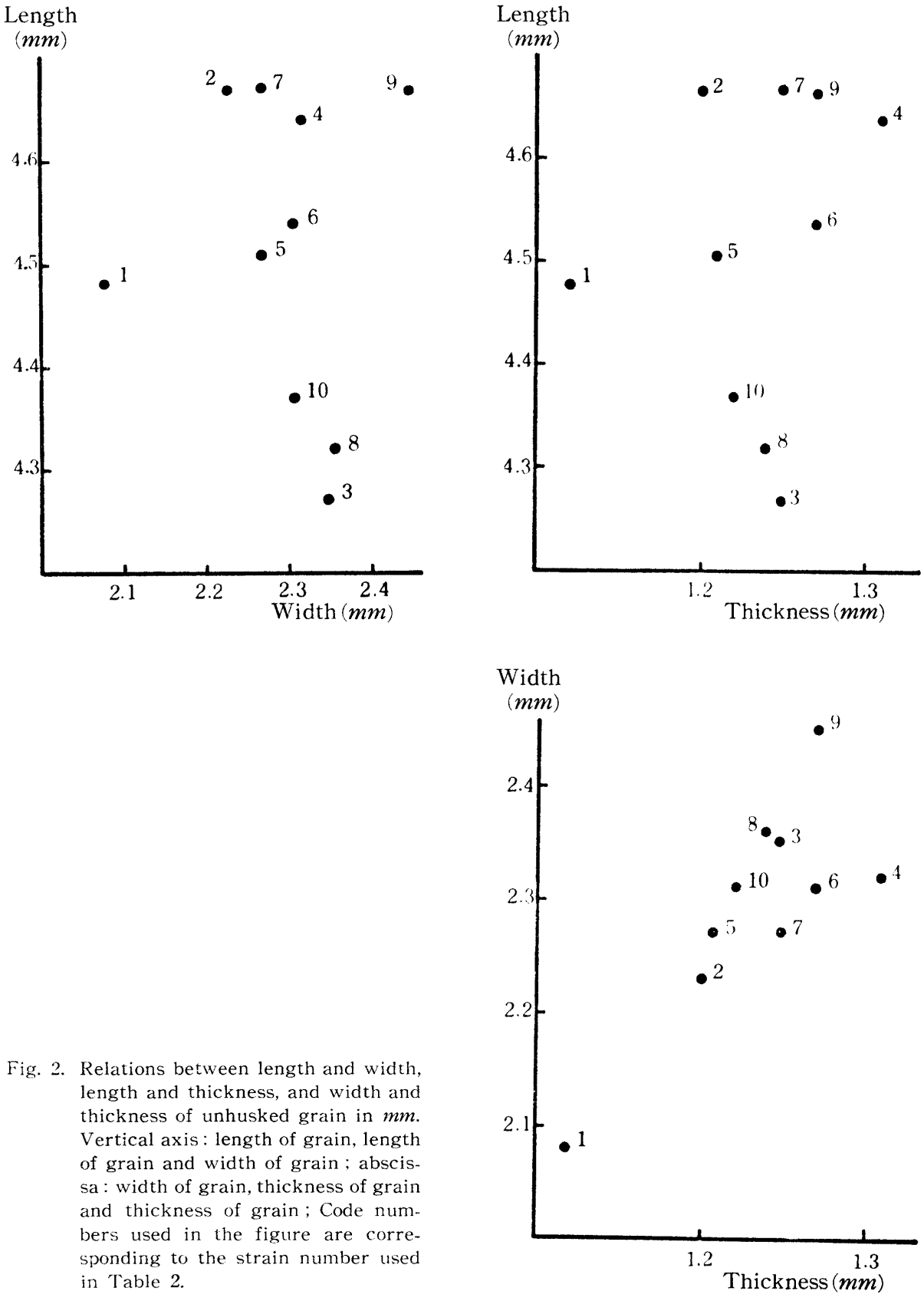


Fig. 2. Relations between length and width, length and thickness, and width and thickness of unhusked grain in *mm*. Vertical axis : length of grain, length of grain and width of grain ; abscissa : width of grain, thickness of grain and thickness of grain ; Code numbers used in the figure are corresponding to the strain number used in Table 2.

Sumatera and W3, W4, W5, W6 and W7 were collected in South Sumatera. W8, W9 and W10 belonged to the relatively larger group in view of grain-width, but belonged to the relatively smaller group in view of grain-thickness. W8, W9 and W10 were collected in West Kalimantan.

To make clear the relationships of the three components of *O. officinalis*, the relations between length and width, length and thickness, width and thickness were shown in Fig. 2.

In Fig. 2, relations between length and width, length and thickness, width and thickness were shown. Code numbers used are corresponding to strain number, which was used in Table 2. Correlation coefficients and linear regressions between length and width, length and thickness, width and thickness were also calculated.

Correlation coefficient between length and width was −0.0536 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the length on the width of unhusked grains was calculated as follows; $Y = -0.034X + 2.451$, where Y and X indicate the former (1 unit = 0.1 *mm*) and the latter (1 unit = 0.1 *mm*), respectively. This formula indicates that the length of grain becomes 0.034 *mm* shorter, by becoming 1.000 *mm* wider in the width of grain.

Correlation coefficient between length and thickness was 0.1823 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of length on thickness of unhusked grains was calculated as follows; $Y = 0.061X + 0.958$, where Y and X indicate the former (1 unit = 0.1 *mm*) and the latter (1 unit = 0.1 *mm*), respectively. This formula indicates that the length of grain becomes 0.061 *mm* longer, by becoming 1.000 *mm* thicker in the thickness of grain.

Correlation coefficient between width and thickness was 0.8112 and showed very high correlation among them at 0.1% level. It was said that the wider was the width of grain, the thicker grew the thickness of grain. Linear regression of width on thickness of unhusked grain was calculated as follows; $Y = 0.430X + 0.247$, where Y and X indicate width of grain (1 unit = 0.1 *mm*) and thickness of grain (1 unit = 0.1 *mm*), respectively. This formula indicates that the width of grain becomes 0.430 *mm* wider, by becoming 1.000 *mm* thicker in the thickness of grain.

Ratios of grain-length to grain-width were observed to be between 1.82 and 5.17, having the large range, as shown in Table 2. The smallest value was found to be 1.82 in W3, which was collected in wet waste land near river in Lokong Terusan. The largest value was found to be 5.17 in W11, which was collected in the road-side swampy and gloomy forest near Sekaju. Mode was found within 2.00 to 2.05. Average value was found to be 2.48. The standard deviation of the whole strains used, *i.e.*, showing inter-strain's variation, was 1.13.

Ten strains of *O. officinalis* belonged to the groups within 1.80 to 2.20. Two strains belonged to the group within 1.80 to 1.85, 2 strains within 1.90 to 1.95, 3 strains within 2.00 to 2.05, 1 strain within 2.05 to 2.10, 1 strain within 2.10 to 2.15 and 1 strain within 2.15 to 2.20, respectively. Two strains of *O. ridleyi* belonged to the groups within 4.80 to 5.20. The strains of *O. ridleyi* were remarkably larger than those of *O. officinalis* in view of ratio of length to width. The whole strains of *O. officinalis*

may be divided into two groups by the border found in 1.95, *i.e.*, the longer and the shorter groups. Four strains belonged to the former, and other 6 strains to the latter groups, respectively. The grains collected in West Kalimantan were relatively short and the grains collected in North Sumatera were relatively long.

Ratios of grain-length to grain-thickness were observed to be between 3.43 and 8.64, having the large range. The smallest value was found to be 3.43 in W3, which was collected in the wet waste land near river in Lokong Terusan. The largest value was found to be 8.64 in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found within 3.55 to 3.65. Average value was found as 4.48. The standard deviation of the whole strains used, *i.e.*, showing inter-strain's variation, was 1.82, which was remarkably larger than that of ratio of length to width.

Ten strains of *O. officinalis* belonged to the groups within 3.40 to 4.05. One strain belonged to the group within 3.40 to 3.45, 1 strain within 3.45 to 3.50, 3 strains within 3.55 to 3.60, 1 strain within 3.65 to 3.70, 2 strains within 3.70 to 3.75, 1 strain within 3.85 to 3.90 and 1 strain within 4.00 to 4.05, respectively. Two strains of *O. ridleyi* belonged to the groups within 8.40 to 8.65. The strains of *O. ridleyi* were remarkably larger than those of *O. officinalis* in ratio of length to thickness. The whole strains of *O. officinalis* may be divided into two groups by the border found in 3.60, *i.e.*, the thicker and the thinner groups. Five strains belonged to the former and other 5 strains to the latter groups, respectively. The grains collected in North Sumatera were relatively large and the grains collected in West Kalimantan were relatively small in view of ratio of grain-length to grain-thickness.

Ratios of grain-width to grain-thickness were observed to be between 1.62 and 1.93, having the narrow range. The smallest value was found to be 1.62 in W11, which was collected in the road-side swampy and gloomy forest near Sekaju. The largest value was found to be 1.93 in W9, which was collected in the road-side open tank in Sungai Duri. Mode was found within 1.85 to 1.90. Average value was found to be 1.84. The standard deviation of the whole strains used, *i.e.*, showing inter-strain's variation, was 0.08, which was remarkably smaller than that of ratios of length to width and length to thickness.

Ten strains of *O. officinalis* belonged to the groups within 1.75 to 1.95. One strain belonged to the group within 1.75 to 1.80, 2 strains within 1.80 to 1.85, 5 strains within 1.85 to 1.90 and 2 strains within 1.90 to 1.95, respectively. Two strains of *O. ridleyi* belonged to the groups 1.60 to 1.80. The clear difference between *O. officinalis* and *O. ridleyi* in view of ratio of grain-width to grain-thickness could not be recognized. They showed normal distribution curve, excepting for W11. The grains collected in West Kalimantan were relatively large in view of ratio of width to thickness.

In comparison with three components, *i.e.*, ratios of length to width, length to thickness and width to thickness of unhusked grain, the following tendency was ascertained to be clear. As compared with the strains of *O. officinalis*, the whole strains of *O. ridleyi* belonged to the remarkably larger group in view of ratios of grain-length to grain-width and grain-length to grain-thickness, but belonged to the relatively smaller group in view of ratio of grain-width to grain-thickness. In relation between ratios of length to width and length to thickness of *O. officinalis*, the grains belonging to the

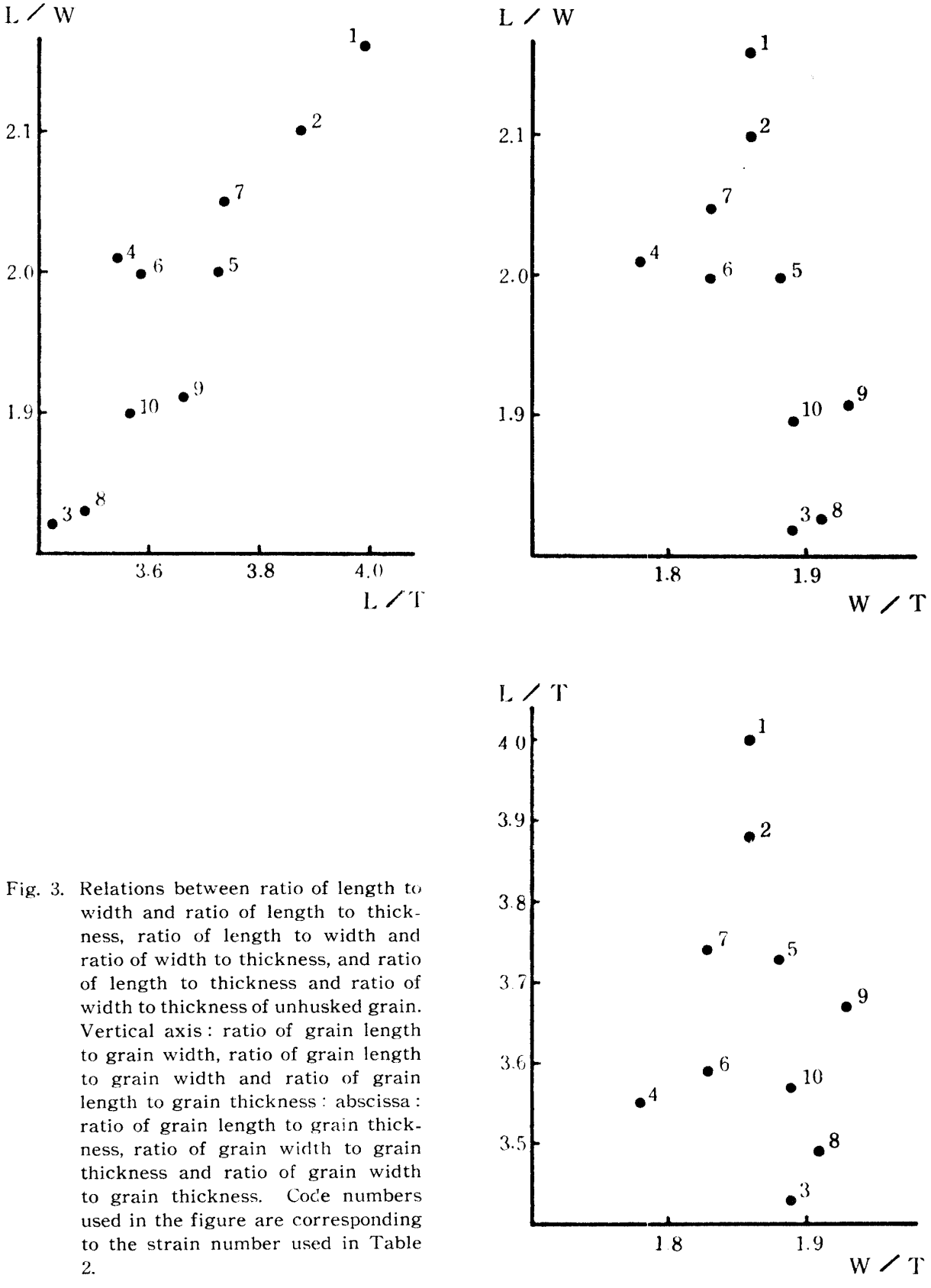


Fig. 3. Relations between ratio of length to width and ratio of length to thickness, ratio of length to width and ratio of width to thickness, and ratio of length to thickness and ratio of width to thickness of unhusked grain. Vertical axis : ratio of grain length to grain width, ratio of grain length to grain width and ratio of grain length to grain thickness : abscissa : ratio of grain length to grain thickness, ratio of grain width to grain thickness and ratio of grain width to grain thickness. Code numbers used in the figure are corresponding to the strain number used in Table 2.

larger group in one component, belonged to the relatively larger group in other component. Namely, W1 and W2 collected in North Sumatera belonged to the relatively larger group and W8, W9 and W10 collected in West Kalimantan belonged to the relatively smaller group. On the other hand, in view of ratio of grain-width to grain-thickness, W8, W9 and W10 belonged to the relatively larger group.

To make clear the relationships between three components of *O. officinalis*, *i.e.*, ratios of length to width, length to thickness and width to thickness of unhusked grains, the relations between them were shown in Fig. 3.

In Fig. 3, relations between ratio of grain-length to grain-width and ratio of grain-length to grain-thickness, ratio of grain-length to grain-width and ratio of grain-width to grain-thickness, and ratio of grain-length to grain-thickness and grain-width to grain-thickness were shown, respectively. In this figure, code numbers used are corresponding to the strain number used in Table 2. Correlation coefficient and linear regression between them were also calculated.

Correlation coefficient between ratio of grain-length to grain-width and ratio of grain-length to grain-thickness was 0.9045 and showed very high correlation among them at 0.1% level. It was said that the larger was the former ratio, the larger was the latter ratio. Linear regression of the former ratio on the latter ratio was calculated as follows; $Y = 1.454X + 0.789$, where Y and X indicate the former ratio (1 unit = 0.1) and the latter ratio (1 unit = 0.1), respectively. This formula indicates that the ratio of grain-length to grain-width becomes 1.454 larger, by becoming 1.000 larger in the ratio of grain-length to grain-thickness.

Correlation coefficient between ratio of grain-length to grain-width and ratio of grain-width to grain-thickness was −0.5550 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of ratio of grain-length to grain-width on ratio of grain-width to grain-thickness was calculated as follows; $Y = -0.222X + 2.304$, where Y and X indicate the former ratio (1 unit = 0.1) and the latter ratio (1 unit = 0.1), respectively. This formula indicates that the ratio of grain-length to grain-width becomes 0.222 smaller, by becoming 1.000 larger in the ratio of grain-width to grain-thickness.

Correlation coefficient between ratio of grain-length to grain-thickness and ratio of grain-width to grain-thickness was −0.1115 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the former ratio on the latter ratio was calculated as follows; $Y = -0.028X + 1.968$, where Y and X indicate the former ratio (1 unit = 0.1) and the latter ratio (1 unit = 0.1), respectively. This formula indicates that the ratio of grain-length to grain-thickness becomes 0.028 smaller, by becoming 1.000 larger in the ratio of grain-width to grain-thickness.

Some morphological characters of husked grains of wild species

Twelve strains of wild rice were collected in this trip, and they were also used for morphological investigations of husked grains, as done before, using the unhusked grains. The results are given in Table 3. In this table, length, width and thickness of husked grains, the ratios of length to width, length to thickness and width to

Table 3. Some morphological characters of husked grains of wild species.

Strain No.	Length (*mm*)	Width (*mm*)	Thickness (*mm*)	L/W	L/T	W/T	No. of grains tested
W 1	3.19±0.12	1.66±0.06	0.92±0.03	1.93	3.48	1.81	20
W 2	3.33±0.09	1.74±0.06	0.94±0.03	1.91	3.53	1.85	20
W 3	3.13±0.09	1.87±0.07	1.01±0.04	1.67	3.09	1.87	20
W 4	3.35±0.16	1.87±0.09	1.08±0.03	1.80	3.09	1.72	20
W 5	3.19±0.15	1.78±0.09	1.00±0.06	1.80	3.21	1.79	20
W 6	3.29±0.12	1.85±0.07	1.11±0.05	1.78	3.13	1.76	20
W 7	3.41±0.08	1.82±0.04	1.02±0.14	1.88	3.35	1.78	20
W 8	3.19±0.06	1.88±0.05	1.00±0.03	1.70	3.20	1.89	20
W 9	3.43±0.09	1.93±0.10	1.00±0.07	1.78	3.44	1.93	20
W10	3.18±0.10	1.85±0.05	0.97±0.05	1.72	3.27	1.91	20
W11	7.32±0.29	1.31±0.62	1.20±0.05	5.60	6.13	1.10	20
W12	7.90±0.32	1.30±0.51	1.19±0.15	6.08	6.65	1.09	11

thickness and number of grains used, were shown. The measurements were done at the largest positions of the respective character. Geographical positions, in which the wild rices were collected are shown in Fig. 1. A numeral in this figure shows the strain number used in Table 1.

Lengths of grain were observed to be between 3.13 and 7.90 *mm*. The shortest grain was obtained as 3.13 *mm* in W3, which was collected in the wet waste land near river in Lokong Terusan. The longest grain was obtained as 7.90 *mm* in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih, which was same as unhusked grain. Mode was found within 3.15 to 3.20 *mm*. Average value was found to be 3.99 *mm*. The obtained standard deviations of each strain, *i.e.*, showing intra-strain's variation, were relatively small, *i.e.*, as 0.14±0.08.

The whole strains of *O. officinalis* belonged to the groups within 3.10 to 3.45 *mm*. One strain of them belonged to the group within 3.10 to 3.15 *mm*, 4 strains within 3.15 to 3.20 *mm*, 1 strain within 3.25 to 3.30 *mm*, 1 strain within 3.30 to 3.35 *mm*, 1 strain within 3.35 to 3.40 *mm* and 2 strains within 3.40 to 3.45 *mm*, respectively. The whole strains of *O. ridleyi* belonged to the groups within 7.30 to 7.90 *mm*. The strains of *O. ridleyi* were remarkably longer than those of *O. officinalis* in view of grain-length. The whole strains of the *O. officinalis* may be divided into two groups by the border in 3.20 to 3.25 *mm*, *i.e.*, the shorter and the longer groups. Five strains belonged to the former and other 5 strains to the latter groups, respectively.

Widths of grain were observed to be between 1.30 and 1.93 *mm*. The narrowest grain was obtained as 1.30 *mm* in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. The widest grain was obtained as 1.93 *mm* in W9, which was collected in the road-side open tank in Sungai Duri. Mode was found within 1.85 to 1.90 *mm*. Average value was found to be 1.74 *mm*. The obtained standard deviations of each strain, *i.e.*, showing intra-strain's variation, were relatively small, *i.e.*, as 0.15±0.19.

The whole strains of *O. officinalis* belonged to the groups within 1.65 to 1.95 *mm*. One strain of them belonged to the group within 1.65 to 1.70 *mm*, 1 strain within

1.70 to 1.75 *mm*, 1 strain within 1.75 to 1.80 *mm*, 1 strain within 1.80 to 1.85 *mm*, 5 strains within 1.85 to 1.90 *mm* and 1 strain within 1.90 to 1.95 *mm*, respectively. The whole strains of *O. ridleyi* belonged to the groups within 1.30 to 1.35 *mm*. The strains of *O. ridleyi* were remarkably narrower than those of *O. officinalis* in view of grain-width. The grains collected in North Sumatera were relatively small and the grains collected in West Kalimantan were relatively large.

Thicknesses of grain were observed to be between 0.92 and 1.20 *mm*, having narrow range. The thinnest grain was obtained as 0.92 *mm* in W1, which was collected in the road-side ditch in Payah Nibung. The thickest grain was obtained as 1.20 *mm* in W11, which was collected in the road-side swampy and gloomy forest near Sekaju. Mode was found within 1.00 to 1.05 *mm*. Average value was found to be 1.04 *mm*. The obtained standard deviations of each strain, *i.e.*, showing intra-strain's variation, were relatively small and remarkably smaller than that of grain-length and grain-width, *i.e.*, as 0.06 ± 0.04.

The whole strains of *O. officinalis* belonged to the groups within 0.90 to 1.15 *mm*. Two strains of them belonged to the group within 0.90 to 0.95 *mm*, 1 strain within 0.95 to 1.00 *mm*, 5 strains within 1.00 to 1.05 *mm*, 1 strain within 1.05 to 1.10 *mm* and 1 strain within 1.10 to 1.15 *mm*, respectively. The whole strains of *O. ridleyi* belonged to the groups within 1.15 to 1.25 *mm*. The strains of *O. ridleyi* were remarkably thicker than those of *O. officinalis* in view of grain-thickness. They showed normal distribution curve. The grains collected in North Sumatera were relatively small.

In comparison with three components, *i.e.*, length, width and thickness of husked grain, the following tendency was noted to be clear. In comparison with the strains of *O. officinalis*, the strains of *O. ridleyi* were remarkably large in view of grain-length and grain-thickness, but were remarkably small in view of grain-width. In the strains of *O. officinalis*, W1 and W2 collected in North Sumatera, belonged to the relatively smaller group in view of grain-width and grain-thickness. W8, W9 and W10 collected in West Kalimantan, belonged to the relatively larger group in view of grain-width, but belonged to the relatively smaller group in view of grain-thickness.

To make clear the relationships between three components of *O. officinalis*, *i.e.*, length and width, length and thickness, and width and thickness of husked grain, correlation coefficient and linear regression between them were calculated.

Correlation coefficient between length and width of husked grain was 0.2500 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of grain-length on grain-width was calculated as follows; $Y = 0.184X + 1.223$, where Y and X indicate length of grain (1 unit = 0.1 *mm*) and width of grain (1 unit = 0.1 *mm*), respectively. This formula indicates that the length of grain becomes 0.184 *mm* larger, by becoming 1.000 *mm* wider in the width of grain.

Correlation coefficient between length and thickness of husked grain was 0.2813 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of grain-length on grain-thickness was calculated as follows; $Y = 0.151X + 0.5111$, where Y and X indicate length of grain (1 unit = 0.1 *mm*) and thickness of grain (1 unit = 0.1 *mm*), respectively. This formula indicates that the length of grain becomes 0.151 *mm*

larger, by becoming 1.000 *mm* thicker in the thickness of grain.

Correlation coefficient between width and thickness of husked grain was 0.5961 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of grain-width on grain-thickness was calculated as follows; $Y = 0.434X + 0.214$, where Y and X indicate width of grain (1 unit = 0.1 *mm*) and thickness of grain (1 unit = 0.1 *mm*), respectively. This formula indicates that the width of grain becomes 0.434 *mm* larger, by becoming 1.000 *mm* thicker in the thickness of grain.

Ratios of grain-length to grain-width were observed to be between 1.67 to 6.08, having large range, as shown in Table 3. The smallest value was found as 1.67 in W3, which was collected in the wet waste land near river in Lokong Terusan. The largest value was found to be 6.08 in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found within 1.70 to 1.80. Average value was found to be 2.47.

The whole strains of *O. officinalis* belonged to the groups within 1.65 to 1.95. One strain of them belonged to the group within 1.65 to 1.70, 2 strains within 1.70 to 1.75, 2 strains within 1.75 to 1.80, 1 strain within 1.85 to 1.90 and 2 strains within 1.90 to 1.95, respectively. The whole strains of *O. ridleyi* belonged to the groups within 5.60 to 6.10. The strains of *O. ridleyi* were remarkably larger than those of *O. officinalis* in view of ratio of grain-length to grain-width. The whole strains of *O. officinalis* may be divided into two groups by the border found in 1.85, *i.e.*, the shorter and the longer groups. Seven strains belonged to the former and other 3 strains to the latter groups, respectively. The grains collected in North Sumatera were relatively large and the grains collected in West Kalimantan were relatively small.

Ratios of grain-length to grain-thickness were observed to be between 3.09 and 6.65, having large range. The smallest values were found to be 3.09 in W3 and W4, which were collected in wet waste land in Lokong Terusan and the road-side open tank in Kertapati. The largest value was found to be 6.65 in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found within 3.20 to 3.30. Average value was found as 3.80.

The whole strains of *O. officinalis* belonged to the groups within 3.05 to 3.55. Two strains belonged to the group within 3.05 to 3.10, 1 strain within 3.10 to 3.15, 2 strains within 3.20 to 3.25, 1 strain within 3.25 to 3.30, 1 strain within 3.35 to 3.40, 1 strain within 3.40 to 3.45, 1 strain within 3.45 to 3.50 and 1 strain within 3.50 to 3.55, respectively. The whole strains of *O. ridleyi* belonged to the groups within 6.10 to 6.70. The strains of *O. ridleyi* were remarkably larger than those of *O. officinalis* in view of ratio of grain-length to grain-thickness. The whole strains of *O. officinalis* may be divided into three groups by the borders found to be 3.15 and 3.30, *i.e.*, the smaller, the middle and the larger groups. Three strains belonged to the former, 3 strains to the middle and 4 strains to the latter groups, respectively. The grains collected in North Sumatera were relatively large.

Ratios of grain-width to grain-thickness were observed to be between 1.09 and 1.93. The smallest value was found to be 1.09 in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. The largest value was found to be 1.93 in W9, which was collected in the road-side open tank near Sungai Duri.

Mode was found within 1.85 to 1.95. Average value was found to be 1.71.

The whole strains of *O. officinalis* belonged to the groups within 1.70 to 1.95, having narrow range. One strain of them belonged to the group within 1.70 to 1.75, 3 strains within 1.75 to 1.80, 1 strain within 1.80 to 1.85, 3 strains within 1.85 to 1.90 and 2 strains within 1.90 to 1.95, respectively. The whole strains of *O. ridleyi* belonged to the groups within 1.05 to 1.15. The strains of *O. ridleyi* were remarkably smaller than those of *O. officinalis* in view of ratio of grain-width to grain-thickness. The strains of *O. officinalis* may be divided into two groups by the border found in 1.80, *i.e.*, the smaller and the larger groups. Four strains belonged to the former and other 6 strains to the latter groups, respectively. The grains collected in West Kalimantan and North Sumatera were relatively large in view of ratio of grain-width to grain-thickness.

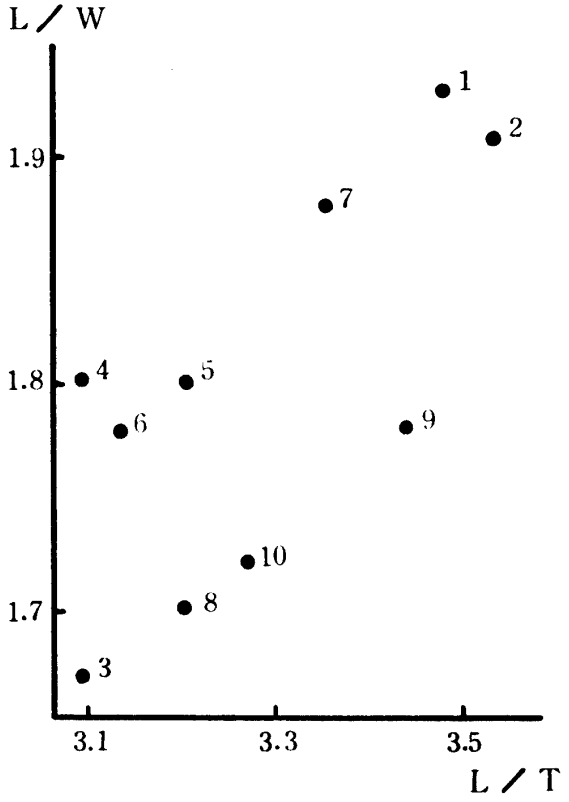
In comparison with three components, *i.e.*, ratios of grain-length to grain-width, of grain-length to grain-thickness and of grain-width to grain-thickness of husked grain, the following tendency was noted to be clear. As compared with the strains of *O. officinalis*, the strains of *O. ridleyi* were remarkably large in view of ratios of grain-length to grain-width and of grain-length to grain-thickness, but were remarkably small in view of ratio of grain-width to grain-thickness. In the whole strains of *O. officinalis*, W1 and W2 collected in North Sumatera belonged to the relatively larger groups in view of whole components. W8, W9 and W10 collected in West Kalimantan belonged to the relatively smaller groups in view of ratio of grain-length to grain-width, but belonged to the relatively larger groups in view of ratio of grain-width to grain-thickness.

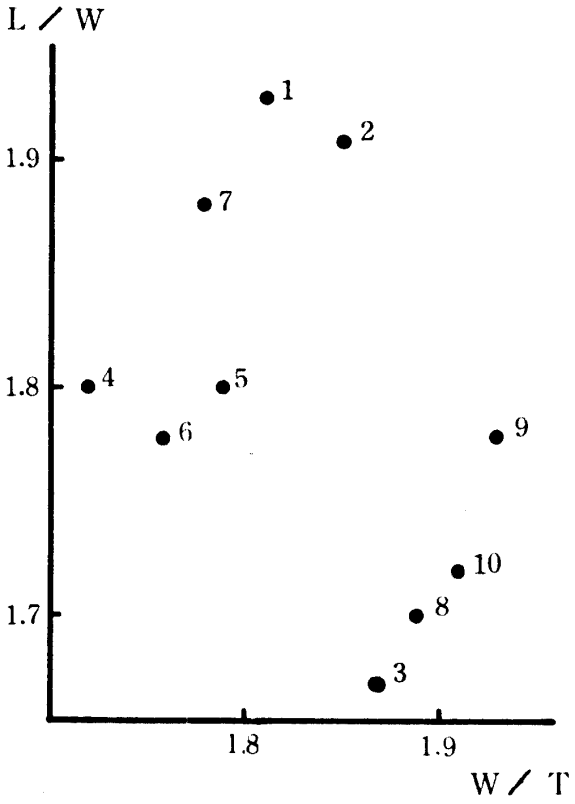
To make clear the relationships between three components of *O. officinalis*, *i.e.*, ratios of length to width, of length to thickness and of width to thickness of husked grain, the relations of them were shown in Fig. 4.

In Fig. 4, relations between ratios of grain-length to grain-width and of grain-length to grain-thickness, ratios of grain-length to grain-width and of grain-width to grain-thickness, and ratios of grain-length to grain-thickness and of grain-width to grain-thickness were shown. In this figure, code-numbers used are corresponding to the strain-number used in Table 3. Correlation coefficient and linear regression between them were also calculated.

Correlation coefficient between ratios of grain-length to grain-width and of grain-length to grain-thickness was 0.7174 and showed very high correlation among them at 1% level. It means that the larger was the former ratio, the larger was the latter ratio. Linear regression of the former ratio on the latter ratio was calculated as follows; $Y = 1.331X + 0.886$, where Y and X indicate the former ratio (1 unit = 0.1) and the latter ratio (1 unit = 0.1), respectively. This formula indicates that the ratio of grain-length to grain-width becomes 1.331 larger, by becoming 1.000 larger in the ratio of grain-length to grain-thickness.

Correlation coefficient between ratios of grain-length to grain-width and of grain-width to grain-thickness was -0.4139 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the former ratio on the latter ratio was calculated as follows; $Y = -0.326X + 2.416$, where Y and X indicate the former





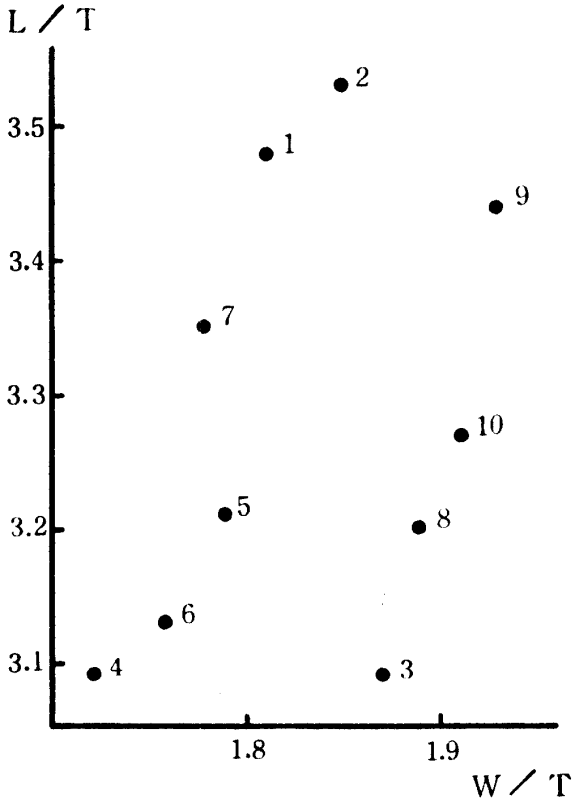


Fig. 4. Relations between ratio of length to width and ratio of length to thickness, ratio of length to width and ratio of width to thickness, and ratio of length to thickness and ratio of width to thickness. Vertical axis: ratio of grain length to grain width, ratio of grain length to grain width and ratio of grain length to grain thickness; abscissa: ratio of grain length to grain thickness, ratio of grain width to grain thickness and grain width to grain thickness. Code numbers used in the figure are corresponding to the strain number used in Table 3.

ratio (1 unit = 0.1) and the latter ratio (1 unit = 0.1), respectively. This formula indicates that the ratio of grain-length to grain-width becomes 0.326 smaller, by becoming 1.000 larger in the ratio of grain-width to grain-thickness.

Correlation coefficient between ratios of grain-length to grain-thickness and of grain-width to grain-thickness was −0.3402 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the former ratio on the latter ratio was calculated as follows; $Y = -0.144X + 2.360$, where Y and X indicate the former ratio (1 unit = 0.1) and the latter ratio (1 unit = 0.1), respectively. This formula indicates that the ratio of grain-length to grain-thickness becomes 0.144 smaller, by becoming 1.000 larger in the ratio of grain-width to grain-thickness.

Comparisons of morphological characters obtained in unhusked and husked grains of the wild species

Correlations between practical values of unhusked and husked grains of wild species and linear regressions between them were calculated in the whole characters measured for the purpose of comparing them. The relations between length, width and thickness of unhusked and husked grains of *O. officinalis* were calculated and shown in Fig. 5.

Correlation coefficient between length of unhusked and husked grains of *O. officinalis* was 0.9050 and showed very high correlation among them at 0.1% level. It means that the larger was the length of unhusked grains, the longer was the length of husked grains. Linear regression of length of unhusked grains on length of husked grains was calculated as follows; $Y = 0.624X + 0.482$, where Y and X indicate length of unhusked grains (1 unit = 0.1 *mm*) and length of husked grains (1 unit = 0.1 *mm*), respectively. This formula indicates that the former becomes 0.624 *mm* larger, by becoming 1.000 *mm* longer in the latter.

Correlation coefficient between width of unhusked and husked grains of *O. officinalis* was 0.9693 and showed very high correlation among them at 0.1% level. It means that the wider was the width of unhusked grains, the wider was the width of husked grains. Linear regression of width of unhusked grains on width of husked grains was calculated as follows; $Y = 0.791X + 0.018$, where Y and X indicate width of unhusked grains (1 unit = 0.1 *mm*) and width of husked grains (1 unit = 0.1 *mm*), respectively. This formula indicates that the former becomes 0.791 *mm* wider, by becoming 1.000 *mm* wider in the latter.

Correlation coefficient between thickness of unhusked and husked grains was 0.8333 and showed very high correlation among them at 0.1% level. It means that the thicker was the thickness of unhusked grains, the thicker was the thickness of husked grains. Linear regression of thickness of unhusked grains on thickness of husked grains was calculated as follows; $Y = 0.932X - 0.146$, where Y and X indicate thickness of unhusked grains (1 unit = 0.1 *mm*) and thickness of husked grains (1 unit = 0.1 *mm*), respectively. This formula indicates that the former becomes 0.932 *mm* larger, by becoming 1.000 *mm* thicker in the latter.

In the whole characters used, the comparative values on morphological characters of unhusked and husked grains of wild species were illustrated by the ratios of value

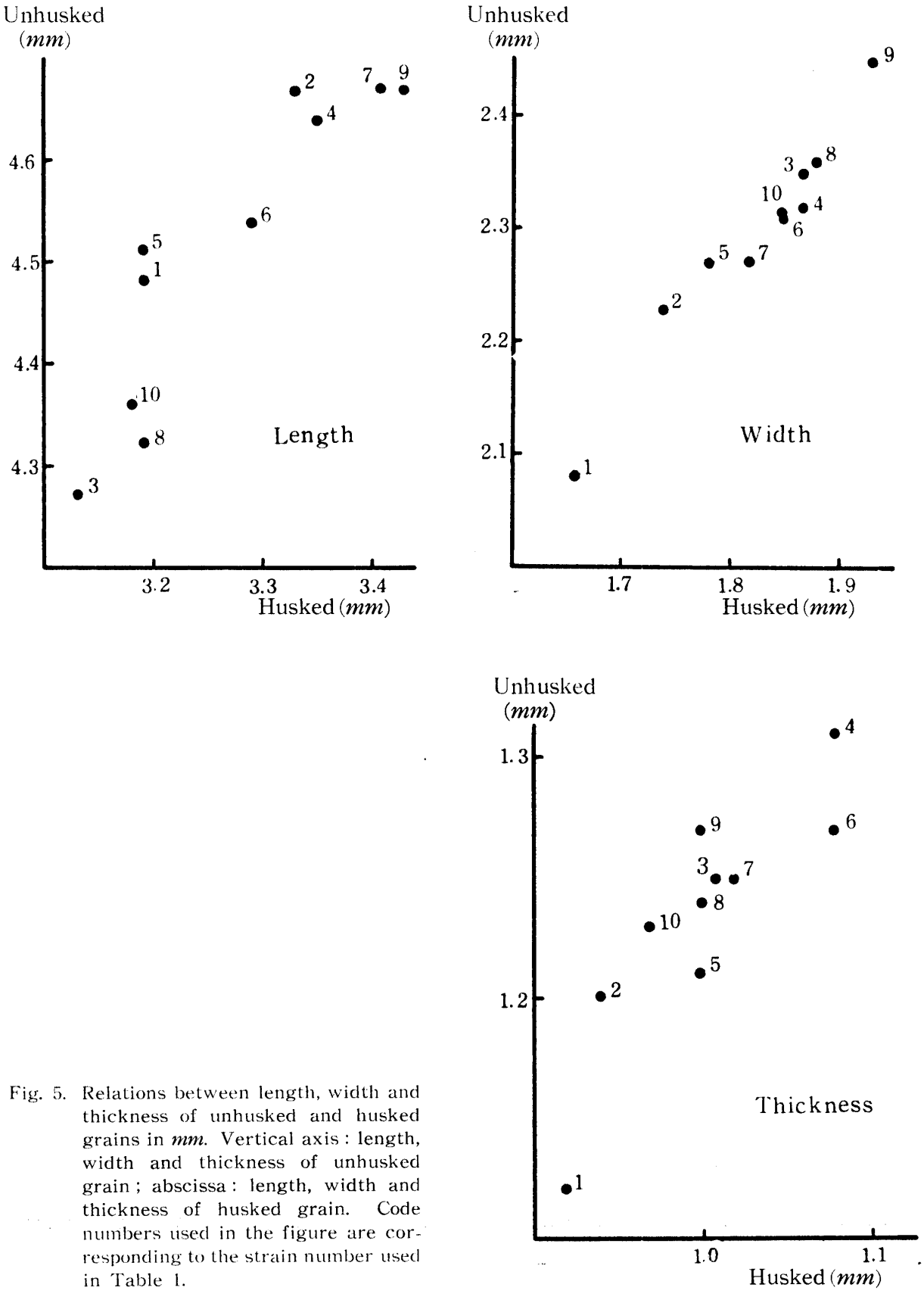


Fig. 5. Relations between length, width and thickness of unhusked and husked grains in *mm*. Vertical axis : length, width and thickness of unhusked grain ; abscissa : length, width and thickness of husked grain. Code numbers used in the figure are corresponding to the strain number used in Table 1.

Table 4. Comparative table on some morphological characters of unhusked and husked grains of the wild species collected; illustrating by the ratios of value in husked to value in unhusked grains in the respective character.

Strain No.	Length	Width	Thickness	L/W	L/T	W/T
W 1	0.71	0.80	0.82	0.89	0.87	0.97
W 2	0.71	0.78	0.78	0.91	0.91	0.99
W 3	0.73	0.80	0.81	0.92	0.90	0.99
W 4	0.72	0.81	0.82	0.90	0.87	0.97
W 5	0.71	0.78	0.83	0.90	0.86	0.95
W 6	0.72	0.80	0.87	0.89	0.87	0.96
W 7	0.73	0.80	0.82	0.92	0.90	0.97
W 8	0.74	0.80	0.81	0.93	0.92	0.99
W 9	0.73	0.79	0.79	0.93	0.94	1.01
W10	0.73	0.80	0.79	0.91	0.92	1.01
W11	0.63	0.58	0.87	1.08	0.73	0.68
W12	0.66	0.52	0.85	1.21	0.77	0.61

obtained in husked grains to the value obtained in unhusked grains in the respective character.

In Table 4, the comparative values on the whole characters were shown. In this table, length, width and thickness, ratios of length to width, of length to thickness and of width to thickness calculated were shown. The calculations were done, using the average values of respective character. Geographical positions, in which the wild rices were collected, are shown in Fig. 1.

Ratios of grain-length of husked to unhusked grains were observed to be between 0.63 and 0.74. The smallest value was obtained as 0.63 in W11, which was collected in the road-side swampy and gloomy forest near Sekaju. The largest value was obtained as 0.74 in W8, which was collected in the road-side ditch in Sungai Tanjung. Mode was found within 0.73 to 0.74. Average value was found to be 0.71. Standard deviation in the whole strains was shown as 0.03.

The whole strains of *O. officinalis* belonged to the groups within 0.71 to 0.75. Three strains of them belonged to the group within 0.71 to 0.72, 2 strains within 0.72 to 0.73, 4 strains within 0.73 to 0.74 and 1 strain within 0.74 to 0.75, respectively. The whole strains of *O. ridleyi* belonged to the groups within 0.60 to 0.70. The strains of *O. ridleyi* were remarkably smaller than those of *O. officinalis* in view of ratio of grain-length of husked to unhusked grains. No clear relation between geographical positions and these values was explained.

Ratios of grain-width of husked to unhusked grains were observed to be between 0.52 and 0.81. The smallest value was obtained as 0.52 in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. The largest value was obtained as 0.81 in W4, which was collected in the road-side open tank in Kertapati. Mode was found within 0.80 to 0.81. Average value was found to be 0.76. Standard deviation of the whole strains was shown as 0.76.

The whole strains of *O. officinalis* belonged to the groups within 0.78 to 0.82, having very narrow range. Two strains of them belonged to the group within 0.78 to 0.79, 1 strain within 0.79 to 0.80, 6 strains within 0.80 to 0.81 and 1 strain within 0.81 to 0.82, respectively. The whole strains of *O. ridleyi* belonged to the groups within 0.50 to 0.58. The strains of *O. ridleyi* were remarkably smaller than those of *O. officinalis* in view of ratio of grain width of husked to unhusked grains. No clear relation between geographical positions and these values was explained.

Ratios of grain-thickness of husked to unhusked grains were observed to be between 0.78 and 0.87. The smallest value was obtained as 0.78 in W2, which was collected in the road-side ditch in Payah Nibung. The largest values were obtained as 0.87 in W6 and W11, which were collected in the river side near Betung and the road-side swampy and gloomy forest near Sekaju. Mode was found within 0.82 to 0.83. Average value was found to be 0.82. Standard deviation of whole strains was shown as 0.03.

In the strains of *O. officinalis*, nine strains, excepting for W6, belonged to the groups within 0.78 to 0.84. One strain of them belonged to the group within 0.78 to 0.79, 2 strains within 0.79 to 0.80, 2 strains within 0.81 to 0.82, 3 strains within 0.82 to 0.83 and 1 strain within 0.83 to 0.84, respectively. W6 belonged to the group within 0.87 to 0.88 and remarkably larger than the other strains. The whole strains of *O. ridleyi* belonged to the groups within 0.85 to 0.88. The strains of *O. ridleyi* were relatively larger than that of 9 strains of *O. officinalis*, excepting for W6. The whole strains of *O. officinalis* may be divided into three groups by the gaps found in 0.79 and 0.83 to 0.86 in view of ratios of grain-thickness of husked to unhusked grains, *i.e.*, the larger, the middle and the smaller groups. One strain belonged to the former, 6 strains to the middle and 3 strains to the latter groups, respectively. The grains collected in West Kalimantan were relatively small in view of ratios of grain-thickness of husked to unhusked grains.

In comparison with three components, *i.e.*, the comparative values of unhusked and husked grains of the wild species in view of length, width and thickness of grain, the following tendency was noted to be clear. As compared with *O. officinalis*, the whole strains of *O. ridleyi* were remarkably small in view of ratios of grain-length and grain-width of husked to unhusked grains, but were relatively large in view of grain-thickness of husked to unhusked grains. The whole strains of *O. officinalis* could not be recognized to have clear tendency in three components.

Correlation coefficients and linear regressions between length and width, length and thickness, and width and thickness of the comparative values found in husked and unhusked grains of *O. officinalis* were also calculated.

Correlation coefficient between length and width of the comparative values found in husked and unhusked grains was 0.3750 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of values of length on width was calculated as follows; $Y = 0.300X + 0.578$, where Y and X indicate values of length (1 unit = 0.1) and values of width (1 unit = 0.1), respectively. This formula indicates that the former becomes 0.300 larger, by becoming 1.000 larger in the latter.

Correlation coefficient between length and thickness of the comparative values

found in husked and unhusked grains was −0.2000 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of values of length on thickness was calculated as follows; $Y = -0.500X + 1.176$, where Y and X indicate values of length (1 unit = 0.1) and values of thickness (1 unit = 0.1), respectively. This formula indicates that the former becomes 0.500 smaller, by becoming 1.000 larger in the latter.

Correlation coefficient between width and thickness of the comparative values found in husked and unhusked grains was 0.4500 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of values of width on thickness was calculated as follows; $Y = 1.500X + 0.379$, where Y and X indicate values of width (1 unit = 0.1) and values of thickness (1 unit = 0.1), respectively. This formula indicates that the former becomes 1.500 larger, by becoming 1.000 larger in the latter.

The comparative ratios of length to width obtained in unhusked and husked grains of wild species were observed to be between 0.89 and 1.24. The smallest value was found to be 0.89 in W 1, which was collected in the road-side ditch in Payah Nibung. The largest value was found to be 1.24 in W 12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found within 0.90 to 0.91. Average value was found to be 0.95. Standard deviation of whole strains, *i.e.*, showing inter-strain's variation, was shown as 0.05.

The whole strains of *O. officinalis* belonged to the groups within 0.89 to 0.94. Two strains of them belonged to the group within 0.89 to 0.90, 2 strains within 0.90 to 0.91, 2 strains within 0.91 to 0.92, 2 strains within 0.92 to 0.93 and 2 strains within 0.93 to 0.94, respectively. The whole strains of *O. ridleyi* belonged to the groups within 1.00 to 1.30, and were remarkably larger than those of *O. officinalis* in view of comparative ratios of length to width obtained in husked and unhusked grains. The grains collected in North Sumatera and South Sumatera showed relatively large values in this respect.

The comparative ratios of length to thickness obtained in unhusked and husked grains of wild species were observed to be between 0.73 and 0.94. The smallest value was found as 0.73 in W 11, which was collected in the road-side swampy and gloomy forest near Sekaju. The largest value was found to be 0.94 in W 9, which was collected in the road-side open tank in Sungai Duri. Mode was found within 0.87 to 0.88. Avarage value was found to be 0.87. Standard deviation of whole strains used, *i.e.*, showing inter-strain's variation, was shown as 0.06.

The whole strains of *O. officinalis* belonged to the groups within 0.86 to 0.95. One strain of them belonged to the group within 0.86 to 0.87, 3 strains within 0.87 to 0.88, 2 strains within 0.90 to 0.91, 1 strain within 0.91 to 0.92, 2 strains within 0.92 to 0.93 and 1 strain within 0.94 to 0.95, respectively. The whole strains of *O. ridleyi* belonged to the groups within 0.73 to 0.78. The grains of *O. ridleyi* were remarkably smaller than those of *O. officinalis* in view of comparative ratios of length to thickness obtained in husked and unhusked grains. The strains of *O. officinalis* may be divided into three groups by the gaps found in 0.88 and 0.92 from this respect, *i.e.*, the smaller, the middle and the larger groups. Four strains belonged to the former, 5

strains to the middle and 1 strain to the latter groups, respectively. The grains collected in West Kalimantan showed relatively large values and collected in South Sumatera, excepting for W 3, showed relatively small values in this respect.

The comparative ratios of width to thickness obtained in husked and unhusked grains of wild species were observed to be between 0.61 and 1.01. The smallest value was found to be 0.61 in W 12, which was collected in the road-side swampy and gloomy forest near Prabumulih. The largest values were found as 1.01 in W 9 and W 10, which were collected in the road-side open tank and ditch in Sungai Duri. Mode was found within 0.96 to 0.98. Average value was found to be 0.93. Standard deviation of whole strains, *i.e.*, showing inter-strain's variation, was found as 0.13.

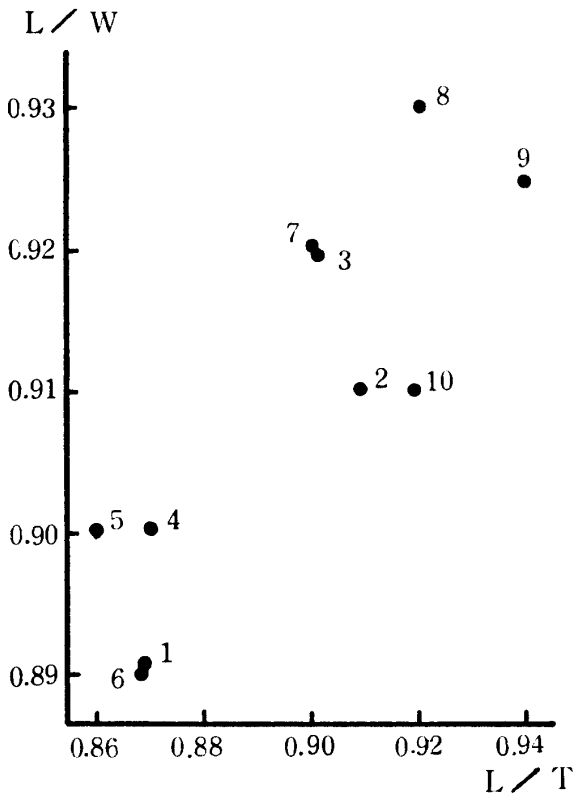
The whole strains of *O. officinalis* belonged to the groups within 0.95 to 1.02. One strain of them belonged to the group within 0.95 to 0.96, 1 strain within 0.96 to 0.97, 3 strains within 0.97 to 0.98, 3 strains within 0.99 to 1.00, and 2 strains within 1.01 to 1.02, respectively. The whole strains of *O. ridleyi* belonged to the groups within 0.60 to 0.68 and were remarkably smaller than those of *O. officinalis* in view of comparative ratios of width to thickness obtained in husked and unhusked grains. The grains collected in West Kalimantan showed relatively large values and collected in South Sumatera showed relatively small values in this respect.

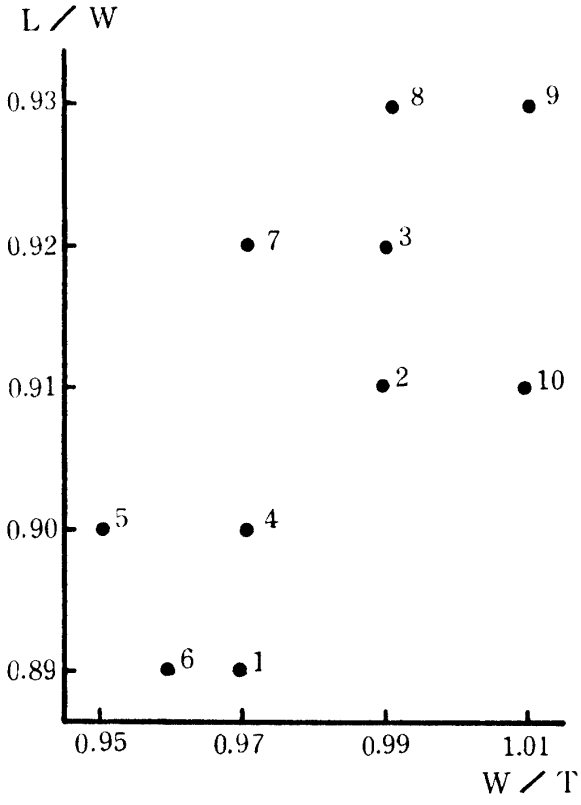
In comparison with three components, *i.e.*, ratios of comparative values of length to width, of length to thickness and of width to thickness obtained in husked and unhusked grains, the following tendency was noted to be clear. As compared with the whole strains of *O. officinalis*, the whole strains of *O. ridleyi* were remarkably large in view of comparative ratios of length to width obtained in husked and unhusked grains, but were remarkably small in view of comparative ratios of length to thickness and width to thickness obtained in husked and unhusked grains. In the whole strains of *O. officinalis*, the grains collected in West Kalimantan belonged to the relatively larger groups and the grains collected in South Sumatera, excepting for W 3, were relatively smaller groups in view of the whole components.

To make clear the relationships between three components, *i.e.*, ratios of the comparative values of length to width, of length to thickness and of width to thickness obtained in husked and unhusked grains of *O. officinalis*, the relations of them were calculated and shown in Fig. 6.

In Fig. 6, relations between ratios of comparative values of length to width and of length to thickness, ratios of comparative values of length to width and of width to thickness, and ratios of comparative values of length to thickness and of width to thickness obtained in husked and unhusked grains were shown. In this figure, code numbers used are corresponding to the strain number which was used in Table 1. Correlation coefficient and linear regression between them were also calculated.

Correlation coefficient between ratio of comparative values of length to width and ratio of comparative values of length to thickness calculated in husked and unhusked grains was 0.8235 and showed very high correlation among them at 0.1% level. It means that the larger was the former ratio, the larger was the latter ratio. Linear regression of the former ratio on the latter ratio was calculated as follows; $Y = 1.400X + 0.398$, where Y and X indicate the former ratio (1 unit = 0.01) and the latter ratio (1 unit = 0.01), respectively. This formula indicates that the ratio of the comparative values of length to width becomes 1.400 larger, by becoming 1.000 larger in the ratio





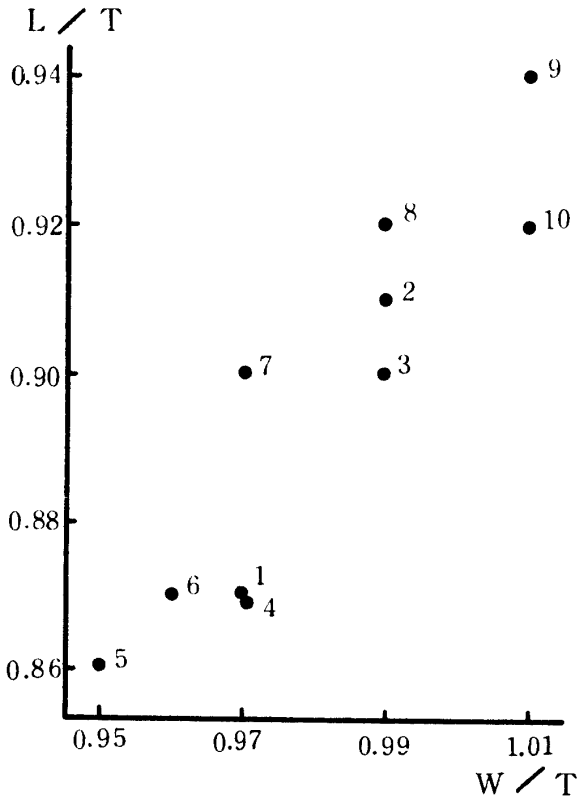


Fig. 6. Relations between ratio of length to width and ratio of length to thickness, ratio of length to width and ratio of width to thickness, and ratio of length to thickness and ratio of width to thickness of comparative values found in husked to unhusked grains. Vertical axis: ratio of length to width, ratio of length to width and ratio of length to thickness; abscissa: ratio of length to thickness, ratio of width to thickness and ratio of width to thickness. Code numbers used in the figure are corresponding to the strain number used in Table 1.

of the comparative values of length to thickness.

Correlation coefficient between ratio of the comparative values of length to width and ratio of the comparative values of width to thickness obtained in husked and unhusked grains was 0.5769 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the ratio of length to width on the ratio of width to thickness was calculated as follows; $Y = 0.750X + 0.300$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the ratio of the comparative values of length to width becomes 0.750 larger, by becoming 1.000 larger in the ratio of the comparative values of width to thickness.

Correlation coefficient between ratio of the comparative values of length to thickness and ratio of the comparative values of width to thickness obtained in husked and unhusked grains was 0.9111 and showed very high correlation among them at 0.1% level. It means that the larger was the former ratio, the larger was the latter ratio. Linear regression of the ratio of length to thickness on the ratio of width to thickness was calculated as follows; $Y = 0.695X + 0.360$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the ratio of the comparative values of length to thickness becomes 0.695 larger, by becoming 1.000 larger in the ratio of the comparative values of width to thickness.

Ecotypic differentiation of the wild rice in Indonesia

In this chapter, ecotypic differentiation of the wild species will be discussed in the order of the following sub-chapters; 1) intra-strain's variation, 2) grainfullness.

1) In this sub-chapter, intra-strain's variations were considered in the order of the followings; i) practical values of unhusked grains, ii) relations between them, iii) practical values of husked grains, iv) relations between them, v) relations between unhusked and husked grains.

i) In Table 2, the practical values of intra-strain's variation obtained in length of unhusked grains were shown. The intra-strain's variations of length of unhusked grains were observed to be between 0.10 and 0.60. The smallest variation was found as 0.10 in W2, which was collected in the road-side ditch in Payah Nibung. The largest variation was found to be 0.60 in W12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Average variation was found to be 0.22.

The whole strains of *O. officinalis* were observed to be between 0.10 and 0.20. One strain of them showed the variation as 0.10, 2 strains as 0.11, 1 strain as 0.13, 2 strains as 0.14, 1 strain as 0.17, 1 strain as 0.18 and 2 strains as 0.20, respectively. The whole strains of *O. ridleyi* showed the variations as 0.52 and 0.60 and were remarkably larger than that of *O. officinalis*. Relation between geographical positions and these values was not clearly explained.

In Table 2, the practical values of intra-strain's variation obtained in width of unhusked grains were observed between 0.07 and 0.21. The smallest variation was found as 0.07 in W3, which was collected in the wet waste land near river in Lokong

Terusan. The largest variation was found to be 0.21 in W 12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found to be 0.09. Average variation was found to be 0.11.

The whole strains of *O. officinalis* were observed between 0.07 and 0.15. One strain of them showed the variation as 0.07, 2 strains as 0.08, 3 strains as 0.09, 1 strain as 0.10, 2 strains as 0.11 and 1 strain as 0.15, respectively. The whole strains of *O. ridleyi* showed the variations as 0.18 and 0.21, and were remarkably larger than that of *O. officinalis*. The grains collected in West Kalimantan showed relatively small values in view of intra-strain's variation of width found in unhusked grains. Further relation between geographical positions and these values was not clearly explained.

In Table 2, the practical values of intra-strain's variation of thickness of unhusked grains were shown. The intra-strain's variations of thickness of unhusked grains were observed to be between 0.01 and 0.14. The smallest variation was found as 0.01 in W 4, which was collected in the road-side open tank in Kertapati. The largest variation was found to be 0.14 in W 3, which was collected in wet waste land near river in Lokong Terusan. Mode was found to be 0.04. Average variation was found as 0.05.

The whole strains of *O. officinalis* were observed between 0.01 and 0.14. One strain of them showed the variation as 0.01, 1 strain as 0.02, 2 strains as 0.03, 3 strains as 0.04, 1 strain as 0.05, 1 strain as 0.08 and 1 strain as 0.14, respectively. The whole strains of *O. ridleyi* showed the variations as 0.07 and 0.09, and could not be recognized clear difference as compared with that of *O. officinalis*. The grains collected in West Kalimantan showed relatively small values in intra-strain's variation of thickness found in unhusked grains. Further relation between geographical positions and these values was not clearly explained.

ii) In comparison with three components, *i.e.*, intra-strain's variations found in length, width and thickness of unhusked grains of *O. officinalis*, the following facts were noted to be clear.

Correlation coefficient and linear regression between them were calculated.

Correlation coefficient between intra-strain's variations of length and width found in unhusked grains was 0.2805 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the variation of length on the variation of width was calculated as follows; $Y = 0.189X + 0.069$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of length becomes 0.189 larger, by becoming 1.000 larger in that of width.

Correlation coefficient between intra-strain's variations of length and thickness found in unhusked grains was -0.3692 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the variation of length on the variation of thickness was calculated as follows; $Y = -0.393 + 0.107$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of length becomes 0.393 smaller, by becoming 1.000 larger in that of thickness.

Correlation coefficient between intra-strain's variations of width and thickness found

in unhusked grains was 0.2299 and showed no significant correlation among them even at 5% level. Such no significant correlation could be recognized in the following linear regression. Linear regression of the variation of width on the variation of thickness was calculated as follows; $Y = 0.364X + 0.013$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of width becomes 0.364 larger, by becoming 1.000 larger in the variation of thickness.

iii) In Table 3, the practical values of intra-strain's variations obtained in length, width and thickness of husked grains were shown.

The intra-strain's variations of length of husked grains were observed between 0.06 and 0.32. The smallest variation was found as 0.06 in W 8, which was collected in the road-side ditch in Sungai Tanjung. The largest variation was found to be 0.32 in W 12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found to be 0.09. Average variation was found to be 0.14.

The whole strains of *O. officinalis* were observed to be between 0.06 and 0.16. One strain of them showed the variation as 0.06, 1 strain as 0.08, 3 strains as 0.09, 1 strain as 0.10, 2 strains as 0.12, 1 strain as 0.15 and 1 strain as 0.16, respectively. The whole strains of *O. ridleyi* showed the variations as 0.29 and 0.32, and were remarkably larger than that of *O. officinalis*. Relation between geographical positions and these values was not clearly explained.

The intra-strain's variations of width of husked grains were observed to be between 0.04 and 0.62. The smallest variation was found to be 0.04 in W 7, which was collected in the road-side ditch near Betung. The largest variation was found to be 0.62 in W 11, which was collected in the road-side swampy and gloomy forest near Sekaju. Average variation was found to be 0.15.

The whole strains of *O. officinalis* were observed between 0.04 and 0.10. One strain of them showed the variation as 0.04, 2 strains as 0.05, 2 strains as 0.06, 2 strains as 0.07, 2 strains as 0.09 and 1 strain as 0.10, respectively. The whole strains of *O. ridleyi* showed the variations as 0.51 and 0.62, and were remarkably larger than that of *O. officinalis*. Relation between geographical positions and these values was not clearly explained.

The intra-strain's variations of thickness of husked grains were showed to be between 0.03 and 0.15. The smallest variation was found as 0.03 in W 8, which was collected in the road-side ditch in Sungai Tanjung. The largest variation was found as 0.15 in W 12, which was collected in the road-side swampy and gloomy forest near Prabumulih. Mode was found to be 0.03. Average variation found to be 0.06.

The whole strains of *O. officinalis* were observed to be between 0.03 and 0.14. Four strains of them showed the variation as 0.03, 1 strain as 0.04, 2 strains as 0.05, 1 strain as 0.06, 1 strain as 0.07 and 1 strain as 0.14, respectively. The whole strains of *O. ridleyi* showed the variations as 0.05 and 0.15. The grains collected in North Sumatera showed relatively small values in intra-strain's variation of thickness found in husked grains. Further relation between geographical positions and these values was not clearly explained.

iv) In comparison with three components, *i.e.*, intra-strain's variations found in length, width and thickness of husked grains of the *O. officinalis*, the following facts could be explained.

Correlation coefficient and linear regression between them were calculated. correlation coefficient between intra-strain's variations found in length and width of husked grains was 0.5833 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of variation of length on the variation of width was calculated as follows; $Y = 0.365X + 0.029$, where Y and X indicate the former variation (1 unit = 0.01) and the latter variation (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of length becomes 0.365 larger, by becoming 1.000 larger in that of width. In other words, it was said that the former variation is independent of the latter variation in this case.

Correlation coefficient between intra-strain's variations found in length and thickness of husked grains was −0.1414 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the variation of length on the variation of thickness was calculated as follows; $Y = -0.146X + 0.070$, where Y and X indicate the former variation (1 unit = 0.01) and the latter variation (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of length becomes 0.146 smaller, by becoming 1.000 larger in that of thickness. In other words, it was said that the former variation is independent of the latter variation in this case.

Correlation coefficient between intra-strain's variations found in width and thickness of husked grains was −0.1935 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the variation of width on the variation of thickness was calculated as follows; $Y = -0.324X + 0.077$, where Y and X indicate the former variation (1 unit = 0.01) and the latter variation (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of width becomes 0.324 smaller, by becoming 1.000 larger in that of thickness. In other words, it was said that the former variation is independent of the latter variation in this case.

v) In comparison with three components, *i.e.*, intra-strain's variations found in length, width and thickness of unhusked and husked grains of *O. officinalis*, the following facts could be explained. Correlation coefficient and linear regression among them were calculated.

Correlation coefficient between intra-strain's variations found in length of unhusked and husked grains was 0.7778 and showed very high correlation among them at 1% level. It means that the larger was the intra-strain's variation of length found in unhusked grains, the larger was the intra-strain's variation of length found in husked grains in this case. Linear regression of the variation of unhusked grains on the variation of husked grains was calculated as follows; $Y = 0.751X + 0.091$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of unhusked grains found in length becomes 0.751 larger, by becoming 1.000 larger in that of the husked grains. In comparison with intra-strain's variations found in length of unhusked and husked grains of *O. officinalis*, the following fact was noted to be clear. Intra-strain's variations of unhusked grains of whole strains were larger than that of husked grains.

Correlation coefficient between intra-strain's variations found in width of unhusked and husked grains was −0.0667 and showed no significant correlation among them

even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the variation of unhusked grains on the variation of husked grains was calculated as follows; $Y = -0.036X + 0.065$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of unhusked grains in view of the width becomes 0.036 smaller, by becoming 1.000 larger in that of husked grains. In other words, it was said that the former variation is independent of the latter variation in this case. In comparison with intra-strain's variations found in width of husked and unhusked grains, the following facts were noted to be clear. Intra-strain's variations of unhusked grains of 8 strains were larger than that of husked grains, that of 1 strain was the same, and that of 1 strain was smaller than that of husked grains.

Correlation coefficient between intra-strain's variations found in thickness of husked and unhusked grains was 0.2583 and showed no significant correlation among them even at 5% level. Such no-significant correlation could be recognized in the following linear regression. Linear regression of the variation of unhusked grains on the variation of husked grains was calculated as follows; $Y = 0.143X + 0.048$, where Y and X indicate the former (1 unit = 0.01) and the latter (1 unit = 0.01), respectively. This formula indicates that the intra-strain's variation of unhusked grains in view of thickness becomes 0.143 larger, by becoming 1.000 larger in that of the husked grains. In other words, it was said that the former variation is independent of the latter variation in this case. In comparison with intra-strain's variations found in thickness of husked and unhusked grains of *O. officinalis*, the following facts were noted to be clear. Intra-strain's variations of unhusked grains of 4 strains were larger than that of husked grains, that of 1 strain was the same, and that of 5 strains was smaller than that of husked grains.

In comparison with intra-strain's variations found in three components, *i.e.*, length, width and thickness of husked and unhusked grains, the following tendency was noted to be clear.

Intra-strain's variations found in respective morphological character of husked and unhusked grains of *O. ridleyi* were remarkably larger than that of *O. officinalis*, excepting for intra-strain's variation of thickness of husked grains. In *O. officinalis*, the average variations found in length, width and thickness of husked and unhusked grains were observed as follows; 0.22, 0.11 and 0.05 in unhusked grains and 0.14, 0.15 and 0.06 in husked grains, respectively. The intra-strain's variations of thickness of husked and unhusked grains were clearly smaller than that of length and width. This fact may be distinctly interpreted that grain-thickness showed the highest stability among them. Correlation coefficients between respective intra-strain's variation found in characters of husked and unhusked grains were also calculated and showed no significant correlation, excepting for correlation among length of husked and unhusked grains. It may be concluded that intra-strain's variations of three components, *i.e.*, length, width and thickness of husked and unhusked grains were exhibited independently of the other components. Geographical relationship among intra-strain's variation and its native habitat was not clearly illustrated, so far as data obtained up to now were concerned.

2) Katayama *et al.*[4] reported that the order found in length, width and thickness in view of grainfullness and its variation range are constant, even if the wild and

cultivated rices are concerned. As shown in Table 4, averages and ranges of variation found in the ratios of husked and unhusked grains of *O. officinalis* became larger in the order of length, width and thickness as follows; 0.71, 0.76 and 0.82 in average values and 0.03 (0.71 to 0.74), 0.04 (0.77 to 0.81) and 0.09 (0.78 to 0.87) in variation ranges, respectively. This fact may be interpreted as follows; unhusked grain as receptor is decided before the flowering stage. Subsequently, husked grain as content is formed in the order of length, width and thickness. Consequently, it seems that latter is formed in the process of husked grain development, the wider variation is found in the grainfullness of the respective character of the grain. As mentioned in the former sub-chapter, intra-strain's variations found in the whole characters to construct grainfullness were looked upon as relatively small. Generally speaking, the smaller is the standard deviation, the higher is the stability. Particularly, intra-strain's variation found in thickness of grains showed the highest stability among them.

It seems that the grainfullness is synthetic expression of interaction between environmental factors and physiological responses. Concerning photosynthetic capacity of physiological responses affected on grainfullness, Ojima *et al.*[5] considered that the response could be used as general character of the species. Butany *et al.*[1] and Katayama[2] reported that wide variations in photoperiodic response and its geographical distribution were found in *O. officinalis*.

Basing on facts mentioned above, as Katayama *et al.*[4] pointed out, it is evident that these characters found in grainfullness are usefull not only as the criterion of diagnosis on growth of rice in agronomical viewpoint, but also as a factor on ecotypic differentiation in evolutional view point. Especially, it seems that thickness found in grainfullness is important character in agronomical and evolutional view points. However, so far as data obtained up to this time are concerned, relations between geographical positions and these characters were not clearly illustrated.

On the other hand, the comparative ratios of length to width, length to thickness and width to thickness obtained in husked and unhusked grains fitted comparatively well for geographical positions. Their averages and variation ranges were as follows; 0.91, 0.87 and 0.98 in average values and 0.04 (0.89 to 0.93), 0.08 (0.86 to 0.94) and 0.06 (0.95 to 1.01) in variation ranges, respectively. Comparative ratios of length to thickness and width to thickness found in husked and unhusked grains were relatively large in variation ranges and showed considerably better agreement for geographical positions as compared with comparative ratio of length to width found in husked and unhusked grains. Namely, in comparative ratios of length to thickness and width to thickness obtained in husked and unhusked grains, grains collected in West Kalimantan belonged to the relatively larger groups and grains collected in South Sumatera to the relatively small groups, respectively. It seems that the geographical differentiation of these characters may be partly due to the relatively wide inter-strain's variations of grain thickness found in grainfullness. This fact suggested that these comparative ratios could be used as some indicators for ecotypic differentiation. Especially, comparative ratios concerning the grain thickness are regarded as important.

Summary

During the trip from October 15 to December 24 in the Indonesia, twelve strains

of wild species, *i.e.*, *Oryza officinalis* WALL. and *Oryza ridleyi* HOOK. were collected. The seeds collected were investigated for morphological characters in unhusked and husked grains. The comparison of these two data obtained, and some considerations on the ecotypic differentiations of the wild species in Indonesia were reported. The results obtained here were summarized as follows:

1) Length, width and thickness of unhusked grains of wild species were measured as 5.73 *mm*, 2.31 *mm* and 1.26 *mm* in average values, respectively. The strains of *O. ridleyi* were remarkably longer than those of *O. officinalis* in grain-length. In the strains of *O. officinalis*, correlation coefficient among length and width, length and thickness, and width and thickness were −0.0536, 0.1823 and 0.8112, respectively. Ratios of length to width, of length to thickness and of width to thickness were found to be 2.48, 4.48 and 1.84 in average values, respectively. The strains of *O. ridleyi* were remarkably larger than those of *O. officinalis* in ratios of length to width and of length to thickness. In the strains of *O. officinalis*, correlation coefficients between ratio of length to width, and ratio of length to thickness, between ratio of length to width and ratio of width to thickness, and between ratio of length to thickness and ratio of width to thickness were 0.9045, −0.5550 and −0.1115, respectively.

2) Length, width and thickness of husked grains of wild species were measured to be 3.99 *mm*, 1.74 *mm* and 1.04 *mm* in average values, respectively. As compared with the strains of *O. officinalis*, the strains of *O. ridleyi* were remarkably large in length and thickness, but were remarkably small in width. In the strains of *O. officinalis*, correlation coefficients among length and width, length and thickness, and width and thickness were 0.2500, 0.2813 and 0.5961, respectively. Ratios of length to width, of length to thickness and of width to thickness were found to be 2.47, 3.80 and 1.71 in average values, respectively. As compared with the strains of *O. officinalis*, the strains of *O. ridleyi* were remarkably large in ratios of length to width and of length to thickness, but were remarkably small in ratio of width to thickness. In the strains of *O. officinalis*, correlation coefficients between ratio of length to width and ratio of length to thickness, between ratio of length to width and ratio of width to thickness, and between ratio of length to thickness and ratio of width to thickness were 0.7174, −0.4139 and −0.3402, respectively.

3) In the strains of *O. officinalis*, correlation coefficients between length, width and thickness of unhusked and husked grains were 0.9050, 0.9693 and 0.8333, respectively, and the whole of them showed very high correlation among them at 0.1% level. The ratios of value found in husked grains to the value in unhusked grains of length, width and thickness were found to be 0.71, 0.76 and 0.82 in average values, respectively. In comparison with the strains of *O. officinalis*, the strains of *O. ridleyi* were remarkably small in view of length and width, but were clearly large in view of thickness. In the strains of *O. officinalis*, correlation coefficients among length and width, length and thickness, and width and thickness were 0.3750, −0.2000 and 0.4500, respectively. In comparison with the strains of *O. officinalis*, the strains of *O. ridleyi* were clearly large in ratio of length to width, but were remarkably small in ratios of length to thickness and of width to thickness. In the strains of *O. officinalis*, correlation coefficients between ratio of length to width and ratio of length to thickness, between ratio of length to width and ratio of width to thickness, and between ratio of length to thickness and ratio of width to thickness were 0.8235, 0.5769 and 0.9111,

respectively.

4) Ecotypic differentiations were considered in addition to the data mentioned above. Intra-strain's variations, illustrating by standard deviation of length, width and thickness of unhusked grains were observed to be 0.22, 0.11 and 0.05 in average values, respectively. In the strains of *O. officinalis*, correlation coefficients among length and width, length and thickness, and width and thickness in view of the intra-strain's variation were 0.2805, −0.3692 and 0.2299, respectively. The whole of them showed no significant correlation among them even at 5% level. Intra-strain's variations of length, width and thickness of husked grains were found to be 0.14, 0.15 and 0.06 in average values, respectively. In the strains of *O. officinalis*, correlation coefficients among length and width, length and thickness, and width and thickness in view of the intra-strain's variation were 0.5833, −0.1414 and −0.1935, respectively, and the whole of them showed no significant correlation among them even at 5% level. In the strains of *O. officinalis*, correlation coefficients of intra-strain's variations among unhusked and husked grains of length, width and thickness were 0.7778, −0.0667 and 0.2583, respectively. The former one showed very high correlation at 1% level, but the other two ones showed no significant correlation among them even at 5% level.

5) Several articles on ecotypic differentiations were discussed in view of the intra-strain's variation and grainfullness.

References

1) Butany, W. T. and Sampath, S.: *Current Sci.*, **29**, 141-142 (1960)
2) Katayama, T. C.: *Mem. Fac. Agr. Kagoshima Univ.*, **8**, 299-320 (1970)
3) , Watabe, T. and Kuroda, T.: *Preliminary Report of Tottori University's Scientific Survey* 1971, Tottori University, Japan, **1**, 1-47 (1972)
4) , and Kuroda, T.: *ibid.* **2**, 19-70 (1974)
5) Ojima, M. and Kawashima, R.: *Proc. Crop Sci. Soc. Japan*, **37**, 667-675 (1968)