Local and Chronic Variations in Some Characters of the Lady-Beetle Harmonia axyridis

AUTHOR(S):

Komai, Taku; Chino, Mitsushige; Hosino, Yasushi

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By

Taku KOMAI, Mitsushige CHINO and **Yasushi HOSINO**

Zoological Institute, University of Kyoto

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Introduction

Dobzhansky (1933 & 1941) has reported his study on the local variation of the elytral pattern of the common lady-beetle, *Harmonia axyridis* Pallas. According to him, "Westcentral Siberia (Altai, Yeniseisk) is occupied by a race manifesting nearly always the pattern *axyridis*. In central Siberia the yellow forms appear and rapidly displace *axyridis*, which on the Pacific Coast of Siberia and in China is very rare or is absent. *Spectabilis* and *conspicua* are found in the Far East only, the latter apparently reaching a high frequency in Japan. *Aulica* is nowhere frequent, but is found almost everywhere in the Far East. The variation in this species could be expressed in terms of frequencies of the genes determining the various patterns, just as well as in terms of frequencies of the patterns themselves. The contradictory results of Tan and Li on the one side, and of Hosino on the other, make such calculations meaningless for the time being." (Dobzhansky 1941 p. 69). Hosino has been working on the inheritance of these patterns since 1933, and the results were published in his serial reports (1936 ~ '46) and also in the Journal of Genetics 40 (1940). He has been of the opinion from the beginning that all these different patterns are due to a series of genes of the multiple-allelic type. Tan and Li (1934) who studied the same problem in China held the view that these patters were due to interactions of several genes. In a more recent report (1946), however, Tan interprets the inheritance of these patterns on the basis of multiple allelism.

Local Variation

As to the local variation in the relative frequency of these patterns, Chino recorded in 1912 and in 1918 his study based on materials collected from seven localities in Japan. Later Kurizaki (1927) supplemented Chino's study by his data based on the materials from eight localities

in Japan and in Korea. This author also noticed that some beetles have a transverse ridge-like process near the distal end of the elytra, and that the percentage of such individuals also show local variation. Hosino has been able to show that this character is due to a single autosomal gene, and that the presence of the ridge behaves as a dominant.

Recently, we have been able to secure, through the kindness of our friends, extensive materials of this beetle from various localities in Japan, as well as in Korea and China, which enabled us to study this problem more in detail. Futhermore, some of these localities have supplied us with materials collected on different occasions, between which there are from twenty to thirty year intervals. Thus we have been able to see a change in the constitution of the population of this beetle which took place during those periods. In Table 1 are presented the data concerning the local variation of these characters.

As shown in the table, in Japan as a whole the type *succinea*, in which are included all of the 'varieties' with a reddish-brown ground color, is to be found less than 50% of the whole population. Thus in Hokkaido and in the north-eastern districts of Honsyu this type comprises about 50%. The percentage decreases gradually as we go to the south-western districts of Honsyu and it becomes only 3% in Kyusyu. Of the districts between these two extermities, Kanto and Nagono have 30 ~ 40%, Gihu and Nagoya 30-%, Kyoto and Osaka 15 ± %, Okayama and Hirosima 10 ± % and Sikoku about 10% *succinea*. In Korea the value suddenly increases to 80+, which is nearly the same as in Manchuria and in North China.

The percentage of the beetles having the elytral ridge shows a similar local variation. Almost all those found in Hokkaido have this ridge; of those inhabiting the north-eastern and central districts of Honsyu down to Nagoya, 40% are provided with the ridge. The percentage decreases gradually westwards. Thus in Kyoto and Osaka districts 30%, in Tyugoku 20%, and in Sikoku and Kyusyu about 10%, have the ridge. In Korea and Manchuria they are similar to those in Hokkaido, where nearly all are provided with the ridge.

Chronic Variation

Table 2 presents data concerning the chronic changes in the constitution of the populations in each locality.

The materials from Tokyo which were collected on five occassions in 27 years show that scarcely any significant change took place in the mean time. The same is apparently true of the two lots of materi-

Table 1. Percentages of different pattern types, and also of those provided with the elytral ridge among the materials from various localities.

In *succinea* are included all 'varieties' having reddish-brown ground color. The localities are arranged from north-east to south-west. * Kurisaki's data, ** Tan & Li's data.

Locality	Year	succinea	axyridis	spectabilis	conspicua	Ridge	Total
Sapporo	'43, '44	42.9	1.0	21.6	34.3	99.5	1184
Simamatu (Hokkaido)	'44	43.1	0.0	26.4	30.6	100.0	72
Akita	'44	60.0	2.2	9.6	28.2	42.2	175
Yamagata	'44, '45	34.0	5.9	10.0	50.2	53.8	253
Nikko	'14	47.3	3.5	8.2	41.0	—	451
Tutiura	'14	52.4	3.9	8.7	35.1	—	231
Takasino (Saitama Pref.)	'45	36.9	3.5	11.8	47.7	58.6	5758
Tokyo	'42	34.3	3.9	7.3	54.5	55.6	178
Suwa	'42, '43	32.0	5.0	13.0	49.8	53.2	823
Matumoto	'13, '14	41.2	4.8	12.3	41.6	—	693
Nakatugawa	'16	30.3	5.9	16.4	47.3	—	152
Gihu	'40	19.0	4.8	11.7	64.4	41.6	272
Nagoya	'40	26.0	6.7	9.6	57.8	36.3	135
Terazu (Aiti Pref.)	'46	29.8	3.1	15.3	51.9	—	131
Kyoto	'40—'43	15.3	5.1	15.8	63.7	24.4	2494
Osaka	'39	16.7	3.3	13.8	66.1	24.9	181
Tondabayasi	'43, '44	16.0	5.7	10.3	68.0	23.8	194
Amagasaki	'40	13.7	3.4	10.9	71.9	20.5	386
Akasi	'44	13.3	5.4	15.0	66.3	18.8	240
*Okayama	'25	10.5	—	—	—	24.0	200
Onomiti	'44	12.3	4.1	13.7	69.9	18.8	219
Hirosima	'44	4.3	2.2	26.1	67.4	10.9	46
Matuyama	'44	10.7	5.8	19.1	64.1	11.2	534
Koti	'45, '46	9.4	8.6	20.1	61.9	8.0	673
Hukuoka	'44	2.3	2.2	11.1	83.6	12.1	995
*Miyazaki	'25	—	—	—	—	17.4	350
*Suigen (Korea)	'25	85.8	—	—	—	97.0	402
Mukden	'44	90.7	0.0	4.5	4.6	96.5	1865
Sekiho (Jehol)	'44	82.4	0.0	12.1	4.4	98.9	91
**Peiping	?	83.3	0.0	8.9	7.3	—	9635

als from Tondabayasi near Osaka collected on occasions within a 30 year interval, as well as the two lots from Hukuoka collected on

Table 2. Data of chronic changes in the percentages of different pattern types and also in those of the individuals with the elytral ridge (*Kurizaki's data)

Locality	Year	succinea	axyridis	spectabilis	conspicua	Ridge	Total
Sapporo	*'23	83.9	—	—	—	99.5	398
	'44	42.9	1.0	21.6	34.3	99.5	1184
Suwa	'12, '13	42.6	4.6	9.5	42.3	—	2005
	'14	41.7	5.6	10.9	41.8	—	1413
	'15, '17	43.4	4.8	10.7	41.1	—	2059
	'17, '20	42.4	4.4	10.6	42.4	—	4512
	'30	37.5	3.9	10.2	48.4	—	13157
	'42, '43	32.0	5.0	13.0	49.8	53.2	823
Tokyo	'14	36.0	2.3	9.6	52.1	—	303
	'17	45.3	0.9	23.1	30.8	—	117
	*'24	45.2	—	—	—	58.0	200
	'30, '31	39.6	3.7	11.0	45.8	52.0	2283
	'42	34.3	3.9	7.3	54.5	55.6	178
Gihu	*'23	26.4	—	—	—	49.0	239
	'40	19.0	4.8	11.7	64.4	41.6	272
Tondabayasi	'11, '13	11.9	6.2	10.6	71.3	—	672
	'43, '44	16.0	5.7	10.3	68.0	23.8	194
Matuyama	*'25	17.1	—	—	—	4.0	158
	'44	10.7	5.8	19.1	64.1	11.2	534
Hukuoka	*'25	3.1	—	—	—	25.0	229
	'44	2.3	2.2	11.1	83.6	12.1	995

occasions within a 20 year interval. The materials from Sapporo, on the other hand, show a rather striking difference between the lot collected in 1923 and that collected in 1944. While *succinea* comprised 83.9% of the former lot, it decreased to 42.6% in the latter. As there can be no personal equation in the classification of the patterns, there is no doubt that this change actually took place. The materials from Suwa are still more noteworthy. Although the lots collected in the period from 1912 to 1920 show little change in the constitution of the population during this period, that of 1930 shows a fairly striking difference from the above: the percentage of *succinea* decreased and that of *conspicua* increased in these 10 years. This tendency is more pronounced in the population of 1942 ~ '43. Thus, in the period from 1920 to 1930 *succinea* lost 5.15 ± 0.65%, while *conspicua* gained 6.31 ± 0.66%, and in the period from 1930 to 1942 ~ ,43 *succinea* lost 5.55±1.68%, while *conspicua* gained 1.57±1.80%. All these difference, except that mentioned last, are statistically significant. These changes

may be interpreted as evidence that the beetle population of Hokkaido, which had resembled that of the Asiatic Continent, came nearer to that of Honsyu, and that the population of Suwa which had resembled that of the north-eastern district of Honsyu, approached that of Gihu-Nagoya district in these 20 years. Similar changes seem to have occurred in the materials of Gihu and Matuyama also. The total material from either of these localities, however, is too small to make the distinction of the lots of the different years statistically significant. As for the elytral ridge too, a rather significant change may be perceived in the materials from Hukuoka and Matuyama ; especially the difference between the two lots from Hukuoka is within the limit of statistically significant. The cause of all these chronic changes seen in the color patterns and elytral ridge in unknown. It is conceivable, however, that the change in the habitat of the beetle, brought about mainly by human agency, is responsible for them.

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