A METHODOLOGICAL CONSIDERATION OF COMPARISON OF INSECT FAUNAS BASED ON THE QUANTITATIVE METHOD

Kimoto, Shinsaku

https://doi.org/10.5109/2350

出版情報：ESAKIA. 5, pp.1-20, 1966-11-15. Hikosan biological laboratory, Faculty of Agriculture, Kyushu University
バージョン：
権利関係：

ESAKIA NO. 5 NOVEMBER 15, 1966

A METHODOLOGICAL CONSIDERATION OF COMPARISON OF INSECT FAUNAS BASED ON THE QUANTITATIVE METHOD*

BY

Shinsaku KIMOTO

I. Preference

Contributions to the zoogeography of insects have worked out by enormous numbers of entomologists. On the other hand, it has been said that insects are a difficult group for the study of zoogeography as compared with the groups of Vertebrata. The reason why insects are unsuitable for the research of zoogeography may be partly attributed to, of course, insufficiently worked taxonomic and faunistic knowledge, but mainly to their enormous numbers of species. From this point of view, its special methodological consideration is to be required. To solve the difficulty resulted by the enormous number of species, quantitative treatment should be considered as one of the most useful tools.

This paper mainly concerns about the methodological consideration on the study of the quantitative zoogeography rather than discussion on the zoogeographical facts themselves.

In the course of this study, I am indebted to Prof. K. Yasumatsu, Kyushu University, for his kind guidance and encouragment. Also my thanks are due to Prof. M. Chûjô, Kagawa University, Dr. J. L. Gressitt, B. P. Bishop Museum, Dr. I. K. Lopatin, Tajik State University, Mr. J. A. Wilcox, New York State Museum, Dr. Y. Ono and Mr. N. Odani, Kyusyu University, who supplied me important reprints of their papers which were indispensable to complete this paper.

II. Various indices hitherto proposed for the comparison of faunas

Up to the present, the studies on the comparison of faunas based on quantitative methods have been worked out by many workers, and various indices have been proposed to express the degrees of similarity of faunas. Most of the indices hitherto proposed can be classified into two. These are :

1) Indices based on the number of common species and the total number of species occurring in each fauna. These are *Coefficient* of *Closeness* by Otsuka

---

* Contribution Ser. 2, No. 32, Hikosan Biological Laboratory, Kyushu University, Mikosan.

(1936), *Standard Common-ratio* by Nomura (1939 & 1940) (= *Simpson's Coefficient*, 1943), *Resemblance Equation* by Preston (1962), *Coefficient* of *Difference* by Savage (1960) and so on. On the other hand, *Coefficient* of *Community* by Jaccard (1902) and *Percentage of Affinity* by Masamune (1931) were proposed for the comparison of flora.

2) Indices based on the ratio of different distributional pattern* consisting each fauna, such as *Correlation Index* by Nomura (1940), Steyskal's work on the Ephydridae of Michigan and Florida, and so on.

As far as I am aware, the *Index of Generic Diversity* by Morishita (19.55) and the *Index of Faunistic Change* by Hagmeier and Stults (1964) are rather appropriate methods which may not be included into the above mentioned categories.

It is generally accepted that a taxon, such as the family, subfamily, tribe or genus, is not evenly distributed in the world, but usually maldistributed. It might be suspected that a quantitative representation of respective taxa within a fauna could be considered as one of the criteria for the degree of similarity of each fauna. In this paper, this prediction is to be investigated through the analysis of the Chrysomelid faunas of Japan and the Ryukyu Archipelago as well as some other selected areas where the Chrysomelid faunas have been well investigated.

III. Geographical representation of Chrysomelid species by subfamilies

In order to indicate the coverage of various subfamilies from different areas of Japan and the Ryukyu Islands, geographical representation of Chrysomelid species by subfamilies is given in Table 1. Fig. 1 is presented by a histogram

Table 1. Geographical representation of Chrysomelid species by subfamilies I.

	Sagrinae	Orsodacninae	Zeugophorinae	Megalopodinae	Donaciinae	Criocerinae	Clytrinae	Cryptocephalinae	Chlamisinae	Lamprosomatinae	Eumolpinae	Synetinae	Chrysomelinae	Galerucinae	Alticinae	Hispinae	Cassidinae	Total
Hokkaido	0	0	3	0	8	5	1	11	0	2	5	1	22	25	45	2	8	135
Honshu	0	1	6	1	8	18	6	22	4	3	22	1	27	58	91	7	9	290
Shikoku	0	1	4	0	2	16	6	14	4	3	22	1	15	40	71	6	10	215
Kyushu	0	0	2	1	6	20	5	19	8	5	30	1	14	49	90	8	10	268
Ryukyu Is.	0	0	2	0	1	4	3	4	2	2	20	0	4	19	55	3	10	129

---

* Of course, used in a zoogeographical sense, but not in an ecological sense.

based on the deta shown in Table 1.

The characteristic figures expressed in Table 1 and Fig. 1 are the ratio of Eumolpinae and Chrysomelinae. The representation of Chrysomelinae is dominant in northern areas of Japan and of Eumolpinae is dominant in southern areas.

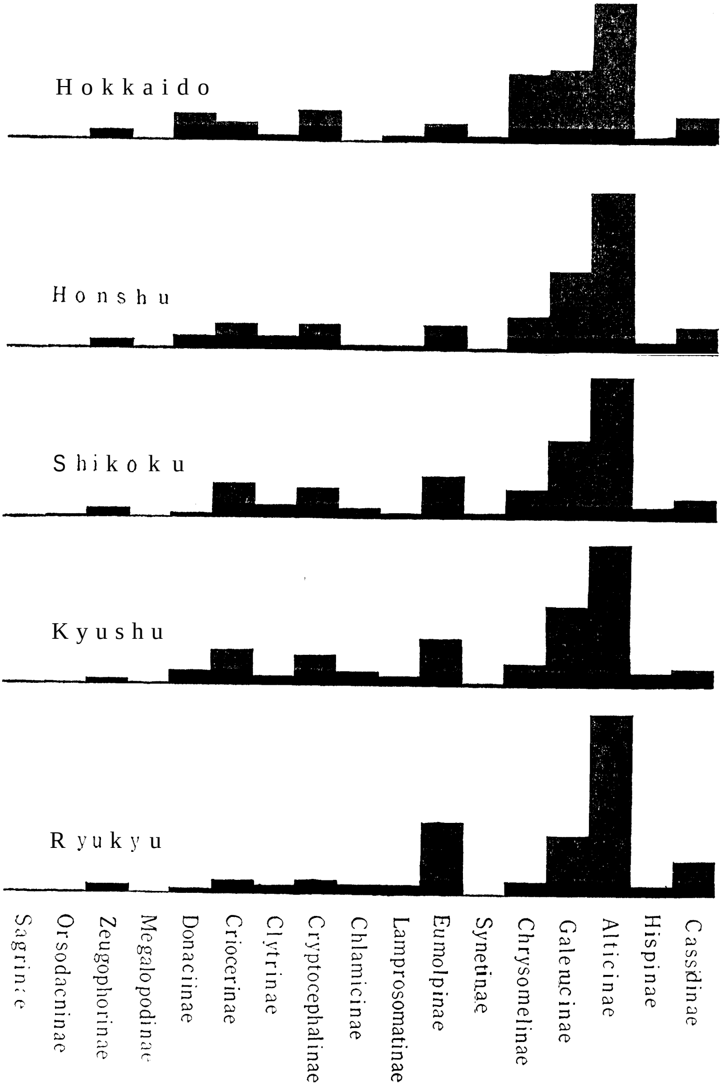

Fig. 1. Geographical representation of Chrysomelid species by subfamilies I.

In the Ryukyu Islands, 20 species of Eumolpinae and only 4 species of Chrysomelinae occur. By contrast, only 5 species of Eumolpinae and 22 species of Chrysomelinae occur in Hokkaido. The figures of Donaciinae and Zeugophorinae indicate a slight dominance in northern areas.

Within the Japanese Archipelago, dominance or inferiority of certain taxon in respective fauna can be considered as one of the important criteria for the degree of the faunal similarity.

In order to get further information of the geographical representation of Chrysomelid species by subfamilies from various areas outside of Japan, I selected the areas where the Chrysomelid faunas have been well investigated. The areas selected for this study are listed in Table 2 with their references to the literature. The figures derived from these literature are shown in Table 3. Figs. 2, 3 and 4 are presented by a histogram based on the same data shown in Table 3. The order of subfamilies is the same as the Fig. 1. Though the faunas of N. China and Korea have been somewhat less well investigated, I made consideration on these faunas too, because their geographical locations are close to the Japanese Archipelago. Also the figures of New Guinea and Australian faunas are from estimated ones made by Gressitt (1961).

Table 2. List of the localities and the works used for the study.

Localities	Works
Ohio State	Wilcox, 1954
Germany	Reitter, 1912
Dnieper River	Lopatin, 1960
Afghanistan	Lopatin, 1963
Korea*	Gressitt & Kimoto, 1961 & '63
N. China*	Gressitt & Kimoto, 1961 & '63
Japan	Kimoto, 1964-'66
Ryukyu Is.	Kimoto, 1964-'66
Taiwan	Chûjô, 1951-'56 & 1958 (partly in press)
S. China	Gressitt & Kimoto, 1961 & '63
Hainan Is.	Gressitt & Kimoto, 1961 & '63
Micronesia	Gressitt, 1955
Samoa	Gressitt, 1957
New Guinea**	Gressitt, 1961
Fiji	Bryant & Gressitt, 1957
Australia**	Gressitt, 1961

* Field work somewhat imperfect.

** Estimated by Gressitt.

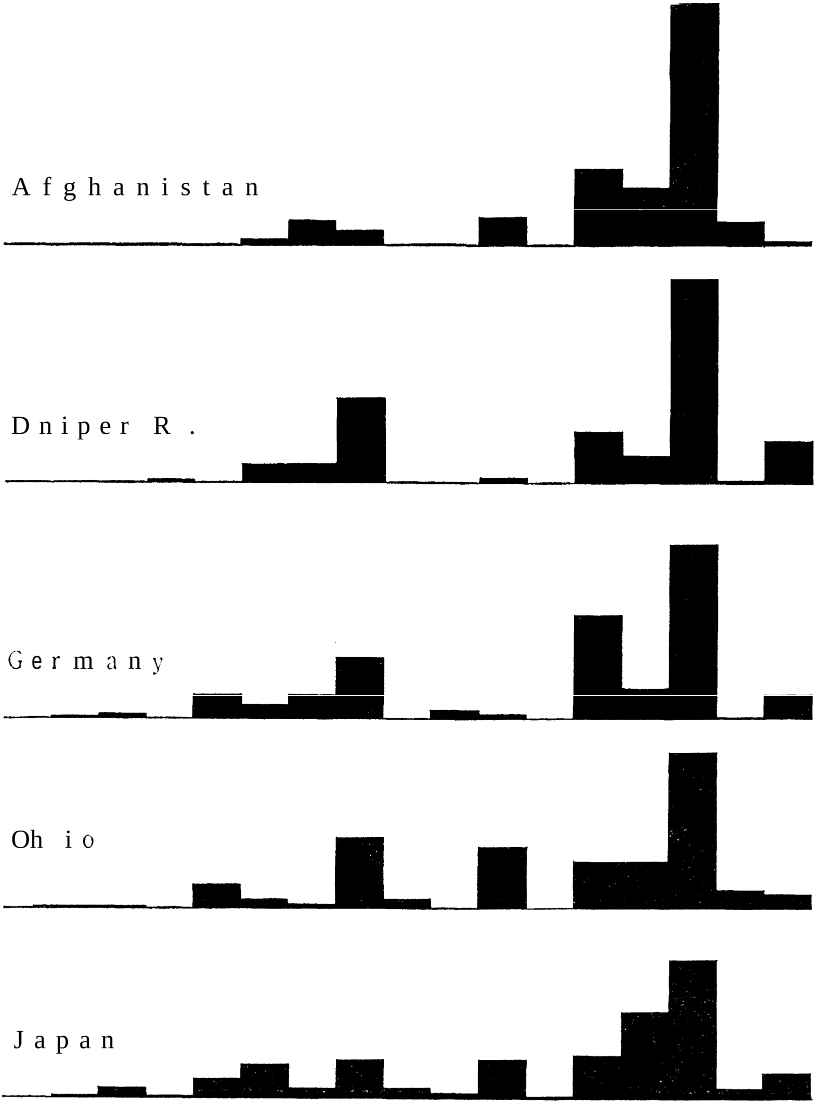

Fig. 2. Geographical representation of Chrysomelid species by subfamilies II.

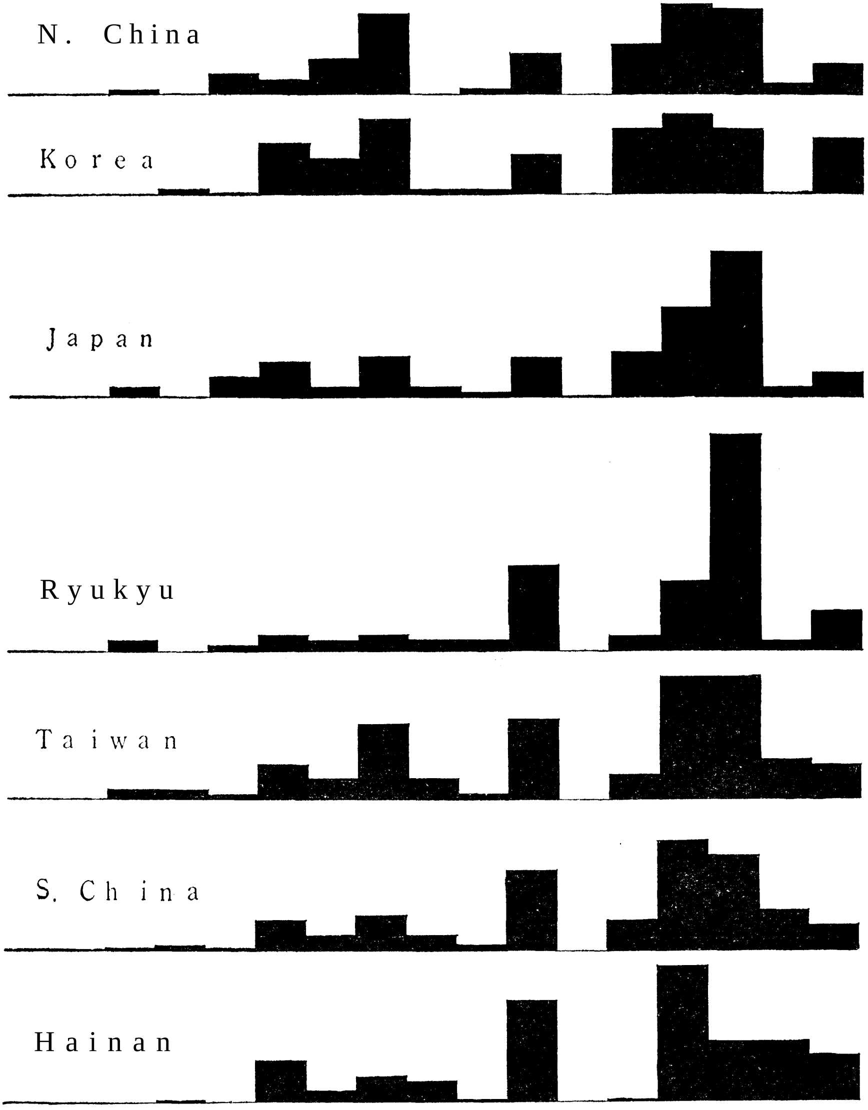

Fig. 3. Geographical representation of Chrysomelid species by subfamilies III.

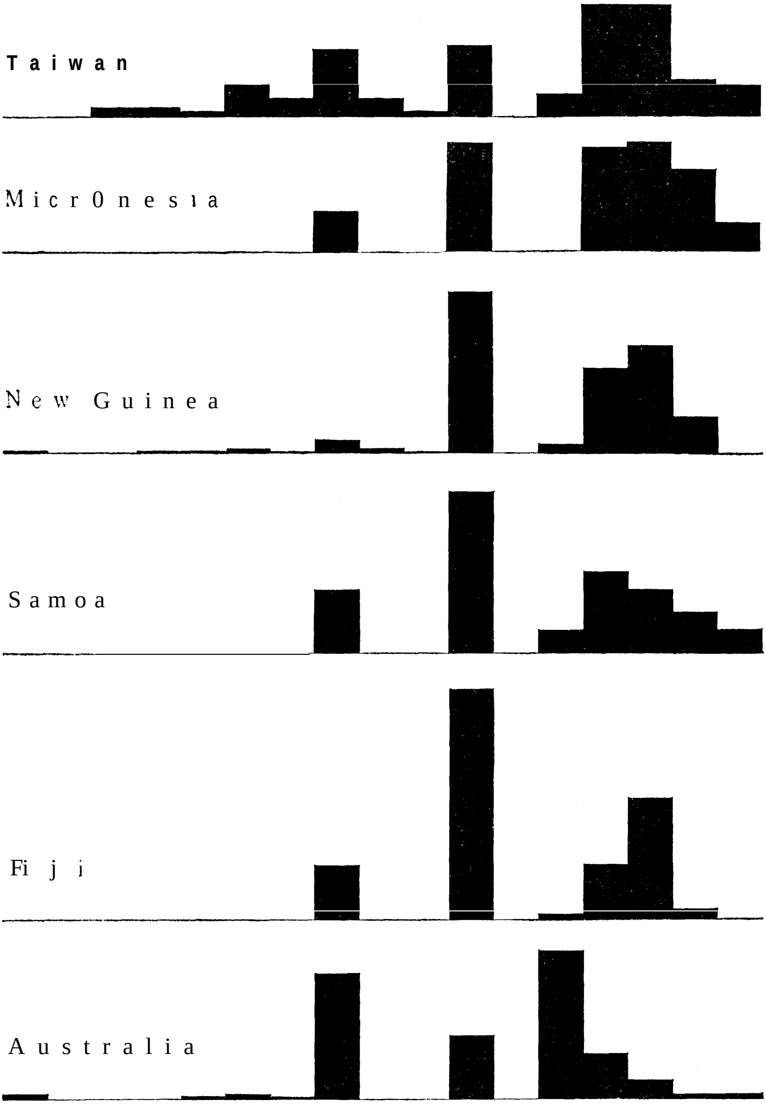

Fig. 4. Geegraphical representation of Chrysomelid species by subfamilies IV.

Table. 3. Geographical representation of Chrysomelid species by subfamilies II.

	Sagrinae	Orsodacninae	Zeugophorinae	Megalopodinae	Donaciinae	Criocerinae	Clytrinae	Cryptocephalinae	Chlamisinae	Lamprosomatinae	Eumolpinae	Synetinae	Chrysomelinae	Galerucinae	Alticinae	Hispinae	Cassidinae	Total
Afghanistan	0	0	0	0	0	1	5	3	0	0	6	0	16	12	50	5	1	99
Dnieper R.	0	0	1	0	9	8	9	37	0	0	3	0	22	12	88	1	18	208
Germany	0	2	4	0	28	14	4	74	0	1	5	0	114	33	194	1	28	522
Ohio State	0	1	I	0	14	7	4	43	6	0	38	1	29	30	97	13	9	293
N. China	0	0	4	2	16	11	2.1	56	1	2	27	1	50	61	57	6	22	340
Korea	0	0	1	3	1	16	11	24	2	1	13	0	21	26	21	1	17	158
Japan	0	1	7	1	14	25	7	33	9	5	32	1	34	71	113	9	21	383
Ryukyu Is.	0	0	2	0	1	4	3	4	2	2	20	0	4	19	55	3	10	129
Taiwan	0	0	6	6	2	21	11	46	14	3	52	0	15	81	80	23	21	318
S. China	11	0	5	13	8	70	31	92	38	5	188	0	76	269	228	97	63	1194
Hainan Is.	0	0	0	2	0	19	6	12	10	4	86	0	0	62	27	26	20	230
Micronesia	0	0	0	0	0	0	0	[illegible]	0	0	408	0	0	7	8	6	2'	34
Samoa	0	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	68	**0**	1	4	3	2	1	22
New Guinea	8	0	0	8	4	40	20	120	40	8	1140	0	72	760	960	320	200	4000
Fiji	0	0	0	**0**	**0**	**0**	**0**	16	0	0	58	0	1	16	28	2	0	131
Australia	63	0	0	0	8	46	4	1200	0	0	590	0	1390	408	190	38	63	4000

IV. Application of Morishita's C_λ-**formula** for the comparison of faunas

In order to examine the degrees of similarity between faunas which are shown in Figs, 1, 2, 3 and 4, some indices are desirable. However, most of indices hitherto proposed are very much influenced by the sample size.

Morishita (1959) proposed an index calculated by a formula named as C_λ for the purpose of comparison of communities. This formula has been used by some ecologists for the comparison of communities, e.g. works on the benthonic community by Ono (1961) and on the Mangrove community by Odani (1964). This index is calculated as follow:

$$C_\lambda=\frac{2\sum\limits_{i=1}^{\infty} n_{1i}\cdot n_{2i}}{(\lambda_1+\lambda_2)N_1\cdot N_2} \qquad 0<C_\lambda<1(\pm)$$

$$\lambda_1=\frac{\sum\limits_{i=1}^{\infty} n_{1i}(n_{1i}-1)}{N_1(N_1-1)}, \quad \lambda_2=\frac{\sum\limits_{i=1}^{\infty} n_{2i}(n_{2i}-1)}{N_2(N_2-1)}$$

Where

N_1 and N_2 be the total numbers of specimens occurring in 1st and 2nd samples.

n_{1i} and n_{2i} be the numbers of specimens of i th species in each sample.

The value of C_λ will be about 1 when the two samples belong to the same community and will be zero when no common species is found between them According to Morishita's test (1959), using an artificial community, value of C_λ keeps almost fixed value for different size of N and not affected by the size of N. This nature is appropriate for measuring the degrees of similarity between faunas.

For the comparison of faunas this index is calculated in this paper as follow

N_1 and N_2 be the total numbers of species occurring in 1st and 2nd faunas.

n_{1i} and n_{2i} be the numbers of species of i-th subfamily of each fauna.

V. Results

In order to indicate the degrees of similarity between Hokkaido, Honshu, Shikoku, Kyushu and the Ryukyu Islands, CA--values were calculated. The results are shown in Table 4. Fig. 8 is made by the series of C_λ-values calculated from the data shown in Table 4. The order of curves is Hokkaido,

Table 4. C--values calculated from geographical representation of Chrysomelid species by subfamilies I.

Ryukyu Is.	Kyushu	Shikoku	Honshu	Hokkaido	
				1.036	Hokkaido
			1.019	1.000	Honshu
		1.021	1.012	.977	Shikoku
	1.020	1.017	1.006	.965	Kyushu
1.027	.981	.977	.944	.913	Ryukyu Is.

Honshu, Shikoku, Kyushu and the Ryukyu Islands from top to bottom. The double mark on the curve is the figure of its self-correlation. The scales on the sides of graph is graduated in CA-value.

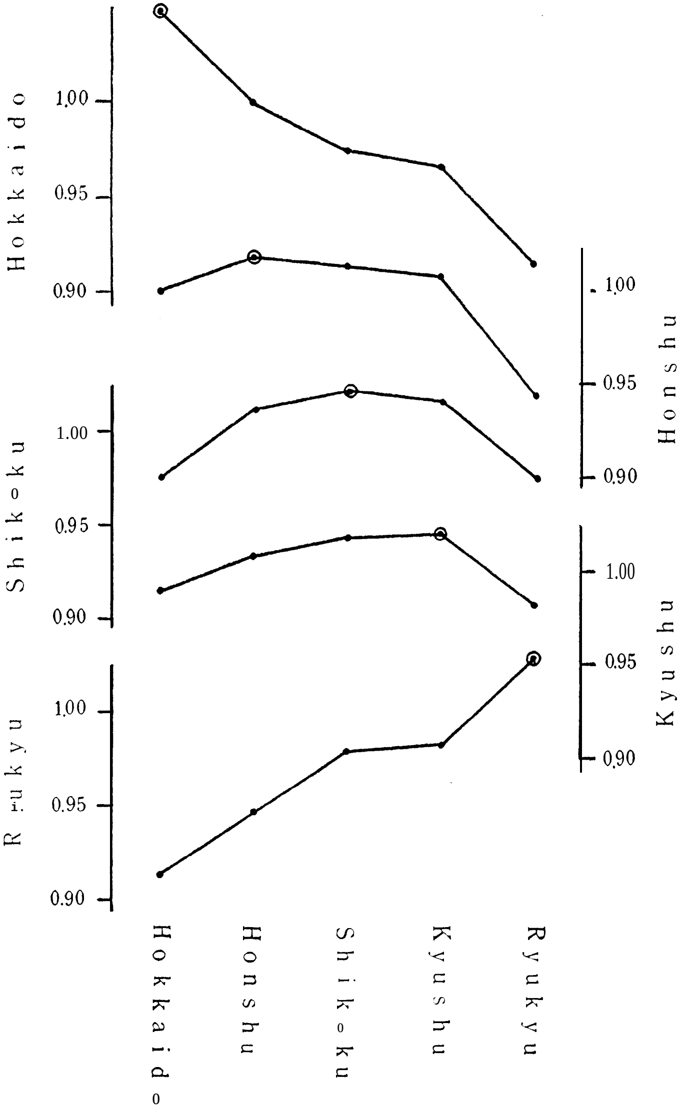

Fig. 5. Series of CA-values calculated from geographical representation of Chrysomelid species by subfamilies I.

Table 5. C_λ-values calculated from geographical representation of Chrysomelid species by subfamilies II.

	Australia	Fiji	New Guinea	Samoa	Micronesia	Hainan Is.	S. China	Taiwan	Ryukyu Is.	Japan	N. China	Korea	Afghanistan	Dnieper R.	Germany	Ohio State
Australia	1.000	.437	.429	.647	.460	.407	.539	.567	.335	.522	.753	.722	.409	.500	.629	.598
Fiji		1.015	.945	1.000	.826	.687	.677	.709	.678	.572	.518	.488	.501	.443	.400	.664
New Guinea			1.003	1.061	1.013	.855	.883	.879	.850	,776	.665	.643	.668	.568	.527	.795
Samoa				1.209	**1.069**	.958	.942	.927	.746	.758	.782	.757	.544	.493	.504	.807
Micronesia					1.141	.981	.994	.986	.886	.880	.788	.739	.724	.666	.614	.887
Hainan Is.						1.026	.958	.924	.701	.783	.749	.783	.504	.460	.417	.629
S. China							1.006	.980	.829	.929	.890	.882	.701	.674	.663	.859
Taiwan								1.015	.880	.950	.895	.878	.758	.770	.724	.904
Ryukyu Is.									1.027	.937	.721	.672	.949	.897	.826	.962
Japan										1.015	.911	.874	.873	.855	.826	.962
N. China											**1.018**	.989	.685	.771	.805	.873
Korea												**1.045**	.601	.713	.730	.801
Afghanistan													1.023	.929	·920	.896
Dnieper R.														1.014	.966	.938
Germany															1.003	.919
Ohio State																1.015

From Fig. 5, it is clearly expressed that there are two distinct gaps from north to south. These are between Hokkaido and Honshu, and between Kyushu and the Ryukyu Islands. Meanwhile, there is no distinct gaps between Honshu,

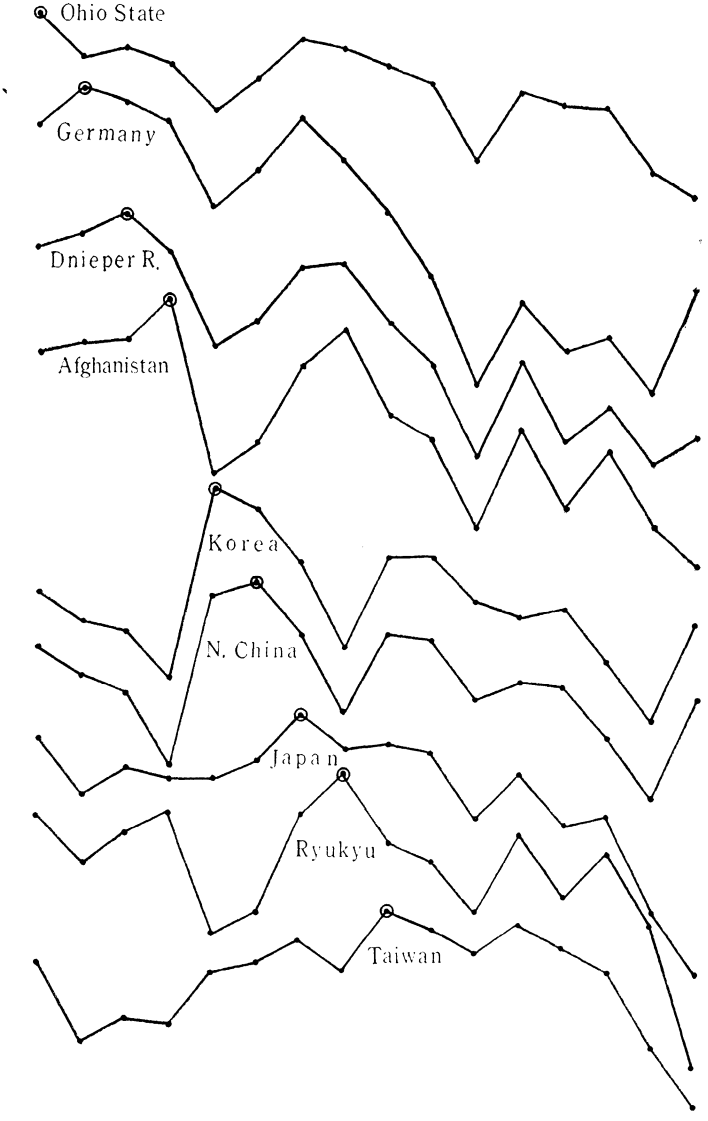

Fig. 6. Series of C_λ-values calculated from geographical representation of Chrysomelid species by subfamilies II.

Shikoku and Kyushu. The results well coincide with generally accepted theories on the zoogeography of insects.

In order to get further information, the figures presented in Table 3 were

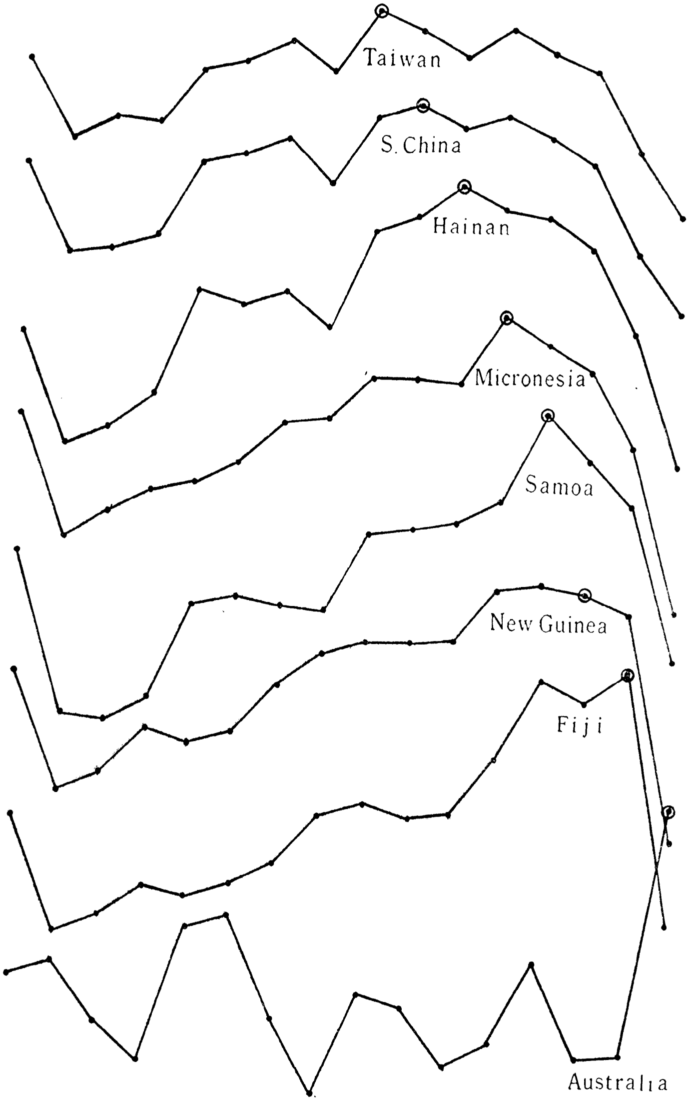

Fig. 7. Series of CA--values calculated from geographical representation of Chrysonzelid species by subfamilies III.

calculated. The results are shown in Table 5. Figs. 6 and 7 were made from the data shown in Table 5. To save a space, scales of CA-values are deleted. From the Figs. 6 and 7, the followings can be summarized.

1) The faunas of Germany, Dnieper River and Afghanistan which belong to the Palaearctic Region are closely related to each other.

2) The fauna of Japan shows different characteristics from any faunas of Germany or Dnieper River or Afghanistan which belong to the Euro-Siberian or Turkmenian Subregions of the Palaearctic Region.

3) faunas of Taiwan, S. China and Hainan which belong to the Indo-Chinese Subregion of the Oriental Region are closely related to each other.

4) The island faunas of the Tropical West Pacific clearly indicate the increasing disharmony of faunas eastward.

5) The island faunas of the Tropical West Pacific including New Guinea show a distinct Oriental facies and strong resemblance to the faunas of Taiwan, S. China and Hainan, and different characteristics from the Australian fauna.

Except for the result 5, all the other results coincide with generally accepted theories of the zoogeography of insects. Although there are still some objections, the result 5 is now becoming a weighty theory of the zoogeography of insects.

The curves for N. China and Korea resemble to each other, but are different from any of Japan or the other Palaearctic areas. However, it must be remembered that the faunas of China and Korea have not been well investigated.

Table 6. CA-values calculated from geographical representation of Chrysomelid species by subfamilies III.

Ohio State	Germany	N. China	Hokkaido	Hohshu	Shikoku	Kyushu	Ryukyu Is.	S. China	
								1.006	S. China
							1.027	.829	Ryukyu Is.
						1.020	.981	.879	Shikoku
					1.021	1.017	.977	.883	Kyushu
				1.019	1.012	1.006	.944	.888	Honshu
			1.036	1.000	.977	.965	.913	.836	Hokkaido
		1.018	.903	.891	.858	.842	.721	.890	N. China
	1.003	.805	.945	.887	.857	.845	.831	.663	Germany
1.015	.919	.873	.951	.955	.958	.963	.936	.859	Ohio State

From Fig. 5, it is apparent that there are two distinct gaps within the Japanese Archipelago, viz. between Hokkaido and Honshu, and between Kyushu and the

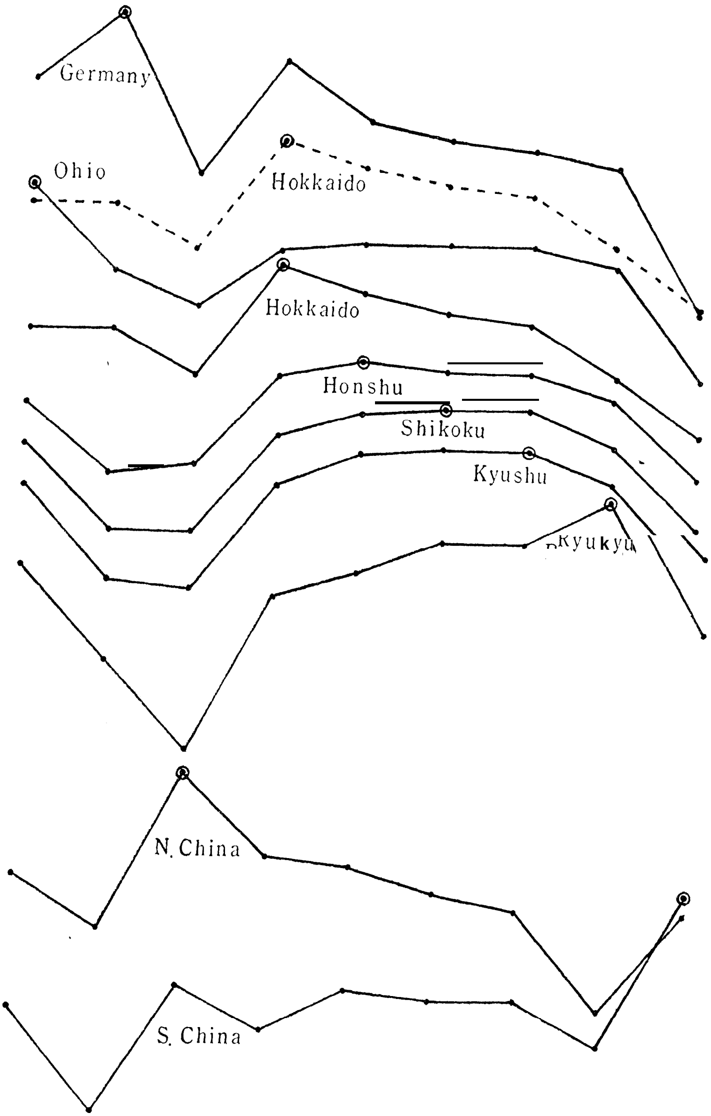

Fig. 8. Series of C_{λ}-values calculated from geographical representative of Chrysomelid species by subfamilies IV.

Ryukyu Archipelago. In order to compare the degree of gap between Hokkaido and Honshu, with that of the other areas of the Palaearctic or the Far Eastern areas, Table 6 was presented.

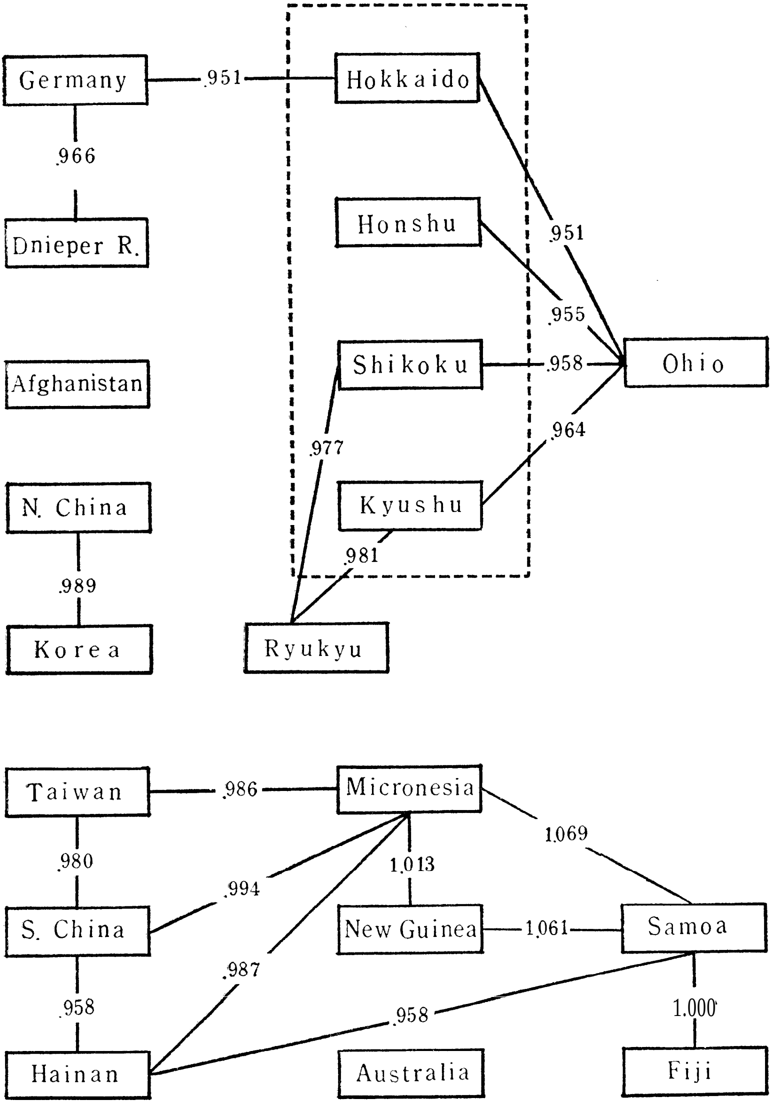

Fig. 9. C_λ-values exceeding 0.950 among the localities compared.

Since the faunas of Germany, Dnieper River and Afghanistan are closely related, Germany is selected as the representative of these three areas. Also, S. China is selected as the representative for faunas of Taiwan, S. China and Hainan Is. In addition to these, the fauna of Ohio of the United State which belongs to Alleghenian fauna is compared.

The results of the CA-values between these areas are shown in Table 6. According to the data of Table 6, a correlation graph is figured (Fig. 8).

The curve for Hokkaido shows an intermediate one if compared with those of Germany and Ohio. It is unfortunate that there is no appropriate data for the comparison of any areas belonging to the Canadian or Hudosonian faunal region which seems to correlate with the Euro-Siberian fauna in the Old World. However, curves for Honshu, Shikoku and Kyushu more closely resemble that of Ohio than that of Germany.

If we consider about the fact that Ohio belongs to Alleghenian faunal region which is equivalent to the Japano-Manchurian faunal region in the east coast of the Old World, the resemblance of curves between Ohio and Honshu, Shikoku and Kyushu is an interesting fact. Such faunal relationship was recognized by Linsely (1953) on the study of Cerambycid fauna of N. America, and was named as the " Alleghenian- Japano-Manchurian Relationship."

The curve for the Ryukyu Islands is also different from any nearby areas. Though I have treated here the entire archipelago as one unit, the Ryukyu islands has to be divided into several faunal groups. The Chrysomelid fauna of the Ryukyu islands has been better investigated as a whole, but not so on individual island at present. Thus the fauna of the Ryukyu islands has to be required further analysis in future, when the fauna of respective island is better worked out.

Fig. 9 was presented in order to summarize the C-values treated in this paper. When CA-values exceed 0.950, those faunas are combined by a line with their CA-values.

VI. Conclusion

In the course of this study, special interest was paid to the methodological consideration of comparison of faunas by quantitatives methods, rather than the zoogeographical facts themselves, and to investigates a prediction that the quantitative representation of taxa consisting of each fauna is appropriate as an important criterion for indicating the degrees of faunal similarity.

As a result of my investigation, faunal similarity based on the quantitative representation of taxa coincides with the generally accepted theories of the zoogeography of insects in most cases, as far as my study on the Chrysomelidae is concerned. Thus, I came to the conclusion that the above-mentioned prediction seems to be an appropriate criterion of the faunal similarity.

&formula proposed by Morishita (1959) is appropriate for the purpose of comparing of faunas, because the value is not affected by the size of the fauna.

Literature Cited

Bryant, G. E. & Gressitt, J. L. 1957. Chrysomelidae of Fiji. Pacific Science 11 : 3-91.

Chûjô, M. 1951. A taxonomic study on the Chrysomelidae from Formosa, part 1, Criocerinae. Kagawa Agr. Coll., Techn. Bull. 2 (2) : 71-120.

Chûjô, M. 1951. A taxonomic study on the Chrysomelidae from Formosa, part 2, Donaciinae. Kagawa Agr. Coll., Techn. Bull. 3 (I) : 43-56.

Chûjô, M. 1951. A taxonomic study on the Chrysomelidae from Formosa, part 3, Magalopodinae. Kagawa Agr. Coll., Techn. Bull. 3 (2): 57-71.

Chûjô, M. 1952. A taxonomic study on the Chrysomelidae from Formosa, part 4, Zeugophorinae. Kagawa Agr. Coll., Techn. Bull. 3 (3): 166-183.

Chûjô, M. 1952. A taxonomic study on the Chrysomelidae from Formosa, part 5, Clytrinae. Kagawa Agr. Coll., Techn. Bull. 4 (1): 32-49; 4 (2): 73-91.

Chûjô, M. 1953. A taxonomic study on the Chrysomelidae from Formosa, part 6, Lamprosominae. Kagawa Agr. Coll., Techn. Bull. 4 (3): 237249.

Chûjô, M. 1954. A taxonomic study on the Chrysomelidae from Formosa, part 7, Cryptocephalinae. Taiwan Mus., Quart. Jour. 7 (3-4): 137-248.

Chûjô, M. 1955-'56. A taxonomic study on the Chrysomelidae from Formosa, part 9, Chlamisinae. Kagawa Agr. Coll., Techn. Bull. 7 (1) : 51-59 (1955) ; 7 (2) : 153 -- 167 (1956).

Chûjô, M. 1956. A taxonomic study on the Chrysomelidae from Formosa, part 8, Eumolpinae. Philip. Jour. Sci. 85 (1) : l-180.

Chûjô, M. 1958. A taxonomic study on the Chrysomelidae from Formosa, part 10, Chrysomelinae. Taiwan Mus., Quart Jour. 11 (1-2) : 1 -85.

Chûjô, 1962. A taxonomic study on the Chrysomelidae from Formosa, part 11, Galerucinae. Philip. Jour. Sci. 91 (l-2): l-239.

Chûjô, M. A taxonomic study on the Chrysomelidae from Formosa, part 12, Alticinae (in press).

Chûjô, M. A taxonomic study on the Chrysomelidae from Formosa, part 13, Hispinae (in press).

Chûjô, M. A taxonomic study on the Chrysomelidae from Formosa, part 14, Cassidinae (in press).

Gressitt, J. L. 1955. Insects of Micronesia, Col. Chrysomelidae 17 (1) : I-60.

Gressitt, J. L. 1957. Chrysomelidae of Samoa (Col.). Hawaiian Ent. Soc., Proc. 16 (2): 241-258.

Gressitt, J. L. 1961. Problems in the Zoogeography of Pacific and Antarctic insects. Pac. Ins. Mon. 2: l-94.

Gressitt, J. L. & Kimoto, S. 1961. The Chrysomelidae of China and Korea I. Pac. Ins. Mon. 1A : l-299.

Gressitt, J. L. & Kimoto, S. 1963. The Chrysomelidae of China and Korea II. Pac. Ins. Mon. 1B : 301-1026.

Hagmeier, E. M. & Stults, C. D. 1964. A numerical analysis of the distributional patterns of North American Mammals. Syst. 2001. 13 (3) : 125-155.

Jaccad, P. 1902. Gezetze der Pflanzenvertheilung in der alpinen Region. Flora, 90: 349-377 (original not seenj.

Kimoto, S. 1964. The Chrysomelidae of Japan and the Ryukyu Islands I. (Subfamilies Orsodacninae, Zeugophorinae, Megalopodinae and Donaciinae). Kyushu Univ., Jour. Fac. Agr. 13 (1): 99-118.

Kimoto, S. 1964. The Chrysomelidae of Japan and the Ryukyu Islands II. (Subfamilies Criocerinae and Clytrinae). Kyushu Univ., Jour. Fac. Agr. 13 (1) : 119-139.

Kimoto, S. 1964. The Chrysomelidae of Japan and the Kyukyu Islands III. (Subfamilies Cryptocephalinae, Chlamisinae and Lamprosomatinae). Kyushu Univ., Jour. Fac. Agr. 13 (1): 141-164.

Kimoto, S. 1964. The Chrysomelidae of Japan and the Ryukyu Islands IV. (Subfamilies Eumolpinae and Synetinae). Kyushu Univ., Jour. Fac. Apr. 13 (2): 235-262.

Kimoto, S. 1964. The Chrysomelidae of Japan and the Ryukyu Islands V. (Subfamily Chrysomelinae). Kyushu Univ., Jour. Fac. Agr. 13 (2) : 263-286.

Kimoto, S. 1964. The Chrysomelidae of Japan and the Ryukyu Islands VI. (Subfamily Galerucinae I). Kyushu Univ., Jour. Fac. Agr. 13 (2): 287-303.

Kimoto, S. 1965. The Chrysomelidae of Japan and the Ryukyu Islands VII. (Subfamily Galerucinae II). Kyushu Univ., Jour. Fac. Agr. 13 (3): 369-400.

Kimoto, S. 1965. The Chrysomelidae of Japan and the Ryukyu Islands VIII. (Subfamily Alticinae I). Kyushu Univ., Jour. Fac. Agr. 13 (3) : 401-429.

Kimoto, S. 1965. The Chrysomelidae of Japan and the Ryukyu Islands IX. (Subfamily Alticinae II). Kyushu Univ., Jour. Fac. Agr. 13 (3) : 431-459.

Kimoto, S. 1966. The Chrysomelidae of Japan and the Ryukyu Islands X. (Subfamily Alticinae III). Kyushu Univ., Jour. Fac. Agr. 13 (4): 601-633.

Kimoto, S. 1966. The Chrysomelidae of Japan and the Ryukyu Islands XI. (Subfamilies Hispinae and Cassidinae, and Bibliography). Kyushu Univ., Jour. Fac. Agr. 13 (4): 635-671.

Linsely, E. G. 1.963. Bering Arc Relationships of Cerambycidae and their host plants. Pacific Basin Biogeography, Bishop Museum Press, 159-178.

Lopatin, I. K. 1960. Materials on the fauna and ecology of leaf-beetles (Col. Chrysomelidae) of the southern Back Bank of the Dnieper River. Rev. d'Ent. URSS 39 (3) : 629-642 (in Russian with English summary).

Lopatin, I. K. 1963. Die Chrysomeliden (Col.) Afghanistans auf Grund der Herrn J. Klapperich in den Jahren 1952/53. Hist.-Nat. Mus. Nat. Hungarici, Zool., Ann. 55 : 349 378.

Morishita, M. 1955. The relation between the number of genera and the number of species. Physiology and Ecology, Osaka, 6 (2): 118-126 (in Japanese with English abstract).

Morishita, M. 1959. Measuring of the dispersion of individuals and analysis of the distributional patterns. Kyushu Univ., Mem. Fac. Sci., Ser. E (Biology), 2 (4) : 215-235.

Morishita, M. 1959. Measuring of interspecific association and similarity between communities. Kyushu Univ., Mem. Fac. Sci., Ser. E (Biology), 3 (1):

65-80.

Masamune, G. 1931. A table showing the distribution of all the genera of flowering plants which are indigenous to the Japanese Empire. Taihoku Botanic Garden, Ann. Report. I. (original not seen).

Nomura, K. 1939. Studies on the Moth-fauna of the Island of Tanegashima, South Kyushu. Vol. Jubilare Prof. Sadao Yoshida, Osaka, 601-634 (in Japanese with English summary).

Nomura, K. 1940. On the methods of comparison of faunae or florae, with special reference to the correlation method. Kyushu Univ., Bull. Fac. Agr. 9 (2): 235-262 (in Japanese with English summary).

Odani, N. 1964. An analysis of dispersion of the Mangrove communities of Iriomote- jima, Yaeyama Group, the Ryukyus. Committee on Foreign Scientific Research, Kyushu University, Reports No. 2: 181-246 (in Japanese with English summary).

Ono, Y. 1961. An ecological study of the *Brachyuran* community on Tomioka Bay, Amakusa, Kyushu. Rec. Oceanographic works in Japan (Special Number 5): 199-210.

Otsuka, Y. 1936. The fauna1 character of the Japanese Pleistocene marine Mollusca, as-evidence of climate having become colder during the Pleistocene in Japan. Biogeograph. Soc. Japan 6 (16): 165-170.

Preston, S. W. 1962. The Canonical distribution of commonness and rarity. Ecology 43 : 185-215, 410-432.

Reitter, E. 1912. Fauna Germanica 4: 236 pp., pls. 129-152.

Savage, J. M., 1960. Evolution of peninsular herpetofauna. Syst. 2001. 9 : 184 - 212.

Simpson, E. H. 1949. Measurement of diversity. Nature 163: 688.

Simpson, G. G. 1943. Mammals and the nature of continents. Amer. J. Sci. 241: l-31.

Steyskal, G. C. ***1958.*** A method for analysis of local fauna1 list. Xth Intern. Congr. Ent. 1: 761-765.

Wilcox, J. A. 1954. Leaf beetles of Ohio (Col. Chrysomelidae). Ohio Biological Survey, Bull. 43: 353-506.