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Morphological Characters of the Cultivated Rice Grains of Madura, Indonesia (IV)

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Introduction

During the period from June to July in 1981, the writer was sent to Indonesia for research on agricultural practices under the project, designated as "Ecological Biology and the Promotion on Tropical Primary Industry", supported by a Grant from the Ministry of Education, Science and Culture, Japan.

Rice cultivation in East Java, Indonesia, was studied from several viewpoints. Observations were also made in Middle Java and Bali Islands for the extensive comparisons, and the results obtained in East Java were briefly reported in the previous papers.

On the grain morphology of rice grains distributed in the islands of Indonesia, some reports have been published[2]. However, no distinct record has been reported on the grain morphology of the cultivated rice varieties in Madura Island, East Java, Indonesia. In these districts, several cultivated rice, *Oryza sativa* L., are used in the lowland and upland fields. Most of them are introduced from Java proper, Bali, India, the Philippines and others. It is said that improved varieties of the *indica* type of rice are being cultivated and that primitive types of *indica* and *javanica* are not used in these areas at the present. However, it has not been ascertained whether the same can be said for Madura.

To obtain sources of RTV (resistance to tungro virus) for the breeding programs in Indonesia, field screening IRRI lines was done in Lanrang sub-station during the wet monsoon season in 1986[10]. On the other hand, scientists evaluated some herbicides to control weeds in hybrid rice Shen Zhan 97A/Sadang in wet season during 1985-1986[11]. In Vietnam, tolerant varieties for low temperature were evaluated[1]. As shown, recent and hybrid rice varieties are adopted. However, primitive varieties are being kept consciously, everywhere. Recently, a local upland rice variety in Indonesia was used for selection of dwarf and semi-dwarf mutant[9].

Accumulations of complete data endorsed by discussions on their aspects have been unfortunately far from being perfect. The present experimental series has been made to search the varietal variations, taking these facts into consideration.

In the previous paper[4], the records of morphological characters of the unhusked and the husked grains, comparison of the unhusked and the husked grains of 12 characters and variation ranges in 24 characters[6], correlation coefficients between the practical values of the unhusked and the husked grains and linear regressions between them[7], were reported, in order to confirm the morphological characters of grains which were to make the strain's specificities clearer. In the present paper, the remaining 15 mutual relations among 24 characters in views of practical values were mainly described.

It is one of the aim of the present experiment to ascertain the specificities of the respective characters, for example, stable or unstable, large or small values. Especially, question whether the character of thicknesses of unhusked and husked grains is of the stable or of the unstable in the whole characters.

Materials and Methods

Twenty-nine strains of rice cultivars, *Oryza sativa* L., collected in east Java during the trip, especially on Madura Island, were used in this experimental series. They are listed up in Table 1 of the previous paper[4]. In this table, collection number, collection date, collection place, and detailed informations are mentioned.

Thirty grains were used for the measurement of the respective strains. To make clearer the relations between the respective 2 characters of the unhusked and the husked grains in the grain level, correlation coefficient and linear regression between them were calculated through the whole characters, *i.e.*, comparative values (Tables 1 and 2), comparison of the unhusked with the husked grains (Tables 3 and 4), and area- and volume-columns (Table 5). Correlation coefficients in the whole character-combinations (=27) were summed-up (Table 6).

Some new techniques, in which relatively larger or smaller strains were picked-up and grouped, were adopted for the comparative studies of the whole strains collected.

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

Results

1. Comparative values of length and width

Correlation coefficient (abbreviated as c.c.) and linear regression (l.r.) of width (W) on length (L) in the same strains were calculated, and are shown in the left column of Table 1. One and 28 strains showed significance at 5% level and no significance even at 5% level, respectively. In the whole strains (=29), c.c. was +0.6333 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of L, the larger is the comparative value of W. L. r. of L on W was calculated as follows; $Y=1.000X+0.120$, where Y and X indicate the comparative values of L and W, respectively. This formula indicates that the comparative value of L becomes 1.000 larger, when the comparative value of W becomes larger by 1 degree.

2. Comparative values of length and thickness

C.c. and l.r. of T on L in the same strains were calculated, and are shown in the central column of Table 1. Two, 3 and 24 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.7658 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of L, the larger is the comparative value of T. L.r. of L on T was calculated as follows; $Y=0.993X+0.177$, where Y and X indicate the comparative values of L and T, respectively. This formula indicates that the comparative value of L becomes 0.993 larger, when the comparative value of T becomes larger by 1 degree.

3. Comparative values of width and thickness

C.c. and l.r. of T on W in the same strains were calculated, and are shown in the right column of

Table 1. Correlation coefficient and linear regression of the three components; comparative values of width (Y) on length (X), comparative values of thickness (Y) on length (X), and comparative values of thickness (Y) on width (X)

Strain No.	Length and Width		Length and Thickness		Width and Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	−0.1720	−	0.6321**	Y = 0.824 X + 0.244	−0.3830	−
2	0.3095	−	−0.2581	−	−0.1286	−
3	0.3346	−	0.1059	−	0.0629	−
4	0.3463	−	0.0548	−	0.0870	−
5	0.2347	−	0.4701*	Y = 0.914 X + 0.239	0.3596	−
6	−0.1970	−	0.4786*	Y = 0.633 X + 0.445	0.0953	−
7	0.2937	−	0.0731	−	0.1883	−
8	−0.2651	−	−0.2499	−	−0.0309	−
9	−0.3178	−	−0.0585	−	−0.1729	−
10	0.0973	−	0.2114	−	0.0966	−
11	−0.2565	−	0.3729	−	0.1467	−
12	0.0836	−	−0.2026	−	0.1747	−
13	0.4334	−	−0.2112	−	−0.1107	−
14	0.2807	−	0.1420	−	0.3308	−
15	0.5088*	Y = 0.938 X + 0.185	0.1462	−	0.4889*	Y = 0.326 X + 0.622
16	0.4333	−	0.2194	−	0.3214	−
17	0.3542	−	0.6664**	Y = 1.136 X + 0.065	0.4906*	Y = 0.450 X + 0.499
18	0.1847	−	−0.2140	−	0.0200	−
19	0.1845	−	0.2023	−	0.4282	−
20	0.1578	−	0.2505	−	0.2108	−
21	−0.4254	−	0.0022	−	0.4409	−
22	0.0308	−	0.1609	−	−0.1296	−
23	0.0097	−	0.0949	−	−0.1090	−
24	−0.2279	−	0.0328	−	−0.5784**	Y = −0.723 X + 1.479
25	−0.1237	−	−0.1191	−	0.2571	−
26	0.2419	−	0.0553	−	−0.3180	−
27	−0.0887	−	0.0272	−	0.5194*	Y = 0.846 X + 0.202
28	0.2760	−	−0.0925	−	0.0432	−
29	0.4116	−	0.5024*	Y = 0.799 X + 0.316	0.4668*	Y = 0.330 X + 0.579

d. f. = 18

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

Table 1. One, 4 and 24 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.6573 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of W, the larger is the comparative value of T. L.r. of W on T was calculated as follows; $Y=0.539X+0.437$, where Y and X indicate the comparative values of W and T, respectively. This formula indicates that the comparative value of W becomes 0.539 larger, when the comparative value of T becomes larger by 1 degree.

Table 2. Correlation coefficient and linear regression of the three components; comparative values of ratio of length to thickness (Y) on ratio of length to width (X), comparative values of ratio of width to thickness (Y) on ratio of length to width (X), and comparative values of ratio of width to thickness (Y) on ratio of length to thickness (X)

Strain No.	L/W and L/T		L/W and W/T		L/T and W/T	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.0292	–	−0.5143*	Y = −0.633 X + 1.540	−0.1461	–
2	−0.0546	–	−0.7263***	Y = −1.135 X + 1.927	0.7100***	Y = 1.213 X + 0.030
3	0.1633	–	−0.4464*	Y = −0.394 X + 1.298	0.5298*	Y = 1.014 X + 0.150
4	0.1686	–	−0.4754*	Y = −0.744 X + 1.583	0.4234	–
5	0.3297	–	−0.7338***	Y = −0.854 X + 1.669	0.3818	–
6	0.4698*	Y = 0.302 X + 0.539	−0.7738***	Y = −0.822 X + 1.636	0.1815	–
7	0.1617	–	−0.8363***	Y = −0.874 X + 1.682	0.3378	–
8	0.5384*	Y = 0.422 X + 0.434	−0.7238***	Y = −0.721 X + 1.546	0.0487	–
9	0.4490*	Y = 0.217 X + 0.608	−0.8261***	Y = −0.853 X + 1.661	0.1008	–
10	−0.1121	–	−0.9102***	Y = −1.050 X + 1.836	0.0364	–
11	0.5071*	Y = 0.145 X + 0.682	−0.8972***	Y = −0.770 X + 1.599	−0.1855	–
12	0.3472	–	−0.5634**	Y = −0.730 X + 1.524	−0.6467**	Y = −0.639 X + 1.436
13	0.3902	–	−0.3604	–	0.6902***	Y = 0.820 X + 0.284
14	0.5332*	Y = 0.535 X + 0.340	−0.3911	–	0.5024*	Y = 0.581 X + 0.475
15	0.5403*	Y = 0.461 X + 0.400	−0.3294	–	0.5382*	Y = 0.658 X + 0.425
16	0.1504	–	−0.8306***	Y = −0.957 X + 1.754	0.3594	–
17	0.1890	–	−0.7979***	Y = −0.987 X + 1.803	0.3793	–
18	0.1549	–	−0.3154	–	0.6880***	Y = 0.681 X + 0.388
19	0.5111*	Y = 0.323 X + 0.534	−0.7178***	Y = −0.733 X + 1.571	0.0904	–
20	0.4953*	Y = 0.338 X + 0.519	−0.6366**	Y = −0.628 X + 1.480	0.3088	–
21	0.6451**	Y = 0.523 X + 0.354	−0.5166*	Y = −0.473 X + 1.341	0.2618	–
22	0.4175	–	−0.6209**	Y = −0.733 X + 1.570	0.4262	–
23	0.4643*	Y = 0.300 X + 0.540	−0.7561***	Y = −0.787 X + 1.605	0.2062	–
24	−0.2192	–	−0.7406***	Y = −1.329 X + 2.113	0.8121***	Y = 1.417 X − 0.199
25	0.5363*	Y = 0.363 X + 0.505	−0.7741***	Y = −0.759 X + 1.604	0.0949	–
26	0.3963	–	−0.6785**	Y = −0.683 X + 1.526	0.3784	–
27	0.2398	–	−0.0179	–	0.4219	–
28	0.5703**	Y = 0.512 X + 0.332	−0.4049	–	0.4728*	Y = 0.491 X + 0.496
29	0.2648	–	−0.7845***	Y = −1.004 X + 1.805	0.3644	–

d. f. = 18

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

4. Comparative values of L/W and L/T

C.c. and l.r. of L/T on L/W in the same strains were calculated, and are shown in the left column of Table 2. Two, 10 and 17 strains showed significances at 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.3078 to the degree of freedom of 27, showing no significance even at 5% level.

5. Comparative values of L/W and W/T

C.c. and l.r. of W/T on L/W in the same strains were calculated, and are shown in the central column of Table 2. Fifteen, 4, 4 and 6 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was −0.6173 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the comparative value of L/W, the smaller is the comparative value of W/T. L.r. of L/W on W/T was calculated as follows; $Y=-0.734X+1.573$, where Y and X indicate the comparative values of L/W and W/T, respectively. This formula indicates that the comparative value of L/W becomes 0.734 larger, when the comparative value of W/T becomes smaller by 1 degree.

6. Comparative values of L/T and W/T

C.c. and l.r. of W/T on L/T in the same strains were calculated, and are shown in the right column of Table 2. Four, 1, 4 and 20 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.2794 to the degree of freedom of 27, showing no significance even at 5% level.

7. Lengths of UHG and HG

C.c. and l.r. of L of HG on L of UHG in the same strains were calculated, and are shown in the left column of Table 3. Twenty-four, 3, 1 and 1 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9170 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the longer is the L of UHG, the longer is the L of HG. L.r. of L of UHG on L of HG was calculated as follows; $Y=0.699X+0.146$, where Y and X indicate L of UHG and L of HG, respectively. This formula indicates that the L of UHG becomes 0.699 mm longer, when the L of HG becomes longer by 1 degree.

8. Widths of UHG and HG

C.c. and l.r. of W of HG on W of UHG in the same strains were calculated, and are shown in the central column of Table 3. Twenty-two, 3, 2 and 2 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9266 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the wider is the W of UHG, the wider is the W of HG. L.r. of W of UHG on W of HG was calculated as follows; $Y=0.790X+0.132$, where Y and X indicate W of UHG and W of HG, respectively. This formula indicates that the W of UHG becomes 0.790 mm wider, when the W of HG becomes wider by 1 degree.

9. Thicknesses of UHG and HG

C.c. and l.r. of T of HG on T of UHG in the same strains were calculated, and are shown in the right column of Table 3. Twenty-eight and 1 strains showed significances at 0.1% and 1% levels, respectively. In the other words, the whole strains (=29) showed significances. In the whole strains, c.c. was +0.9864 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the thicker is the T of UHG, the thicker is the T of HG. L.r. of UHG on T of HG was calculated as follows; $Y=1.111X-0.459$, where Y and X indicate T of UHG and T of HG, respectively. This formula indicates that the T of UHG becomes 1.111 mm thicker, when the T of HG becomes thicker by 1 degree.

10. L/W of UHG and HG

C.c. and l.r. of L/W of HG on L/W of UHG in the same strains were calculated, and are shown in the lelft column of Table 4. Twenty-two, 4, 2 and 1 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9787 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/W of UHG, the larger is the L/W of HG. L.r. of L/W of UHG on L/W of HG was calculated as follows; $Y=0.799X+0.176$, where Y and X indicate L/W of UHG and L/W of HG,

Table 3. Correlation coefficient and linear regression of the three characters of unhusked (Y) on husked (X) grains; length, width and thickness

Strain No.	Length		Width		Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.1251	–	0.4990*	Y =0.917 X −0.504	0.9068***	Y =0.943 X −0.261
2	0.9142***	Y =0.628 X +0.885	0.8419***	Y =0.672 X +0.459	0.8529***	Y =1.104 X −0.439
3	0.8880***	Y =0.509 X +1.994	0.6594***	Y =0.411 X +1.163	0.8242***	Y =0.862 X +0.067
4	0.9815***	Y =0.704 X +0.056	0.8700***	Y =0.552 X +0.730	0.9640***	Y =0.914 X −0.045
5	0.5931**	Y =0.298 X +3.566	0.9118***	Y =0.724 X +0.330	0.8327***	Y =0.988 X −0.208
6	0.5842**	Y =0.547 X +1.559	0.8268***	Y =0.595 X +0.690	0.9128***	Y =1.084 X −0.401
7	0.9199***	Y =0.690 X +0.273	0.6296**	Y =0.748 X +0.256	0.9094***	Y =0.876 X +0.047
8	0.9699***	Y =0.742 X −0.351	0.8933***	Y =0.746 X +0.296	0.8107***	Y =0.748 X +0.322
9	0.9227***	Y =0.624 X +0.785	0.7448***	Y =0.771 X +0.254	0.8048***	Y =0.628 X +0.609
10	0.9336***	Y =0.686 X +0.343	0.5133*	Y =0.303 X +1.469	0.9290***	Y =1.012 X −0.239
11	0.9141***	Y =0.754 X −0.167	0.4074	–	0.8593***	Y =0.949 X −0.092
12	0.7529***	Y =0.442 X +2.490	0.7172***	Y =0.662 X +0.515	0.8688***	Y =0.861 X +0.056
13	0.6346**	Y =0.381 X +2.787	0.7364***	Y =0.694 X +0.524	0.7602***	Y =0.764 X +0.433
14	0.9314***	Y =0.812 X −0.900	0.8391***	Y =0.871 X −0.111	0.9129***	Y =0.866 X +0.065
15	0.9841***	Y =0.781 X −0.669	0.9828***	Y =0.697 X +0.442	0.8813***	Y =0.838 X +0.133
16	0.8981***	Y =0.737 X −0.202	0.8255***	Y =1.241 X −1.358	0.9728***	Y =1.030 X −0.291
17	0.8413***	Y =0.539 X +1.792	0.8703***	Y =0.891 X −0.061	0.9561***	Y =1.086 X −0.403
18	0.4444*	Y =0.608 X +0.275	−0.3227	–	0.6278**	Y =0.792 X +0.063
19	0.9685***	Y =0.795 X −0.674	0.8431***	Y =1.058 X −0.624	0.8614***	Y =0.996 X −0.222
20	0.8926***	Y =0.547 X +1.445	0.7995***	Y =0.560 X +0.803	0.9270***	Y =0.704 X +0.379
21	0.9818***	Y =0.750 X −0.349	0.9914***	Y =0.748 X +0.218	0.9669***	Y =0.773 X +0.229
22	0.7965***	Y =0.572 X +1.343	0.8335***	Y =0.752 X +0.268	0.7982***	Y =0.957 X −0.134
23	0.9212***	Y =0.913 X −1.899	0.8929***	Y =0.693 X +0.385	0.9225***	Y =0.894 X +2.472
24	0.9818***	Y =0.729 X −0.068	0.8056***	Y =0.866 X −0.039	0.8124***	Y =1.044 X −0.349
25	0.9758***	Y =0.749 X −0.254	0.6313**	Y =0.450 X +1.054	0.8831***	Y =1.055 X −0.334
26	0.8002***	Y =0.430 X +2.952	0.5881**	Y =0.475 X +1.032	0.8874***	Y =0.826 X +0.171
27	0.9529***	Y =0.790 X −0.620	0.9539***	Y =0.664 X +0.396	0.8283***	Y =0.741 X +0.306
28	0.8293***	Y =0.436 X +2.437	0.6802***	Y =0.583 X +0.635	0.8896***	Y =0.885 X +0.020
29	0.9468***	Y =0.857 X −1.211	0.9370***	Y =0.988 X −0.303	0.9823***	Y =1.059 X −0.326

d. f. = 18

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

respectively. This formula indicates that the L/W of UHG becomes 0.799 larger, when the L/W of HG becomes larger by 1 degree.

11. L/T of UHG and HG

C.c. and l.r. of L/T of HG on L/T of UHG in the same strains were calculated, and are shown in the central column of Table 4. Twenty-six, 1, 1 and 1 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9819 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the L/T of UHG, the larger is the L/T of HG. L.r. of L/T of UHG on L/T of HG was calculated as follows; $Y=0.749X+0.249$, where Y and X indicate L/T of UHG and L/T of HG, respectively. This formula indicates that the L/T of UHG becomes 0.749 larger, when the L/T of HG

Table 4. Correlation coefficient and linear regression of the three characters of unhusked (Y) on husked (X) grains; ratio of length to width, ratio of length to thickness, and ratio of width to thickness

Strain No.	Length/Width		Length/Thickness		Width/Thickness	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.4603*	Y = 0.837 X + 0.129	0.9178***	Y = 0.772 X + 0.307	0.7515***	Y = 0.984 X − 0.006
2	0.8106***	Y = 0.684 X + 0.609	0.7719***	Y = 0.844 X − 0.137	0.7682***	Y = 0.799 X + 0.212
3	0.7976***	Y = 0.560 X + 0.999	0.8727***	Y = 0.619 X + 0.908	0.7783***	Y = 0.662 X + 0.405
4	0.7710***	Y = 0.674 X + 0.590	0.7138***	Y = 0.482 X + 1.455	0.6504**	Y = 0.538 X + 0.547
5	0.9316***	Y = 0.683 X + 0.491	0.8658***	Y = 0.729 X + 0.294	0.9181***	Y = 0.785 X + 0.219
6	0.6303**	Y = 0.418 X + 1.496	0.8966***	Y = 0.755 X + 0.165	0.8538***	Y = 0.989 X − 0.056
7	0.6071**	Y = 0.577 X + 0.958	0.8979***	Y = 0.657 X + 0.659	0.4384	−
8	0.9659***	Y = 0.857 X − 0.089	0.9562***	Y = 0.837 X − 0.233	0.8850***	Y = 0.818 X + 0.169
9	0.4617*	Y = 0.516 X + 0.880	0.7558***	Y = 0.616 X + 0.681	0.6335**	Y = 0.766 X + 0.253
10	0.6757**	Y = 0.548 X + 1.090	0.7438***	Y = 0.671 X + 0.601	0.6465**	Y = 0.590 X + 0.457
11	0.8094***	Y = 1.291 X − 1.053	0.9519***	Y = 0.869 X − 0.221	0.4088	−
12	0.6867***	Y = 0.589 X + 0.848	0.7958***	Y = 0.423 X + 1.738	0.7767***	Y = 0.904 X + 0.076
13	0.8623***	Y = 0.583 X + 0.649	0.5394*	Y = 0.345 X + 1.625	0.7638***	Y = 0.756 X + 0.271
14	0.9059***	Y = 0.908 X − 0.158	0.8911***	Y = 0.888 X − 0.368	0.9299***	Y = 0.962 X − 0.037
15	0.9936***	Y = 0.751 X + 0.232	0.9479***	Y = 0.770 X + 0.055	0.9839***	Y = 0.861 X + 0.108
16	0.6168**	Y = 0.732 X + 0.386	0.9322***	Y = 0.831 X − 0.129	0.7016***	Y = 0.836 X + 0.119
17	0.8489***	Y = 0.834 X + 0.015	0.9581***	Y = 0.964 X − 0.683	0.8560***	Y = 1.005 X − 0.038
18	0.0249	−	0.3564	−	0.5190*	Y = 0.447 X + 0.719
19	0.8994***	Y = 0.875 X − 0.072	0.9313***	Y = 0.841 X − 0.142	0.9298***	Y = 1.194 X − 0.345
20	0.8707***	Y = 0.693 X + 0.474	0.8974***	Y = 0.642 X + 0.683	0.8922***	Y = 0.713 X + 0.327
21	0.9620***	Y = 0.696 X + 0.490	0.7975***	Y = 0.546 X + 1.105	0.9654***	Y = 0.863 X + 0.097
22	0.8799***	Y = 0.736 X + 0.363	0.7950***	Y = 0.739 X + 0.287	0.8180***	Y = 0.884 X + 0.087
23	0.8531***	Y = 0.636 X + 0.739	0.7290***	Y = 0.668 X + 0.576	0.8414***	Y = 0.714 X + 0.295
24	0.9637***	Y = 0.993 X − 0.458	0.8428***	Y = 0.591 X + 1.058	0.8045***	Y = 1.298 X − 0.429
25	0.8587***	Y = 1.071 X − 0.865	0.9403***	Y = 0.861 X − 0.241	0.7810***	Y = 0.723 X + 0.304
26	0.7018***	Y = 0.581 X + 1.024	0.8220***	Y = 0.514 X + 1.309	0.6541**	Y = 0.578 X + 0.446
27	0.9299***	Y = 0.767 X + 0.416	0.8569***	Y = 0.689 X + 0.548	0.9186***	Y = 0.810 X + 0.133
28	0.7658***	Y = 0.726 X + 0.500	0.6066**	Y = 0.627 X + 0.660	0.8195***	Y = 0.952 X − 0.097
29	0.8372***	Y = 0.640 X + 0.558	0.9002***	Y = 0.813 X − 0.039	0.7839***	Y = 0.781 X + 0.286

d. f. = 18

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

becomes larger by 1 degree.

12. W/T of UHG and HG

C.c. and l.r. of W/T of HG on W/T of UHG in the same strains were calculated, and are shown in the right column of Table 4. Twenty-two, 4, 1 and 2 strains showed significances at 0.1%, 1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9349 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the W/T of UHG, the larger is the W/T of HG. L.r. of W/T of UHG on W/T of HG was calculated as follows; Y=0.914X+0.040, where Y and X indicate W/T of UHG and W/T of HG, respectively. This formula indicates that the W/T of UHG becomes 0.914 larger, when the W/T of

Table 5. Correlation coefficient and linear regression of the three components; area of husked grain (Y) on area of unhusked grain (X), volume of husked grain (Y) on volume of unhusked grain (X), and quotient of volume (Y) on qoutient of area (X)

Strain No.	Area		Volume		Quotient	
	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression	Correlation coefficient	Linear regression
1	0.2169	–	0.8329***	Y=0.542X−5.856	0.7924***	Y=0.883X−0.049
2	0.8785***	Y=0.489X+3.051	0.9054***	Y=0.501X+1.832	0.8174***	Y=0.791X+0.058
3	0.7333***	Y=0.317X+7.365	0.5859**	Y=0.240X+14.658	0.9058***	Y=0.961X−0.039
4	0.9596***	Y=0.517X+1.772	0.9727***	Y=0.496X+1.497	0.8957***	Y=0.937X−0.030
5	0.8590***	Y=0.506X+2.233	0.8314***	Y=0.521X+0.412	0.8827***	Y=1.057X−0.098
6	0.8207***	Y=0.544X+1.406	0.8614***	Y=0.582X−2.901	0.8747***	Y=1.142X−0.148
7	0.7842***	Y=0.648X−1.091	0.8850***	Y=0.670X−6.446	0.9570***	Y=0.957X−0.085
8	0.9052***	Y=0.558X+1.125	0.9020***	Y=0.488X+2.937	0.8181***	Y=0.742X+0.094
9	0.8993***	Y=0.574X+0.970	0.9275***	Y=0.501X+3.053	0.9191***	Y=0.851X+0.035
10	0.7113***	Y=0.300X+8.150	0.7600***	Y=0.315X+12.806	0.9545***	Y=0.954X−0.035
11	0.4588*	Y=0.253X+8.789	0.4879*	Y=0.320X+12.423	0.9591***	Y=0.979X−0.044
12	0.7657***	Y=0.413X+4.825	0.8131***	Y=0.444X+4.853	0.9011***	Y=0.768X+0.034
13	0.5131*	Y=0.397X+5.955	0.6305**	Y=0.434X+7.610	0.9117***	Y=0.814X+0.056
14	0.8993***	Y=0.662X−1.948	0.8843***	Y=0.546X−0.960	0.8111***	Y=0.996X−0.060
15	0.7806***	Y=0.482X+2.958	0.7520***	Y=0.463X+4.123	0.9342***	Y=1.099X−0.118
16	0.8888***	Y=0.847X−7.289	0.9558***	Y=0.716X−11.377	0.9621***	Y=0.996X−0.059
17	0.8554***	Y=0.559X+1.768	0.9110***	Y=0.580X−0.930	0.9574***	Y=1.183X−0.184
18	0.1794	–	0.5197*	Y=0.374X+1.018	0.7376***	Y=0.754X+0.035
19	0.9332***	Y=0.758X−3.860	0.8909***	Y=0.647X−5.690	0.9330***	Y=1.032X−0.086
20	0.8390***	Y=0.363X+5.769	0.8718***	Y=0.362X+8.546	0.8854***	Y=1.052X−0.097
21	0.9945***	Y=0.559X+0.630	0.9906***	Y=0.479X+1.948	0.8011***	Y=1.287X−0.237
22	0.7018***	Y=0.473X+3.538	0.6862***	Y=0.404X+7.540	0.7658***	Y=0.751X+0.085
23	0.9227***	Y=0.611X−0.457	0.9457***	Y=0.562X−1.600	0.9253***	Y=0.854X+0.023
24	0.9268***	Y=0.490X+2.791	0.9598***	Y=0.547X−0.765	0.3426	–
25	0.9437***	Y=0.487X+3.348	0.9094***	Y=0.464X+4.669	0.8729***	Y=1.030X−0.084
26	0.6929***	Y=0.337X+7.726	0.7102***	Y=0.337X+13.438	0.9518***	Y=0.896X+0.005
27	0.9612***	Y=0.616X−0.684	0.9407***	Y=0.525X−0.029	0.7121***	Y=0.923X−0.018
28	0.7560***	Y=0.330X+6.326	0.8349***	Y=0.319X+10.686	0.9124***	Y=0.879X+0.009
29	0.9631***	Y=0.763X−3.101	0.9819***	Y=0.677X−5.186	0.9348***	Y=1.089X−0.126

d. f. = 18

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

HG becomes larger by 1 degree.

13. Areas of UHG and HG

C.c. and l.r. of area of HG on area of UHG in the same strains were calculated, and are shown in the left column of Table 5. Twenty-five, 2 and 2 strains showed significances at 0.1% and 5% levels and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.8620 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the wider is the area of UHG, the wider is the area of HG. L.r. of area of UHG on area of HG was calculated as follows; Y=0.608X−10.259, where Y and X indicate the area of UHG and area of HG, respectively. This formula indicates that the area of UHG becomes 0.608 mm^2 wider, when the area of HG becomes wider by 1 degree.

14. Volumes of UHG and HG

C.c. and l.r. of volume of HG on volume of UHG in the same strains were calculated, and are shown in the central column of Table 5. Twenty-five, 2 and 2 strains showed significances at 0.1%, 1% and 5% levels, respectively. In the other words, the whole strains (=29) showed significances. In the whole strains, c.c. was +0.9475 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the volume of UHG, the larger is the volume of HG. L.r. of volume of UHG on volume of HG was calculated as follows; Y=0.609X−4.056, where Y and X indicate the volume of UHG and volume of HG, respectively. This formula indicates that the volume of UHG becomes 0.609 mm^3 larger, when the volume of HG becomes larger by 1 degree.

15. Quotients of area and volume

C.c. and l.r. of quotient of volume on quotient of area in the same strains were calculated, and are shown in the right column of Table 5. Twenty-eight and 1 strains showed significances at 0.1% level and no significance even at 5% level, respectively. In the whole strains, c.c. was +0.9699 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the larger is the quotient of area, the larger is the quotient of volume. L.r. of quotient of area on quotient of volume was calculated as follows; Y=1.150X−0.157, where Y and X indicate the quotient of area and quotient of volume, respectively. This formula indicates that the quotient of area becomes 1.150 larger, when the quotient of volume becomes larger by 1 degree.

Discussion

Basing on the results obtained in the previous[7] and in the present experiments, the following problematic items are to be discussed here.

1. C.c. of the respective character-combinations in the strain level were fixed to be significant in 430 cases of 783 combinations of the whole cases (=29 strains × 27 character-combinations) (Table 6). In detail, some characteristics were found. Significant correlations in the strain level were accounted as follows in the order of the combination numbers from 1 to 27; 2, 3, 3; 9, 22, 19; 1, 6, 4; 15, 24, 16; 1, 5, 5; 12, 23, 9; 28, 27, 29; 28, 28, 27; 27, 29, 28 strains, respectively. It may be noticed that the values were particularly large in the combinations with Nos.5, 11, 17 and Nos.19~27. Average value and its s.d. through the whole combinations were found to be 47.78±30.23.

The whole combinations were divided into 2 groups, *i.e.*, group Ⅰ (combination Nos.1~18) and group Ⅱ (Nos.19~27). Significant correlations were accounted as 34.3% (=179/522) and 96.2% (=251/261) in groups Ⅰ and Ⅱ, respectively. Those averages and their s.ds. through the whole combinations within groups were found to be 29.83±20.11 and 83.67±0.47 in groups Ⅰ and Ⅱ, respectively. Moreover, group Ⅰ were re-divided into 6 sub-groups as follows; sub-group 1 (combination Nos.1~3), sub-2 (Nos.4~6), sub-3 (Nos.7~9), sub-4 (Nos.10~12), sub-5 (Nos.13~15) and sub-6 (Nos.16~18). Significant correlations were accounted as follows in the order from sub-1 to sub-6; 9.2% (=8/87), 57.5% (50/87), 12.6% (11/87), 63.2% (55/87), 12.6% (11/87) and 50.6% (44/87), respectively. It was ascertained that subs-2, -4 and -6, *i.e.*, ratio-columns, showed higher significances [57.1% (149/261)] in comparison with those of subs-1, -3 and -5 [11.5% (30/261)]. It might, reasonably, be attributed to gene actions. These ascertained differences might be looked upon as specificities of the character or character-combinations. Those averages and their s.ds. through the whole combinations within sub-groups were found to be 49.67±4.50 and 10.00±1.41 in the higher and the lower sub-groups, respectively.

Table 6. Summed-up table showing correlation coefficients in the 27 character-combinations; data of Nos.1～12 and Nos.13～27 cited from the previous[7] and the present papers, respectively

Combination No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Character No.	1·2	1·3	2·3	4·5	4·6	5·6	11·12	11·13	12·13	14·15	14·16	15·16	21·22	21·23	22·23	24·25	24·26	25·26	1·11	2·12	3·13	4·14	5·15	6·16	31·33	32·34	35·36
1	*					***		**				***		**			*			*	***	*	***	***		***	***
2					***	*			*		***	***					***	***	***	***	***	***	***	***	***	***	***
3				*	*	*					**	**					*	*	***	***	***	***	***	***	***	**	***
4				*						**	**						**		***	***	***	***	***	**	***	***	***
5			**			***					***	***		*			***		**	***	***	***	***	***	***	***	***
6					**						*	***		*		*	***		**	***	***	**	***	***	***	***	***
7				*	*					**	**						***		***	**	***	**	***		***	***	***
8					***	*				***	***	*				*	***		***	***	***	***	***	***	***	***	***
9					***	*					***	*				*	***		***	***	***	*	***	**	***	***	***
10					**	*					*	*					***		***	*	***	**	***	**	***	***	***
11					***					***	***					*	***		***		***	***	***		*	*	***
12	*			***				*			***	*					**	**	***	***	***	***	***	***	***	***	***
13					***	*			*		***	*						***	**	***	***	***	*	***	*	**	***
14					*	***					**	**				*		*	***	***	***	***	***	***	***	***	***
15					*	**				***	***	**	*		*	*		*	***	***	***	***	***	***	***	***	***
16						***				*		**					***		***	***	***	**	***	***	***	***	***
17					*					**		**		**	*		***		***	***	***	***	***	***	***	***	***
18			**	**	***	***	*			*		***						***	*		**			*		*	***
19						*					**					*	***		***	***	***	***	***	***	***	***	***
20		*			**	**		*		*	**					*	**		***	***	***	***	***	***	***	***	***
21					***	**		*	*		***					**	*		***	***	***	***	***	***	***	***	***
22				**	**					*	***						**		***	***	***	***	***	***	***	***	***
23					***	***					***	*				*	***		***	***	***	***	***	***	***	***	***
24					*	***				**	***				**		***	***	***	***	***	***	***	***	***	***	
25		*		**	*					***						*	***		***	**	***	***	***	***	***	***	***
26				*	**					*	**						**		***	**	***	***	***	**	***	***	***
27			**	***	**			*	*	***	*				*				***	***	***	***	***	***	***	***	***
28						*					**					**		*	***	***	***	***	**	***	***	***	***
29		***			***	*		**		*	*			*	*		***		***	***	***	***	***	***	***	***	***
Whole Total	*		***	***	***				***	***	***		***	***	***		***		***	***	***	***	***	***	***	***	***
B type															**	**			*	*			**	**	*	*	*
C type	*		**	***	**			*	***	***	**		***	***	***		***		***	***	***	***	***	***	***	***	***

Character numbers; 1, 11, 21-length, 2, 12, 22-width, 3, 13, 23-thickness, 4, 14, 24-L/W, 5, 15, 25-L/T, 6, 16, 26-W/T, 1～6-unhusked grains, 11～16-husked grains, 21～26-comparative values (= husked/unhusked), 31-area (UHG), 32-volume (UHG), 33-area (HG), 34-volume (HG), 35-quotient of areas (= 33/31), 36-quotient of volumes (=34/32)

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

d.f.; 2 in type B, 23 in type C and 27 in the whole, respectively

2. The respective strains showed significant correlations as follows in the order from strain No.1 to No.29; 13, 16, 16, 13, 15, 15, 13, 16, 15, 14, 12, 16, 15, 15, 18, 13, 15, 13, 13, 17, 16, 14, 15, 15, 15, 14, 17, 13, 18, respectively. It was noticeable that the strain Nos.15 and 29 showed significances in 18/27 combinations (=66.7% in the whole character-combinations), and Nos.20 and 27 showed significances in 17/27 combinations (=63.0% in the whole). On the other hand, No. 11 showed significances only in 12/27 combinations (=44.4% in the whole). Two, 2, 5, 9, 3, 7 and 1 strains showed significances in 18, 17, 16, 15, 14, 13 and 12 character-combinations, respectively. Average value and its s.d. through the whole strains were found to be 14.83±1.56.

3. Significant correlations were analyzed in the positive or the negative status and in the degree of their statuses. Significant correlations were accounted as follows in the order of 0.1% levels (positive, negative and the whole), 1% levels (positive, negative and the whole) and 5% levels (positive, negative and the whole); 246 combinations (57.2%), 36 (8.4%), 282 (65.6%); 40 (9.3%), 22 (5.1%), 62 (14.4%); 67 (15.6%), 19 (4.4%), 86 (20.0%).

It might be regarded as a noticeable phenomenon that about two thirds (65.6%) of them showed significant combinations at 0.1% level. It might mean those extreme biological actions, usually called "all or nothing", *i.e.,* going from one extreme to another. While in a stricter sense, those characters were looked upon as being in possession of a stable state, and they were exhibited independently of the other characters. The positive and the negative combinations in the total were accounted as 353 combinations (82.1%) and 77 combinations (17.9%), respectively.

Negative correlations were found in the strain level in some combinations, though positive correlations were found in the most strains in the same character-combinations, *vice versa.* Six cases were found, *i.e.,* strain No. 1 --- combination 1·2; strain No.2 --- combination 12·13; strain No.5 --- combination 2·3; strain No.13 --- combination 12·13; strain No.18 --- combination 2·3; strain No.21 --- combination 12·13. They were found only in group I. In detail, 1, 2 and 3 cases were found in character-combinations 1·2, 2·3 and 12·13, respectively. Unfortunately, those unnatural facts and discrepancies are not to be explained fully at the present time. It was, however, an interesting phenomenon to be clarified concerning strain differentiations. These phenomena might be attributed to the actions of the respective genes concerned in all the events.

4. According to the tripartite classification[8], correlation coefficients of the respective characters in the strain level were fixed to be significant in 59/108 cases (=54.6%) and 371/675 cases (=55.0%) in type B (=4 strains) and type C (=25 strains), respectively. There was no clear difference between two types. Those averages and their s.ds. through the whole combinations within types were found to be 6.56±4.67 and 41.22±25.61 in group I and group II, respectively.

In detail, significant correlations were accounted as 41 cases (=38.0%), 7 cases (=6.5%) and 11 cases (=10.2%) at 0.1%, 1% and 5% levels, respectively in type B. Those were accounted as 241 cases (=35.7%), 55 cases (=8.2%) and 75 cases (=11.1%) at 0.1%, 1% and 5% levels, respectively in type C. No clear difference was also ascertained between these two types.

In type B, significant correlations were constituted by positive and negative statuses in 49 cases (=83.1%) and 10 cases (=16.9%), respectively. In type C, they were constituted in 304 cases (=81.9%) and 67 cases (=18.1%), respectively. No clear difference was also found between two types.

5. As the whole strains, the detailed considerations were done in the tripartite classifications. In type B, significant correlations were accounted as 31.9% (=23/72) and 100.0% (=36/36) in group I (combination Nos.1~18) and group II (combination Nos.19~27), respectively. Those averages and their s.ds. through the whole combinations within groups were found to be 3.83±3.24

and 12.00±0.00 in groups I and II, respectively. Moreover, significant correlations were accounted as follows in the order from sub-1 to sub-6; 0%, 58.3% (7/12), 16.7% (2/12), 58.3% (7/12), 0% and 58.3% (7/12), respectively. It was ascertained that subs-2, -4 and -6, *i.e.*, ratio columns, showed higher significances [58.3% (21/36)] in comparison with those of subs-1, -3 and -5 [5.6% (2/36)]. It might reasonably be attributed to gene actions. These ascertained differences might be looked upon as a specificity of character or character-combinations. Those averages and their s.ds. through the whole combinations within sub-groups were found to be 7.00±00 and 0.67±0.94 in the higher and the lower sub-groups, respectively.

In type C, significant correlations were accounted as 34.7% (=156/450) and 95.6% (=215/225) in group I and group II, respectively. Those averages and their s.ds. through the whole combinations within groups were found to be 26.00±16.99 and 71.67±0.47, respectively. Moreover, significant correlations were accounted as follows in the order from sub-1 to sub-6; 10.7% (8/75), 57.3% (43/75), 12.0% (9/75), 64.0% (48/75), 14.7% (11/75) and 49.3% (37/75), respectively. It was also ascertained that subs-2, -4 and -6, *i.e.*, ratio columns, showed higher significances [56.9% (128/225)] in comparison with those of subs-1, -3 and -5 [12.4% (28/225)]. Those averages and their s.ds. through the whole combinations within sub-groups were found to be 42.67±4.50 and 9.33±1.25 in the higher and the lower sub-groups, respectively.

In the whole strains within types, significant correlations were ascertained as follows in the order of 0.1% levels (positive, negative and the whole), 1% levels (positive, negative and the whole) and 5% levels (positive, negative and the whole); type B (4 strains, d.f.=2) --- 0, 0, 0, 4 (4/27=14.8%), 0, 4 (=14.8%), 5 (=18.5%), 0, 5 (=18.5%); type C (25 strains, d.f.=23) --- 15 (=55.6%), 1 (=3.7%), 16 (=59.3%), 1 (3.7%), 2 (=7.4%), 3 (=11.1%), 1 (=3.7%), 1 (=3.7%), 2 (=7.4%); both of the types B and C (29 strains, d.f.=27) --- 16 (=59.3%), 3 (=11.1%), 19 (=70.4%), 0, 0, 0, 0, 1 (=3.7%), 1 (3.7%).

6. The three strains showing the relatively larger values found in correlation coefficient were picked-up in the respective character-combinations (=27), regardless of the positive or negative and significant or non-significant statuses. The respective strains showed the following numbers of the larger values in the order from strain No. 1 to No. 29; 5, 2, 0, 1, 3, 1, 1, 4, 3, 1, 4, 3, 2, 1, 7, 3, 4, 5, 0, 1, 10, 1, 0, 4, 1, 0, 6, 1, 7, respectively. It was noticed that strain No. 21 showed the larger values in 10 cases. Average and its s.d. through the whole strains were found to be 2.79±2.46.

Neither the same order nor the same combination was not found at all.

7. The three strains showing the relatively smaller values were picked-up in the respective combinations (=27), regardless of the positive or the negative and significant or non-significant statuses. The respective strains showed the following numbers of the smaller values in the order from strain No. 1 to No. 29; 7, 1, 1, 1, 3, 3, 3, 2, 1, 3, 5, 2, 2, 0, 3, 0, 1, 14, 3, 0, 4, 4, 2, 4, 2, 0, 5, 4, 1, respectively. It was noticed that strain No. 18 showed the smaller values in 14 cases. Average and its s.d. through the whole strains were found to be 2.79±2.71.

The same order was not found at all.

On the other hand, some sets did not show the same orders, but showed the same combination numbers, which meant the strain numbers occurring regardless of the orders. Only 1 case was found, *i.e.*, 1·11·18 --- character-combination No. 20, width of UHG and width of HG (18>11>1) and area of UHG and area of HG (18>1>11).

8. The strains showing the relatively larger and smaller values were summed-up in the respective combinations, regardless of the positive or the negative and significant or non-significant statuses. The respective strains showed the following numbers in the order from strain Nos. 1 to 29;

12, 3, 1, 2, 6, 4, 4, 6, 4, 4, 9, 5, 4, 1, 10, 3, 5, 19, 3, 1, 14, 5, 2, 8, 3, 0, 11, 5, 8, respectively. It was noticeable that the values were particularly large and small in strain No.18 and No.26, respectively. Average and its s.d. through the whole strains were found to be 5.59±4.26.

9. From the data mentioned in the previous 3 chapters, c.c. and l.r. of the respective character-combinations were calculated, and the following facts were found. C.c. of numbers of strains showing the larger and the smaller values were found to be +0.3566 to the degree of freedom of 27, showing no significance even at 5% level.

C.c. of the numbers of strains showing the larger values and the total strains (=larger+smaller) was +0.8039 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the more are the numbers of strains showing the larger values, the more are the numbers of the total strains. L.r. of the numbers of strains showing the larger values on the number of total strains was calculated as follows; $Y=1.393X+1.694$, where Y and X indicate the number of strains showing larger values and the total strains, respectively. This formula indicates that the number of strains showing the larger values becomes 1.393 more, when the number of total strains becomes more by 1 degree.

C.c. of the number of strains showing the smaller values and the total strains were +0.8423 to the degree of freedom of 27, which is obviously significant at 0.1% level. Generally speaking, the more are the numbers of strains showing the smaller values, the more are the numbers of the total strains. L.r. of the numbers of strains showing the smaller values on the number of total strains was calculated as follows; $Y=1.323X+1.890$, where Y and X indicate the number of strains showing smaller values and the total strains, respectively. This formula indicates that the number of strains showing the smaller values becomes 1.323 more, when the number of total strains becomes more by 1 degree.

In the strains of Indian cultivars[3] and Burma[5], non-significant, significant and non-significant correlations were ascertained between the larger and smaller, the larger and total and the smaller and the total values, respectively. On the other hand, the present strains showed non-significant, significant and significant correlations in the same order, respectively. These difference was explained as geographical and ecotypic differences.

Summary

Succeeding to the previous papers, some morphological studies on grain characters and considerations on ecotypic differentiations of 29 strains of cultivated rice species, *Oryza sativa* L., collected in Madura in 1981, were reported in the present paper. The results obtained here were summarized as follows:

Concerning correlation coefficients among 15 character-combinations, 306/435 cases (=70.4%) showed significant relations through the whole cases.

From the previous and the present experiments, concerning correlation coefficients among 27 character-combinations, 430/783 cases (=54.8%) showed significant relations through the whole cases. The whole combinations were divided into 2 groups in view of the correlation-occurrence-frequencies, *i.e.*, group I (character-combination Nos.1～18) and group II (Nos.19～27). Significant correlations were accounted as 34.3% (179/522 cases) and 96.2% (251/261 cases) in groups I and II, respectively. Those averages and their s.ds. through the whole combinations within the groups were found to be 29.83±20.11 and 83.67±0.47, respectively, and 47.78±30.23 in the whole cases.

According to the tripartite classification, type B (=4 strains) and type C (=25 strains) showed

significances in 59/108 cases (=54.6%) and 371/675 cases (=55.0%), respectively. No clear difference between them was found at all.

The three strains showing relatively the larger and the smaller values in the correlation coefficients were picked-up in the respective correlation-combinations (=27), regardless of the positive or the negative statuses. These characters and techniques confirmed in the experiments were to be looked upon as something useful, having some universal validities in the experiments of strain differentiations.

Moreover, some new techniques, by which correlation coefficients and linear regressions based on the respective character-combinations were re-calculated in view of correlation between them, were adopted. Although some findings were ascertained, several problems were left unascertained, hence further experiments might be requested.

It was noticeable that the thickness showed relatively stable status (right column of Table 3).

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