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ALLOMETRIC ANALYSES IN WING LENGTH AND WING INDICES OF *DROSOPHILA* SPECIES

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ABSTRACT

F. J. Lin, T. C. Wang and H. C. Tseng (1973). *Allometric analyses in wing length and wing indices of* Drosophila *species.* Bull. Inst. Zool., Academia Sinica, **12**(2): 59-69. The relationships among wing characters (*i. e.*, wing-vein indices and wing length) of *Drosophila melanogaster* species group were statistically analysed. The results from these analyses are listed as follows: (1) negative correlation exists between Costal and 4th vein, Costal and 4th-costal vein, and Costal and Acrocostal indices; positive correlation exists between 4th-costal vein and 4th vein, and 4th-costal veins and Acrocostal indices. (2) the sexual differences of the wing characters are as follows: female larger than male in Costal, 4th-costal vein indices and wing length; male larger than female in 5th-cross vein index; and indifferences in 4th vein and Acrocstal indices. (3) these quantitative data of wing characters can be applied for phylogenetic considerations of orthodox systematics.

The terms of wing-vein indices, the Costal index (C-index), the 4th vein index (4V-index), the 4th-costal vein index (4c-index) and the 5th-cross vein index (5x-index) were first described by Sturtevant[14,15]; they were calculated from the ratio of a section of a vein to another section of the same vein or other vein, and used as the taxonomic characters for the drosophilid fauna. He[16] further stated that the C-index and the 4V-index are somewhat less variable and more useful as specific characters. He also stated that the 4V-index showed a weak negative correlation with the C-index. The negative correlation between the C-index and the 4V-index is called "Sturtevant's rule" by Okada[10]. Burla[5] studying above mentioned four wing indices of 17 species of West African *Pholadoris* flies of the genus *Drosophila*, concluded that these four morphological characters had mutual relations that if these species were arranged in ascending order of the C-index, the other three indices would assume roughly in descending orders. This is called as "Burla's rule" by Okada[10]. Apparently the "rules" were derived from "Lameree and Geoffrey-Smith's rule"[3,4].

The authors intend here not only to re-examine these rules statistically but also to discuss the possible relationships between flies of the species of *melanogaster* group collected in Taiwan.

MATERIALS AND METHODS

The flies used in this experiment are from

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TABLE 1

Drosophila melanogaster species group of flies used in the analyses and their sources

Species	Subgroup	Stock no.	Locality	Collector (s)
D. trilutea	*takahashii*	0033.4	Alishan	F.J. Lin and J.C. Wu
D. prostipennis	*takahashii*	0093.7	Chi-tou	F.J. Lin and H.C. Tseng
D. sp. from Chi-tou	*suzukii*	0080.7	Chi-tou	F.J. Lin and J.C. Wu
D. lucipennis	*suzukii*	0079.3	Wulai	F.J. Lin and J.C. Wu
D. kikkawai	*montium*	0060.3	Jui-fang	J.I. Ting
D. rufa	*montium*	0068.5	Puli	J.I. Ting
D. bipectinata	*ananassae*	0075.7	Chi-peng	F.J. Lin and H. Wang
D. ananassae	*ananassae*	0095.1	Peng-Hu Id.	H.C. Tseng
D. melanogaster	*melanogaster*	0075.3	Chi-peng	F.J. Lin and H. Wang

laboratory stocks in the Institute as shown in Table 1.

One hundred of wings of each sex of the nine species of *Drosophila* taken randomly from new imago to 15 days old flies were plucked and mounted in cuparal on slides. A total of 1,800 wing specimens including 10,800 calculated character values were examined in this experiment. The wing length and wing indices were measured by an eyepiece micrometer attached on Olympus Z-III stereomicroscope.

The wing length is measured as the distance from the outer cross suture of radius to the tip of the third long vein (R_{4+5}). C-index is measured by dividing the length of the second section of costa (first long vein) by that of the third section of costa. 4V-index is obtained by dividing the length of the ultimate section of the fourth long vein (M_{1+2}) by that of penultimate section of the fourth long vein. 5x-index is obtained by dividing the

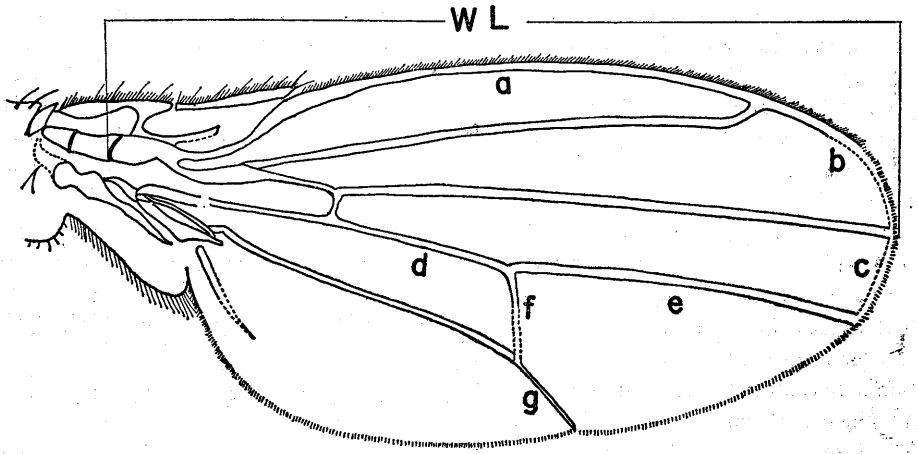

Fig. 1. The wing of *Drosophila*.

C-index=a/b; 4c-index=b/d;
Ac-index=b/c; 4V-index=e/d;
5x-index=g/f; WL=wing length.

length of the last section of the fifth long vein (M_3 $+Cu_1$) by the length of the posterior cross vein (m). 4c-index is obtained by dividing the length of the third section of costa by the penultimate section of the fourth long vein. Ac-index was the first mentioned by Burla[6], is obtained by dividing thethird section of costa by the fourth section of costa (Fig. 1).

Analysis of variance, *t*-test, least significant differences and Spearman's method of rank correlation were employed in these analyses.

RESULTS

Mean values of the wing characters of nine species of *melanogaster* group of flies are shown in Table 2. Sturtevant[16] pointed out that the C-index in the subgenus *Sophophora* of the genus *Drosophila* is in general 3.00 to 1.20, and the 4V-index in the subgenus is 2.00. The C-index (1.51 to 2.98) and the 4V-index (1.96 to 2.66) in this experiment agree with that of Sturtevant's observation. In the present study 4c-index varies from 0.90 to 1.64, the 5x-index from 1.72 to 2.51, the Ac-index from 2.36 to 3.42 and wing length ranges from 1.51 to 2.36 mm (Tables 2, 11). These values are considered to be the characteristics of this species group.

The male C-index of the nine species of *melanogaster* group of flies were arranged in descending order and *t*-values were calculated (Table 3). Sturtevant and Burla stated that negative correlation existed between C- & 4V-, C- & 4c-, and C- & 5x-indices; and positive correlation existed between C-index & wing length; but from the *t*-test of the present analyses there is hardly to say that whether the ranking of these characters, namely 4V-, 4c- and 5x- inidices, agree with the order of C-index. Okada[10] summerized that in supraspecific taxa (subgenus, species group and species, good species and sibling species) and infraspecific taxa (subspecies, race and strain,

TABLE 2

Mean and standard error of the morphological characters (Wing-vein indices and wing length) in the *melanogaster* species of flies

Species	Sex	C-index	4V-index	4c-index	5x-index	Ac-index	Wing length
ananassae	M	1.51±0.082	2.38±0.153	1.64±0.105	1.97±0.166	2.98±0.197	1.98±0.056
	F	1.58±0.093	2.42±0.108	1.60±0.111	1.88±0.184	3.04±0.221	2.25±0.088
bipectinata	M	1.54±0.112	2.31±0.147	1.60±0.116	2.02±0.256	3.42±0.384	1.51±0.038
	F	1.61±0.122	2.34±0.187	1.55±0.108	2.07±0.207	3.38±0.256	1.76±0.061
rufa	M	1.93±0.122	2.66±0.221	1.49±0.117	2.51±0.179	2.74±0.206	1.82±0.108
	F	2.16±0.532	2.55±0.142	1.36±0.070	2.41±0.186	2.76±0.166	2.15±0.083
kikkawai	M	1.95±0.107	2.45±0.155	1.42±0.094	2.21±0.030	2.86±0.202	1.87±0.086
	F	2.18±0.104	2.40±0.154	1.31±0.075	2.14±0.187	2.78±0.158	2.12±0.094
sp. from Chi-tou	M	2.25±0.155	2.50±0.165	1.30±0.103	2.29±0.192	2.66±0.264	1.82±0.052
	F	2.46±0.160	2.49±0.206	1.23±0.119	2.12±0.189	2.68±0.192	2.24±0.079
lucipennis	M	2.39±0.142	2.24±0.140	1.15±0.089	2.18±0.136	2.42±0.221	1.70±0.066
	F	2.55±0.165	2.23±0.152	1.10±0.080	2.12±0.169	2.38±0.147	1.99±0.079
prostipennis	M	2.42±0.191	2.11±0.202	1.12±0.098	2.04±0.205	2.47±0.172	1.84±0.138
	F	2.81±0.177	2.12±0.130	1.00±0.060	1.97±0.201	2.41±0.110	2.22±0.071
melanogaster	M	2.49±0.143	2.32±0.197	1.16±0.088	1.72±0.126	2.36±0.148	2.06±0.105
	F	2.59±0.140	2.32±0.186	1.12±0.076	1.72±0.147	2.41±0.161	2.29±0.073
trilutea	M	2.62±0.133	1.97±0.096	1.00±0.051	2.04±0.111	2.46±0.171	2.01±0.083
	F	2.98±0.165	1.96±0.099	0.90±0.054	1.91±0.131	2.43±0.126	2.36±0.087

Wing length in mm.

TABLE 3

Comparison of male vein indices and wing length in 9 species of *melanogaster* group of flies according to the descending order of C-index

Species	C-index	4V-index	4c-index	5x-index	Ac-index	Wing length
trilutea	2.62±0.133	1.97±0.096	1.00±0.051	2.04±0.111	2.46±0.171	2.02±0.033
t (P)	6.656(<0.001)	15.970(<0.001)	15.731(<0.001)	19.056(<0.001)	4.421(<0.001)	3.735(<0.001)
melanogaster	2.49±0.143	2.32±0.197	1.16±0.038	1.72±0.126	2.36±0.148	2.06±0.105
t (P)	2.933(<0.01)	7.442(<0.001)	3.036(<0.01)	13.298(<0.001)	4.847(<0.001)	12.687(<0.001)
prostipennis	2.42±0.191	2.11±0.202	1.12±0.093	2.04±0.205	2.47±0.172	1.84±0.138
t (P)	1.260(>0.2)	5.239(<0.001)	2.266(<0.05)	5.690(<0.001)	1.735(>0.05)	9.152(<0.001)
lucipennis	2.39±0.142	2.24±0.140	1.15±0.039	2.18±0.136	2.42±0.221	1.70±0.066
t (P)	6.660(<0.001)	11.485(<0.001)	10.971(<0.001)	8.038(<0.001)	6.970(<0.001)	14.282(<0.001)
sp. from Chi-tou	2.25±0.155	2.50±0.165	1.30±0.103	2.29±0.192	2.66±0.264	1.82±0.052
t (P)	15.927(<0.001)	2.203(<0.05)	8.605(<0.001)	1.543(>0.1)	6.016(<0.001)	4.975(<0.001)
kikkawai	1.95±0.107	2.45±0.155	1.42±0.094	2.21±0.030	2.86±0.202	1.87±0.036
t (P)	1.232(>0.2)	7.779(<0.001)	4.664(<0.001)	16.528(<0.001)	4.159(<0.001)	3.621(<0.001)
rufa	1.93±0.122	2.66±0.221	1.49±0.117	2.51±0.179	2.74±0.206	1.82±0.103
t (P)	23.549(<0.001)	11.535(<0.001)	6.676(<0.001)	15.686(<0.001)	15.604(<0.001)	27.076(<0.001)
bipectinata	1.54±0.112	2.31±0.147	1.60±0.116	2.02±0.256	3.42±0.384	1.51±0.038
t (P)	2.161(<0.05)	3.299(<0.01)	2.556(<0.02)	1.638(>0.1)	10.195(<0.001)	69.444(<0.001)
ananassae	1.51±0.032	2.38±0.153	1.64±0.105	1.97±0.166	2.98±0.197	1.98±0.056

t=*t*-distribution to show singnificance of difference between two successive means.

$t_{0.05}$=1.980, significant level.

P=probability.

Wing length in mm.

individuals, sexual forms), 54.5% (110 in 210) of his results are agreed with, 23.2% (51 in 210) insignificant of, and 22.3% (49 in 210) disagreed with the "rules". The torelance of mutual relations between two successive means by ascending or descending order of the C-index are obviously invalid. Thus, the authors tried to get more precise analyses of the wing characters using analysis of variance, least significant difference (LSD) and rank correlation[7] to compare with the previous reports. The factorial analyses of the present results are listed in Table 4. Tables 5, 6, 7 and 8 show that the LSD among species, between sexes and among the wing characters. F-ratios show that the main effects of species, sexes and wing characters, and of the interactions between species and sexes, between species and characters, between sexes and characters and among species, sexes and characters are mutually related (Table 4).

The least significant differences among species (Table 5) show that there is no significance between *lucipennis* & *prostipennis*, *prostipennis* & *melanogaster*, *melanogaster* & *trilutea* and *lucipennis* & *trilutea*; weak significance between *bipectinata* & *ananassae*, whereas mutual relations between evey two species excluding species stated above are at the level of sigificance. Table 6 shows that the least significant difference between male and female, obviously they are quite above the significant level. The mean differences among the characters are shown in Table 7. The least significant differences of these means show that all of the characters are mutually related (Table 8). In C-index the female is significantly larger than the male in total means of the nine species. In 4V-index the total means of the male is larger than that of the female, but shows no significance statistically. In 4c-index the female is significantly larger than the male statistically. The 5x-index shows that the total means of the male is larger than that of the female. In Ac-index there is no difference between the male and the female, however the male is slightly larger than the female. The female has longer wing length than the male in total means as in the C-index and 4c-index. Alternative analysis by *t*-test also shows that the sexual difference of the wing characters

TABLE 4

Factorial analysis of variance for the species, sexes and characters of 9 species of *melanogaster* group of flies

Sources of variations	Sum of squares	Degrees of freedom	Mean squares	F ratio
Main effects:				
Species (Sp)	36.75	8	4.95	229.50**
Sexes (Sx)	8.35	1	8.35	417.50**
Characters (C)	1,998.86	5	399.77	19,988.50**
Interactions:				
Sp:Sx	0.66	8	0.08	4.00**
Sp:C	731.90	40	18.30	915.00**
Sx:C	57.34	5	11.47	573.50**
Sp:Sx:C	10.81	40	0.27	13.50**
Errors	264.14	10,692	0.02	
Total	3,108.81	10,799		

** significant at 1% level.

TABLE 5
Mean difference among species

Species	$\bar{x}$								
rufa	2.2153 (2,658.39)	0.1717**	0.1656**	0.1639**	0.1565**	0.1198**	0.1077**	0.0699**	0.0403**
sp. from Chi-tou	2.1750 (2,610.02)	0.1314**	0.1253**	0.1236**	0.1162**	0.0795**	0.0674**	0.0296**	
kikkawai	2.1454 (2,574.58)	0.1018**	0.0957**	0.0940**	0.0866**	0.0499**	0.0378**		
ananassae	2.1076 (2,529.14)	0.0640**	0.0579**	0.0562**	0.0488**	0.0121*			
bipectinata	2.0955 (2,514.71)	0.0519**	0.0458**	0.0441**	0.0367**				
trilutea	2.0588 (2,470.60)	0.0152**	0.0091	0.0074					
melanogaster	2.0514 (2,461,72)	0.0078	0.0017						
prostipennis	2.0497 (2,459.68)	0.0061							
lucipennis	2.0436 (2,452.40)								

No. in parenthesis shows sum of total.
*, **: least significant difference at 5% and 1% level respectively.

of the nine species of *Drosophila* (Table 9).

Non-parametric Spearman's method of rank correlation was employed for the analysis of mutual relationships between each two characters. As mentioned before *t*-test for the two successive means by ascending or descending order of the wing characters is not a good method for the analysis for the correlation between each two characters (Table 3). Each character of the nine species of *Drosophila* is arranged in ranking order, for instance, in C- index *trilutea* has the highest value in the rank and *ananassae* has the lowest value in the rank. In 4V-index *rufa* has the highest value in the rank and *trilutea* has the lowest value in the rank. In 4c-index *ananassae* has the highest value in the rank and *trilutea* has the lowest value in the rank. In 5x-index *rufa* has the highest value in the rank and *melanogaster* has the lowest value in the rank. In Ac-index *bipectinata* has the highest value in the rank and *melanogaster* has the lowest value in the rank. In wing length *trilutea* has the longest value in the rank and *bipectinata* has the shortest value in the rank. The formula of Spearman's method for the rank correlation is as follow:

$$\rho = 1 - \frac{6\sum(d^2)}{n(n^2-1)}$$

where n is the number of the rank and d is the difference value

The mutual relations between each two characters were calculated, the results are shown in Table 10. There are negative correlations between C- & 4V-indices, C- & 4c-indices, and C- & Ac-indices; positive correlations between 4V- & 4c-indices, and 4c- & Ac-indices; and no correlations for the rest of each two characters.

TABLE 6
Mean difference between sexes

Sexes	$\bar{x}$	
Female	2.1325 (11,515.72)	0.0555**
Male	2.0769 (11,215.52)	

TABLE 7
Mean difference among characters

Characters	$\bar{x}$					
Ac-index	2.7078 (4,874.17)	1.4232**	0.7026**	0.6295**	0.4806**	0.3827**
4V-index	2.3251 (4,185.19)	1.0405**	0.3199**	0.2468**	0.0979**	
C-index	2.2272 (4,009.00)	0.9426**	0.2220**	0.1489**		
5x-index	2.0783 (3,741.05)	0.7937**	0.0732**			
Wing length	2.0052 (3,609.43)	0.7206**				
4c-index	1.2846 (2,312.38)					

TABLE 8
Mean difference for sexes and characters

Sex and C-index	$\bar{x}$	
Female-	2.3287 (2,095.88)	0.2031**
Male-	2.1256 (1,913.12)	

Sex and 4V-index	$\bar{x}$	
Male-	2.3310 (2,097.90)	0.0118
Female-	2.3192 (2,087.29)	

Sex and 4c-index	$\bar{x}$	
Female-	1,3244 (1,192.03)	0.0796**
Male-	1,2448 (1,120.35)	

Sex and 5x-index	$\bar{x}$	
Male-	2.1136 (1,902.40)	0.0708**
Female-	2.0429 (1,838.65)	

Sex and Ac-index	$\bar{x}$	
Male-	2.7140 (2,442.64)	0.0123
Female-	2.7017 (2,431.55)	

Sex and Wing length	$\bar{x}$	
Female-	2.1577 (1,942.00)	0.3050**
Male-	1.8527 (1,667.43)	

** significant at 1% level as on TABLES 6, 7 and 8.

TABLE 9

Sexual differences of means of vein indices and wing length in the *melanogaster* group of flies

Species	C-index	4V-index	4c-index	5x-index	Ac-index	Wing lenghth
trilutea *t* (P)	16.986(<0.001)	0.725(>0.4)	13.462(<0.001)	6.358(<0.001)	1.412(>0.1)	29.108(<0.001)
Sexual difference	F>M	M=F	M>F	M>F	M=F	F>M
melanogaster *t* (P)	4.997(<0.001)	0.276(>0.7)	3.439(<0.001)	0.335(>0.7)	2.286(<0.05)	17.985(<0.001)
Sexual difference	F>M	M=F	M>F	F=M	F=M	F>M
prostipennis *t* (P)	14.976(<0.001)	0.416(>0.6)	10.442(<0.001)	2.438(<0.02)	2.938(<0.01)	24.486(<0.001)
Sexual difference	F>M	F=M	M>F	F>M	M>F	F>M
lucipennis *t* (P)	7.349(<0.001)	0.483(>0.6)	4.178(<0.001)	2.765(<0.01)	1.507(>0.1)	28.171(<0.001)
Sexual difference	F>M	M=F	M>F	M>F	M=F	F>M
sp. from Chi-tou *t* (P)	9.426(<0.001)	0.378(>0.7)	4.447(<0.001)	6.309(<0.001)	0.612(>0.5)	44.406(<0.001)
Sexual difference	F>M	M=F	M>F	M>F	F=M	F>M
kikkawai *t* (P)	15.414(<0.001)	2.288(<0.05)	9.147(<0.001)	3.696(<0.001)	3.119(<0.01)	19.623(<0.001)
Sexual difference	F>M	M>F	M>F	M>F	M>F	F>M
rufa *t* (P)	4.213(<0.001)	4.187(<0.001)	9.534(<0.001)	3.873(<0.001)	0.755(>0.4)	24.227(<0.001)
Sexual difference	F>M	M>F	M>F	M>F	F=M	F>M
bipectinata *t* (P)	4.226(<0.001)	1.261(>0.2)	3.154(<0.01)	1.518(>0.1)	0.866(>0.3)	34.785(<0.001)
Sexual difference	F>M	F=M	M>F	F=M	M=F	F>M
ananassae *t* (P)	5.645(<0.001)	1.693(<0.05)	2.617(=0.01)	3.631(<0.001)	2.026(<0.05)	25.884(<0.001)
Sexual difierence	F>M	F=M	M>F	M>F	F>M	F>M

$t_{0.05}$=1.980, significant level.

P=probability.

TABLE 10
Results of Spearman's rank correlation coefficient

	C-index	4V-index	4c-index	5x-index	Ac-index
C-index					
4V-index	−0.7167*				
4c-index	−0.9833**	0.7333*			
5x-index	−0.2667	0.6500	0.1833		
Ac-index	−0.8417**	0.5167	0.8000**	0.2667	
Wing length	0.4667	−0.3000	−0.3667	−0.6000	0.3500

*, **: significant at 5% and 1% level respectviely.

TABLE 11
Average wing-vein characters in the *melanogaster* group of flies

Subgroup	C-index	4V-index	4c-index	5x-index	Ac-index	Wing length
ananassae	1.51-1.54	2.31-2.38	1.60-1.64	1.97-2.02	2.98-3.42	1.51-1.98
Av.	1.53	2.35	1.62	2.00	3.25	1.75
montium	1.93-1.95	2.45-2.66	1.42-1.49	2.21-2.51	2.74-2.86	1.82-1.87
Av.	1.94	2.56	1.46	2.36	2.80	1.85
suzukii	2.25-2.39	2.24-2.50	1.15-1.30	2.18-2.29	2.42-2.66	1.70-1.80
Av.	2.34	2.35	1.23	2.24	2.54	1.75
melanogaster	2.49	2.32	1.16	1.72	2.36	2.06
takahashii	2.42-2.62	1.97-2.11	1.00-1.12	2.04	2.46-2.47	1.84-2.01
Av.	2.52	2.04	1.06	2.04	2.47	1.98

Interestingly, the mutual relations between C- & 5x-indices, and C-index & wing length from the present results (no mutual relationships in this analysis) are not going with Sturtevant and Burla's rules (positive correlations between C- & 5x-indices, and C-index & wing length), but the direction of their relations points out they are at the same side of the correlation from previous reports[5,6,10,11], will discuss later.

DISCUSSION

The wing of insects is composed of two elements of different origins, the veins and the membranes. The embryology of *Drosophila* wing has been thoroughly studied[1,2]. They have at various occassions been ascertained to develop independently[9], and their developments follow with the allometric growth of the logic of Reeve and Myrray[13]. As pointed before, Sturtevant[16] found that the C-index is negatively correlated with the 4V-index (higher C-index with lower 4V-index), Burla[5,6] refered that the C-index is positively correlated with the wing length and the 4V-index is negatively correlated with the wing length in drosophilid flies. Moreover, Okada[11] proved statistically that Sturtevant and Burla's findings were acceptable not only by the infraspecific level but also by the supraspecific hierarchies in the subgenus *Drosophila*. The generalization were eventually called "Sturtevant and

Burla's rules" by Okada[10].

As summerized by Okada[11], the allomorphic patterns of the wing characters show that they are subject to phylogenic developments and harmonious to some extents with ontogenic developments. The characteristics in comparatively higher systematic categories exhibit diphasic or triphasic species-form allomorphosis. Terms of the allometric growth were proposed by him, tachymetry and bradymetry referring to the positive allometric growth and negative allometric growth, respectively. He also pointed out that the degree of C-index and wing length is roughly correlated with the phylogenic constant as expressed by Burla[6] and C-index and wing length are proved acceptable in the forms having tachymetric allomorphosis. Moreover, he expressed that the phenomenon of Lameree & Geoffrey-Smith referring to the occurence of the similar patterns of allomorphosis both among the individuals of each related species and among these nine related species, in which the interspecific evolutionary change in wing-vein correlations is more diversified than the infraspecific one[12]. Waddington[17] demonstrated that the flies of *Drosophila melanogaster* the C-index increased as the fly getting older (1.25 at 18 hours, 2.93 at 28 hours and 3.33 at 38 hours after pupation), $\alpha = 0.65$, heterauxesis[8], and pointed out that the phases of its development are tempted to be subject to the heterauxesis changes (ontogenic development or ontogenic changes). The fact implies that the increase of C-index in intraspecific level is the same as the increase of C-index in interspecific level. The allomorphosis patterns of the wing-veins and wing length strikingly reflect the hitherto known relationship of insects. The sequence of allomophosis and the Sturtevant and Burla's rules would have some connections with the heterauxetic growth of the wings in the genus *Drosophila*.

Although linear regressions of the wing-vein indices and wing length of the nine species of *melanogaster* group of flies demonstrated here was not calculated, but the same results were obtained by the analyses of non-parametric analysis, *i.e.*, Spearman's rank correlation (Table 10). As shown in the Tables 1 and 2 lineage allomorphosis and species-form allomorphosis, *i.e.*, phylogeny and systematics, can be implied.

The classification using these wing-vein characters for subgroups of the *melanogaster* group of flies obtained from the present study is as followings. The most prominent characters for the classification are C-index and 4c-index, however the others remain some certain degree of overlapping. The average of the C-index in subgroups *ananassae*, *montium*, *suzukii*, *melanogaster* and *takahashii* are ranked in ascending order, being 1.53, 1.94, 2.34, 2.49 and 2.52, respectively. However, the average of the 4c-index in those subgroups are ranked in descending order, being 1.62, 1.46, 1.23, 1.16 and 1.06, respectively (Table 11).

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果蠅的翅長與翅脈係數之相對生長分析

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本文分析黃果蠅種羣 (*Drosophila melanogaster* species group) 之九種果蠅的翅長與翅脈係數之相對生長關係，發現(1)前緣脈係數 (C-iedex) 與第四脈係數 (4V-index)、前緣脈係數與第四-前緣脈係數 (4c-index)、前緣脈係數與末前緣脈係數 (Ac-index) 爲負相關生長；而第四脈係數與第四-前緣脈係數、第四-前緣脈係數與末前緣脈係數爲正相關生長。(2)在性別差異方面，雌的特徵大於雄的特徵有：前緣脈係數、第四-前緣脈係數及翅長；雄的大於雌的特徵有第五-臀橫脈係數 (5x-index)；其他的特徵則沒有差異。(3)這些翅脈係數與翅長可應用於果蠅之分類學、系統學之研究。