59.57.72D

Article XXI.—EXPERIMENTS WITH *DROSOPHILA AMPELOPHILA* CONCERNING NATURAL SELECTION.

By Frank E. Lutz.

Most of the many discussions concerning Natural Selection have not only been purely theoretical but have postulated that the characters under consideration are in each case heritable ones. As a matter of fact Natural Selection is one problem and Inheritance another; combined they form an important part of a certain theory of evolution but one may be studied separately just as well as the other. Natural selection as applied to *Homo sapiens* has been carefully investigated for some time by the life insurance companies and in the only way in which such problems can be profitably studied — by the analysis of the death rate in populations. There have also been a few actuarial papers concerning lower organisms. Some of the more important of these have been reviewed by Harris.[1]

Ordinarily we think of natural selection as changing the average by killing off mainly those creatures which have a given characteristic or which have it in a given degree. Thus if very heavy men tend to die at an earlier age than those who are not so heavy natural selection is acting to decrease the mean, or average, weight of the population. However, natural selection may tend to kill off both the very heavy and the very light men in such proportions that the mean would remain the same. Natural selection is, nevertheless, acting and manifests itself by the decreased variability of the surviving population, it being largely made up of those who are neither heavy nor light. It is conceivable that natural selection might favor the very heavy and the very light but kill off first those of medium weight. In that case the average weight of the population might remain the same but the variability of the surviving population would be greater than that of the original one or of the one which perished.

Finally, the weight, in itself, of the men might have nothing to do with natural selection and we could suppose that height, in itself, had nothing to do with natural selection but if those men who were short and heavy as well as those who were tall and light died earlier than the rest of men natural selection would be acting. The basis of its action would not be weight or stature but the correlation between the two and the effect would be to increase the positive correlation. It is easy to see that there might be cases

[1] J. Arthur Harris. 1911. 'The Measurement of Natural Selection.' Popular Science Monthly, LXXVIII, pp. 521–538.

in which selection acts on the basis of correlation in such a way that the surviving population has a lesser positive or a greater negative correlation than those which perished. Furthermore Pearson [1] has shown that selection of the mean and variability of a character influences very markedly the correlations between this and other characters.

The result of these considerations is that we are forced to take a wider view of selection than has ordinarily been done. If that portion of the population which perishes differs significantly in either mean, variability or correlations from that portion which survives we must admit that natural selection has been effective. Furthermore, although it is relatively easy to demonstrate by statistical methods whether or not selection has influenced a given character, it is impossible in the present stage of science to determine just what the basis was upon which selection worked. If characters A, B and C are correlated in their variabilities, selection acting directly upon the mean of character A would change not only the means and variabilities of characters B and C but the correlations among the three characters. If we studied only B and C we would find that selection had acted but might be at a loss to explain its action. The only thing to do, in a case as complicated as is the problem of selection, is to accumulate facts bearing on the subject, keeping the various hypotheses in mind and leave it to future generations to find out the right.

The present paper concerns the Pomace Fly, *Drosophila ampelophila.* There are two sets of experiments. In one, carried on at the Carnegie Institution's Station for Experimental Evolution, the flies were reared at a temperature kept rather close to 20° C. and the adults were given water but no food. In the other, carried on at the American Museum of Natural History, the flies were reared under normal, *i. e.* uncontrolled, temperature conditions and the adults were carefully fed. The only unnatural condition in the second set of experiments, as far as could be determined, was that the adults were not allowed to mate. In both sets of experiments the relation of physiological characters, the duration of the embryonic periods, to the duration of adult life was studied and in one of them two anatomical characters also were studied. On account of the practical difficulty of determining the exact time of hatching, the egg and the larval periods were combined in the records.

There are two ways of determining whether or not selection acts (directly or indirectly) upon the actual size of a character: we may compare the mean of the character among those which perished with that among those which survived or we may calculate the correlation between the size of the character and the ability to survive. Both methods are used here.

---

[1] Pearson, K. 1902. 'On the Influence of Natural Selection on the Variability and Correlation of Organs.' Phil. Trans. Royal Soc. London, Series A, Vol. 200, pp. 1–66.

	Normal		Starvation	
	Males	Females	Males	Females
Egg-larval Period	−0.1270±0.0420	−0.1609±0.0405	+0.0535±0.0624	−0.1133±0.0598
Pupal Period	−0.1392±0.0418	−0.2525±0.0389	−0.0457±0.0625	−0.0274±0.0605
Length Post. Cell			+0.1325±0.0626	+0.2536±0.0573
Breadth Wing			+0.3176±0.0573	+0.1231±0.0604

Table 1. Correlations between the Length of Adult Life and other characters.

From Table 1 we see that in the set which were allowed to die normally there is a negative correlation in each sex between the length of adult life and the duration of the embryonic periods — those individuals which completed their embryonic periods quickly, probably because they were those whose physiological processes were working well, tended to have long lives. In all cases the cofficient of correlation is at least three times as great as its probable error so that the results may be considered statistically trustworthy. The same thing is seen from Table 2 in which it is shown that

		Normal		Starvation	
		Males	Females	Males	Females
Egg-larval Period	General Population	7.3560±0.1015	7.3764±0.0922	6.5353±0.0422	6.4266±0.0328
	Short lived	7.9837±0.1525	7.6905±0.1185	6.4929±0.0384	6.5434±0.0565
	Long lived	6.7480±0.1240	6.8211±0.1377	6.5750±0.0688	6.3394±0.0373
Pupal Period	General Population	5.6440±0.0350	5.3346±0.0306	6.2026±0.0297	5.8145±0.0334
	Short lived	5.8211±0.0338	5.4881±0.0359	6.1964±0.0393	5.8396±0.0388
	Long lived	5.4724±0.0490	5.0632±0.0511	6.2083±0.0441	5.7958±0.0505
Length of Post. Cell	General Population			45.9643±0.1410	52.4091±0.1345
	Short lived			45.5741±0.2218	51.8137±0.2086
	Long lived			46.3276±0.1715	52.8429±0.1674
Breadth of Wing	General Population			31.5179±0.1095	35.3595±0.0989
	Short lived			30.9444±0.1652	35.0098±0.1522
	Long lived			32.0517±0.1282	35.6143±0.1264

Table 2. Means. In the "normal" experiments the "short-lived" adults died before they were 32.5 days old and in the starvation experiments they died before they were 66 hours old. The "long-lived" ones survived these respective ages.

the population which lived less than 32.5 days as adults had markedly longer embryonic periods not only than those with longer adult lives but than the general population.

The results of the starvation experiments were not what I expected them to be for I had thought that those larvæ which fed for a long time would have laid up a large supply of reserve material which would enable them to withstand starvation in the adult stage better than those which pupated early. Perhaps the outcome is a resultant between this factor and the one suggested in the preceding paragraph as explaining the negative correlation found there. The two physiological conditions might largely neutralize each other and the result would be no correlation. At any rate, the fact is that no significant correlation was found between the ability of adults to withstand starvation and the length of the embryonic periods. In three of the four cases the coefficient is less than the probable errors and in the fourth it is less than twice the probable error. The means (Table 2) show the same thing. The only case in which there is a possible relation shown is between the egg-larval period of the females and their ability to withstand starvation. Such as it is, it is in the same direction as that found when considering normal adult life.

It is clear that selective death rate is demonstrated with respect to these physiological characters when the adult flies are given all the food they can eat. When the adult flies are given no food no selection is *demonstrated* but it may nevertheless exist, being masked by complicating circumstances. The explanation, given above, of this masking is not entirely satisfactory. There are still other complications as is shown by a study of the correlations between the durations of the embryonic periods. In the American Museum experiments where the temperature was that of the laboratory, *i. e.* that at which the flies normally live, there was found to be a strong positive correlation between the duration of the egg-larval period and that of the pupal period. In the Carnegie Institution experiments, however, which were conducted at a higher temperature than normal there is no significant correlation between the duration of the embryonic periods. I have no idea what this difference, which is referred to again below, means. I am quite aware that in most of the correlations considered here the regression is not linear but I do not believe that the correlation ratio would alter the significance of the results.

In the starvation experiments we have a pair of anatomical characters to consider. They were selected from among the many which might have been measured simply because they were easy to measure. They give a fair notion of the relative size of the individuals and while not likely to have been directly concerned in selection they are no less likely to have been correlated with the direct factors than any of the other characters which suggested themselves. Table 1 shows that there is a positive correlation between these characters, the length of the first posterior cell in the wing and breadth of the wing, and the ability to withstand starvation. In two cases, the breadth of the wing in males and the length of the posterior cell in females, the correlation is certainly statistically significant. In the other two cases it is barely significant. The difference of the means in those which died early and those which lived longer (see Table 2) was great enough to make it safe to assert that the larger flies, or at least those with larger wings, were better able to withstand starvation than those which were smaller.

		Normal		Starvation	
		Males	Females	Males	Females
Egg-larval Period	General Population	32.3361±1.0725	30.0453±0.9600	9.8273±0.4394	8.4351±0.3638
	Short lived	31.4147±1.4783	29.6227±1.2813	6.5700±0.4205	9.3235±0.6161
	Long lived	30.7086±1.4109	29.1638±1.5437	12.0179±0.7506	7.3585±0.4188
Pupal Period	General Population	14.5452±0.4479	13.8051±0.4137	7.6435±0.3404	9.4768±0.4095
	Short lived	13.4871±0.5905	12.5720±0.4699	7.0453±0.4512	7.1666±0.4719
	Long lived	14.9557±0.6469	14.5707±0.7280	8.1593±0.5057	10.8950±0.6240
Length of Post. Cell	General Population			4.8147±0.2175	4.1844±0.1817
	Short lived			5.3013±0.3450	4.2622±0.2852
	Long lived			4.1794±0.2622	3.9303±0.2244
Breadth of Wing	General Population			5.4514±0.2464	4.5596±0.1981
	Short lived			5.8148±0.3787	4.6039±0.3081
	Long lived			4.5159±0.2834	4.4008±0.2514

Table 3. Coefficients of Variation. See Table 2.

Since in at least half of the cases the mean had been altered by natural selection the coefficient of variation is a better measure of variability than is the standard deviation. Table 3 shows that in the American Museum "normal" set of experiments there was no very marked difference in variability of embryonic periods associated with differences in length of adult life. In the other experiments the males which withstood starvation best were distinctly more variable with respect to the duration of their egg-larval period and only slightly, if at all, more variable with respect to their pupal period than those which succumbed early. As to the females, those which lived longest had been less variable in their egg-larval period and more variable in their pupal period than their weaker sisters. The discordant results, with respect to variability, taking this set of experiments as a whole, gives an additional indication of some unknown complexity influencing the outcome. The males best able to withstand starvation were less variable with respect to the length of the first posterior cell and the breadth of the wing than either those which succumbed early or the general population, while those which succumbed early were slightly but not significantly more variable than the general population. In the case of the females the differences were all insignificant.

		Normal	Starvation	
		Egg-larval and Pupal Periods	Egg-larval and Pupal Periods	Length Post. Cell and Breadth Wing
Males	General Population	+0.7470±0.0189	−0.0561±0.0624	+0.8807±0.0143
	Short lived	+0.6591±0.0344	−0.4383±0.0728	+0.9424±0.0103
	Long lived	+0.8223±0.0194	+0.2238±0.0827	+0.8209±0.0315
Females	General Population	+0.7126±0.0205	−0.0267±0.0601	+0.8449±0.0175
	Short lived	+0.6604±0.0293	−0.2757±0.0856	+0.8254±0.0301
	Long lived	+0.7823±0.0268	+0.1182±0.0789	+0.8014±0.0288

Table 4. Coefficients of Correlation. See Table 2.

In the "normal" experiments both the males and the females which lived longest (see Table 4) showed a distinctly higher correlation between the embryonic periods than did the short-lived ones. In the starvation experiments the survivors had a probably significant positive correlation between the embryonic periods while those which perished had a certainly significant *negative* correlation. Apparently the zero correlation shown by the general population was caused by a mixture of two sorts which natural selection partly, at least separated. In the case of the anatomical characters no difference is shown by the females but the males which succumbed were less highly correlated than those which perished.

These results must seem unsatisfactory to those who look for hard and fast conclusions along certain definite lines. They do, however, demonstrate once more that natural selection does exist and that it influences mean, variability and correlation. Much as we would like to have explanations, the facts are, at present, the important things.

Tables of Data.

Throughout, the units for the egg-larval and pupal periods are days. The units for length of adult life are days in the "normal" experiments and hours in the starvation experiments. The units for the wing measurements are divisions on an arbitrary micrometer scale.

Egg-Larval Period

Survival	4	5	6	7	8	9	10	11	12	13	14	15	16	
5	....	1	....	....	....	....	1	1	....	1	1	....	1	6
10	....	1	2	1	4	2	2	....	....	....	1	....	....	13
15	....	3	5	1	1	5	3	1	1	1	....	1	....	22
20	....	1	6	3	1	11	1	2	1	1	....	....	....	27
25	....	15	3	....	2	2	....	....	....	....	1	....	....	23
30	....	3	6	4	7	9	....	1	1	1	....	....	....	32
35	1	15	16	9	5	1	....	1	1	....	....	....	....	49
40	....	14	5	3	1	....	1	....	....	....	....	....	....	24
45	....	....	....	1	1	....	....	....	....	....	....	....	....	2
50	....	2	....	3	....	....	....	....	....	1	....	....	....	6
55	....	7	1	....	1	1	1	....	....	1	....	....	1	13
60	....	1	1	1	....	....	....	....	....	....	....	....	....	3
65	....	....	....	....	1	....	....	....	1	....	....	....	....	2
70	....	4	....	3	....	1	....	....	....	....	....	....	....	8
75	....	....	....	2	5	....	....	....	1	....	....	....	....	8
80	....	1	....	1	1	....	....	2	1	....	....	....	....	6
85	....	....	....	2	2	1	....	....	....	....	....	....	....	5
90	....	1	....	....	....	....	....	....	....	....	....	....	....	1
	1	69	45	34	32	33.	9	8	7	6	3	1	2	250

Table 5. Data for males concerning correlation between the Duration of the Egg-Larval Period and Normal Length of Adult Life.

Egg-Larval Period

Survival	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
5	....	4	1	....	4	1	1	....	2	....	....	....	....	....	13
10	....	2	5	2	3	16	....	1	....	....	....	....	....	....	29
15	....	1	....	1	1	5	2	2	....	....	1	....	....	....	13
20	1	12	20	7	5	2	....	1	....	2	1	....	....	....	51
25	....	6	4	6	7	3	2	....	4	....	....	1	....	1	34
30	....	4	1	8	7	6	1	....	....	....	1	....	....	....	28
35	....	8	13	....	2	1	1	2	1	....	....	....	1	....	29
40	....	5	3	4	3	1	....	....	....	....	....	....	....	....	16
45	....	7	....	1	1	1	....	....	....	1	....	....	....	....	11
50	....	2	....	6	3	....	1	....	....	....	....	....	....	....	12
55	....	5	2	2	3	2	....	....	....	....	....	....	....	....	14
60	....	3	....	....	1	....	....	....	....	....	....	....	....	....	4
65	....	2	....	1	1	....	....	....	....	....	....	....	....	....	4
70	....	....	....	....	2	....	1	....	....	....	....	....	....	....	3
75	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1
80	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1
	1	61	49	38	45	38	9	6	7	3	3	1	1	1	263

Table 6. Data for females concerning correlation between the Duration of the Egg-Larval Period and Normal Length of Adult Life.

Pupal Period

Survival	4	5	6	7	8	
5	....	1	2	3	....	6
10	1	2	3	7	....	13
15	....	5	11	6	....	22
20	1	6	15	5	....	27
25	1	18	2	2	....	23
30	1	12	12	7	....	32
35	....	31	15	3	....	49
40	....	16	7	1		24
45	....	1	1	....	....	2
50	2	2	1	1	....	6
55	7	......	2	3	1	13
60	1	......	2	....	....	3
65	....	......	1	1	....	2
70	4	......	3	1	....	8
75	....	......	7	1	....	8
80	1	......	3	2	....	6
85	....	......	5	....	....	5
90	1	......	......	....	....	1
	20	94	92	43	1	250

Table 7. Data for males concerning correlation between the Duration of the Pupal Period and Normal Length of Adult Life.

	Pupal Period					
Survival	4	5	6	7	8	
5	3	4	4	1	1	13
10	3	8	17	1	....	29
15	2	......	8	3	....	13
20	2	33	14	2	....	51
25	....	15	16	3	....	34
30	3	12	13	....	....	28
35	6	17	3	3	....	29
40	2	10	4	....	....	16
45	3	6	2	....	....	11
50	1	8	3	....	....	12
55	7	2	3	2	....	14
60	2	2	......	....	....	4
65	1	1	2	....	....	4
70	....	2	1	....	....	3
75	....	1	......	....	....	1
80	....	1	......	....	....	1
	35	122	90	15	1	263

Table 8. Data for females concerning correlation between the Duration of the Pupal Period and Normal Length of Adult Life.

	Egg-Larval Period								
Survival	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.1	
48	1	2	2	5	....	....	....	....	10
60	4	12	24	5	1	....	....	....	46
72	5	19	13	8	2	2	....	1	50
84	3	1	1	2	....	....	1	1	9
96	....	1	....	....	....	....	....	....	1
	13	35	40	20	3	2	1	2	116

Table 9. Data for males concerning correlation between the Duration of the Egg-larval Period and Ability to Withstand Starvation.

Egg-Larval Period

		5.6	6.1	6.6	7.1	7.6	8.1	8.6	
Survival	36	....	....	1	....	....	....	....	1
	48	1	....	....	1	1	....	....	3
	60	6	14	17	7	3	2	....	49
	72	7	22	16	6	....	....	....	51
	84	2	5	10	....	....	....	....	17
	96	....	2	....	....	....	....	1	3
		16	43	44	14	4	2	1	124

Table 10. Data for females concerning correlation between the Duration of the Egg-larval Period and Ability to Withstand Starvation.

Pupal Period

		5.5	6.0	6.5	7.0	7.5	8.0	8.5	
Survival	48	....	4	5	....	....	....	1	10
	60	4	29	10	3	....	....	....	46
	72	7	28	7	6	1	1	....	50
	84	2	1	4	2	....	....	....	9
	96	....	1	....	....	....	....	....	1
		13	63	26	11	1	1	1	116

Table 11. Data for males concerning correlation between the Duration of the Pupal Period and Ability to Withstand Starvation.

Pupal Period

		5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	
Survival	36	....	....	1	....	....	....	....	....	....	1
	48	....	1	1	....	....	1	....	....	....	3
	60	....	26	18	3	2	....	....	....	....	49
	72	2	31	14	1	1	....	....	1	1	51
	84	1	12	2	1	1	....	....	....	....	17
	96	....	....	1	1	1	....	....	....	....	3
		3	70	37	6	5	1	....	1	1	124

Table 12. Data for females concerning correlation between the Duration of the Pupal Period and Ability to Withstand Starvation.

Length of Posterior Cell

Survival		41.5	42.5	43.5	44.5	45.5	46.5	47.5	48.5	49.5	50.5	
	48	.....	2	1	.....	.....	2	.....	4	.....	.....	9
	60	2	11	3	3	3	5	12	5	1	.....	45
	72	1	3	3	6	5	9	14	3	2	2	48
	84	.....	.....	.....	2	2	2	1	2	.....	.....	9
	96	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
		3	16	7	11	10	19	27	14	3	2	112

Table 13. Data for males concerning correlation between the Length of the Posterior Cell and Ability to Withstand Starvation.

Length of Posterior Cell

Survival		47.5	48.5	49.5	50.5	51.5	52.5	53.5	54.5	56.5	57.5	
	36	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
	48	.....	1	.....	.....	.....	1	1	.....	.....	.....	3
	60	4	3	6	1	5	13	7	6	2	.....	47
	72	3	3	2	1	4	10	13	11	2	1	50
	84	.....	.....	1	1	1	3	2	6	3	.....	17
	96	.....	.....	.....	1	.....	.....	1	1	.....	.....	3
		7	7	9	4	10	28	24	24	7	1	121

Table 14. Data for females concerning correlation between the Length of the Posterior Cell and Ability to Withstand Starvation.

Breadth of Wing

Survival		27.5	28.5	29.5	30.5	31.5	32.5	33.5	34.5	
	48	.....	2	2	1	.....	2	2	.....	9
	60	2	8	5	5	7	14	4	.....	45
	72	1	2	2	5	11	13	12	2	48
	84	.....	.....	.....	2	1	3	3	.....	9
	96	.....	.....	.....	.....	.....	1	.....	.....	1
		3	12	9	13	19	33	21	2	112

Table 15. Data for males concerning correlation between the Breadth of the Wing and Ability to Withstand Starvation.

Breadth of Wing

Survival	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	
36	.....	.....	.....	.....	.....	1	.....	.....	1
48	.....	1	.....	.....	.....	2	.....	.....	3
60	1	2	2	6	8	14	10	4	47
72	.....	4	3	2	5	11	15	10	50
84	.....	.....	.....	.....	3	7	4	3	17
96	.....	.....	.....	.....	.....	3	.....	.....	3
	1	7	5	8	16	38	29	17	121

Table 16. Data for females concerning correlation between the Breadth of the Wing and Ability to Withstand Starvation.

Pupal Period

Egg-Larval Period	4	5	6	7	8	
4	....	....	1	....	....	1
5	17	51	1	....	....	69
6	1	26	18	....	....	45
7	....	13	19	2	....	34
8	....	4	20	7	1	32
9	1	....	26	6	....	33
10	....	....	2	7	....	9
11	....	....	1	7	....	8
12	....	....	2	5	....	7
13	....	....	1	5	....	6
14	1	....	....	2	....	3
15	....	....	1	....	....	1
16	....	....	....	2	....	2
	20	94	92	43	1	250

Table 17. Data for the general population of males concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Normal experiments.

Egg-Larval Period	Pupal Period 4	5	6	7	8	
4	....	1	....	....	....	1
5	29	31	1	....	....	61
6	4	37	8	....	....	49
7	....	24	14	....	....	38
8	1	25	17	2	....	45
9	....	2	33	3	....	38
10	....	....	7	2	....	9
11	1	....	2	3	....	6
12	....	1	3	2	1	7
13	....	....	3	....	....	3
14	....	....	1	2	....	3
15	....	....	....	1	....	1
16	....	....	1	....	....	1
17	....	1	....	....	....	1
	35	122	90	15	1	263

Table 18. Data for the general population of females concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Normal Experiments.

Egg-Larval Period	Pupal Period 4	5	6	7	
5	1	23	....	....	24
6	1	12	9	....	22
7	....	5	2	2	9
8	....	4	4	7	15
9	1	....	24	4	29
10	....	....	2	5	7
11	....	....	1	4	5
12	....	....	1	2	3
13	....	....	1	3	4
14	1	....	....	2	3
15	....	....	1	....	1
16	....	....	....	1	1
	4	44	45	30	123

Table 19. Data for those males which lived less than 32.5 days concerning correlation between the Durations of the Egg-larval and Pupal Periods. Normal Experiments.

Egg-Larval Period \ Pupal Period	4	5	6	7	8	
4	....	1	....	....	....	1
5	9	19	1	....	....	29
6	2	22	7	....	....	31
7	....	14	10	....	....	24
8	1	14	10	2	....	27
9	....	....	32	1	....	33
10	....	....	4	2	....	6
11	1	....	2	1	....	4
12	....	1	3	1	1	6
13	....	....	2	....	....	2
14	....	....	1	2	....	3
15	....	....	....	1	....	1
16	....	....	....	....	....	......
17	....	1	....	....	....	1
	13	72	72	10	1	168

Table 20. Data for those females which lived less than 32.5 days concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Normal Experiments.

Egg-Larval Period \ Pupal Period	4	5	6	7	8	
4	....	....	1	....	....	1
5	16	28	1	....	....	45
6	....	14	9	....	....	23
7	....	8	17	....	....	25
8	....	....	16	....	1	17
9	....	....	2	2	....	4
10	....	....	....	2	....	2
11	....	....	....	3	....	3
12	....	....	1	3	....	4
13	....	....	....	2	....	2
14	....	....	....	....	....	......
15	....	....	....	....	....	......
16	....	....	....	1	....	1
	16	50	47	13	1	127

Table 21. Data for those males which lived more than 32.5 days concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Normal Experiments.

Egg-Larval Period \ Pupal Period	4	5	6	7	
5	20	12	....	....	32
6	2	15	1	....	18
7	....	10	4	....	14
8	....	11	7	....	18
9	....	2	1	2	5
10	....	....	3	....	3
11	....	....	....	2	2
12	....	....	....	1	1
13	....	....	1	....	1
14	....	....	....	....	......
15	....	....	....	....	......
16	....	....	1	....	1
	22	50	18	5	95

Table 22. Data for those females which lived more than 32.5 days concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Normal Experiments.

Egg-Larval Period \ Pupal Period	5.5	6.0	6.5	7.0	7.5	8.0	8.5	
5.6	....	1	10	....	1	....	1	13
6.1	....	26	4	5	....	....	....	35
6.6	9	24	6	1	....	....	....	40
7.1	4	9	4	2	....	1	....	20
7.6	....	2	1	....	....	....	....	3
8.1	....	....	....	2	....	....	....	2
8.6	....	....	1	....	....	....	....	1
9.1	....	1	....	1	....	....	....	2
	13	63	26	11	1	1	1	116

Table 23. Data for the general population of males concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Starvation Experiments.

Pupal Period

Egg-Larval Period	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	
5.6	....	6	8	1	....	1	....	....	....	16
6.1	3	19	17	....	3	....	....	....	1	43
6.6	....	32	10	1	1	....	....	....	....	44
7.1	....	8	2	2	1	....	....	1	....	14
7.6	....	3	....	1	....	....	....	....	....	4
8.1	....	2	....	....	....	....	....	....	....	2
8.6	....	....	....	1	....	....	....	....	....	1
	3	70	37	6	5	1	....	1	1	124

Table 24. Data for the general population of females concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Starvation Experiments.

Pupal Period

Egg-Larval Period	5.5	6.0	6.5	7.0	7.5	8.0	8.5	
5.6	....	1	3	....	....	....	1	5
6.1	....	8	4	2	....	....	....	14
6.6	1	20	4	1	....	....	....	26
7.1	3	3	4	....	....	....	....	10
7.6	....	1	....	....	....	....	....	1
	4	33	15	3	....	....	1	56

Table 25. Data for those males which lived less than 66 hours concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Starvation Experiments.

Pupal Period

Egg-Larval Period	5.5	6.0	6.5	7.0	7.5	
5.6	1	5	....	....	1	7
6.1	6	7	....	1	....	14
6.6	10	7	....	1	....	18
7.1	5	1	2	....	....	8
7.6	3	....	1	....	....	4
8.1	2	....	....	....	....	2
	27	20	3	2	1	53

Table 26. Data for those females which lived less than 66 hours concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Starvation Experiments.

Egg-Larval Period	Pupal Period 5.5	6.0	6.5	7.0	7.5	8.0	
5.6	....	....	7	....	1	....	8
6.1	....	18	....	3	....	....	21
6.6	8	4	2	....	....	....	14
7.1	1	6	....	2	....	1	10
7.6	....	1	1	....	....	....	2
8.1	....	....	....	2	....	....	2
8.6	....	....	1	....	....	....	1
9.1	....	1	....	1	....	....	2
	9	30	11	8	1	1	60

Table 27: Data for those males which lived more than 66 hours concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Starvation Experiments.

Egg-Larval Period	Pupal Period 5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	
5.6	....	5	3	1	....	....	....	....	....	9
6.1	3	13	10	....	2	....	....	....	1	29
6.6	....	22	3	1	....	....	....	....	....	26
7.1	....	3	1	....	1	....	....	1	....	6
7.6	....	....	....	....	....	....	....	....	....	......
8.1	....	....	....	....	....	....	....	....	....	......
8.6	....	....	....	1	....	....	....	....	....	1
	3	43	17	3	3	....	....	1	1	71

Table 28. Data for those females which lived more than 66 hours concerning correlation between the Durations of the Egg-Larval and Pupal Periods. Starvation Experiments.

Breadth of Wing

Length of Posterior Cell	27.5	28.5	29.5	30.5	31.5	32.5	33.5	34.5	
41.5	1	2	.....	.....	.....	.....	.....	.....	3
42.5	2	9	4	1	.....	.....	.....	.....	16
43.5	.....	1	4	2	.....	.....	.....	.....	7
44.5	.....	.....	.....	5	3	3	.....	.....	11
45.5	.....	.....	.....	4	3	1	2	.....	10
46.5	.....	.....	1	1	6	9	2	.....	19
47.5	.....	.....	.....	.....	5	13	9	.....	27
48.5	.....	.....	.....	.....	2	7	5	.....	14
49.5	.....	.....	.....	.....	.....	.....	2	1	3
50.0	.....	.....	.....	.....	.....	.....	1	1	2
	3	12	9	13	19	33	21	2	112

Table 29. Data for the general population of males concerning correlation between the Length of the First Posterior Cell and the Breadth of the Wing. Starvation Experiments.

Breadth of Wing

Length of Posterior Cell	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	
47.5	1	3	1	2	.....	.....	.....	.....	7
48.5	.....	3	2	1	1	.....	.....	.....	7
49.5	.....	1	2	4	2	.....	.....	.....	9
50.5	.....	.....	.....	.....	3	1	.....	.....	4
51.5	.....	.....	.....	.....	3	5	2	.....	10
52.5	.....	.....	.....	1	4	14	5	4	28
53.5	.....	.....	.....	.....	3	9	9	3	24
54.5	.....	.....	.....	.....	.....	8	11	5	24
55.5	.....	.....	.....	.....	.....	1	2	4	7
56.5	.....	.....	.....	.....	.....	.....	.....	1	1
	1	7	5	8	16	38	29	17	121

Table 30. Data for the general population of females concerning correlation between the Length of the First Posterior Cell and the Breadth of the Wing. Starvation Experiments.

Breadth of Wing

Length of Posterior Cell	27.5	28.5	29.5	30.5	31.5	32.5	33.5	
41.5	1	1	.....	.....	.....	.....	.....	2
42.5	1	9	2	1	.....	.....	.....	13
43.5	.....	.....	4	.....	.....	.....	.....	4
44.5	.....	.....	.....	2	1	.....	.....	3
45.5	.....	.....	.....	2	1	.....	.....	3
46.5	.....	.....	1	1	2	3	.....	7
47.5	.....	.....	.....	.....	2	8	2	12
48.5	.....	.....	.....	.....	1	5	3	9
49.5	.....	.....	.....	.....	.....	.....	1	1
	2	10	7	6	7	16	6	54

Table 31. Data for those males which lived less than 66 hours concerning correlation between the Length of the First Posterior Cell and the Breadth of the Wing. Starvation Experiments.

Breadth of Wing

Length of Posterior Cell	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	
47.5	1	1	1	1	.....	.....	.....	.....	4
48.5	.....	2	.....	1	1	.....	.....	.....	4
49.5	.....	.....	1	4	1	.....	.....	.....	6
50.5	.....	.....	.....	.....	1	.....	.....	.....	1
51.5	.....	.....	.....	.....	2	2	1	.....	5
52.5	.....	.....	.....	.....	2	9	3	1	15
53.5	.....	.....	.....	.....	1	4	3	.....	8
54.5	.....	.....	.....	.....	.....	2	3	1	6
55.5	.....	.....	.....	.....	.....	.....	.....	2	2
	1	3	2	6	8	17	10	4	51

Table 32. Data for those females which lived less than 66 hours concerning correlation between the Length of the First Posterior Cell and the Breadth of the Wing. Starvation Experiments.

Breadth of Wing

Length of Posterior Cell	27.5	28.5	29.5	30.5	31.5	32.5	33.5	34.5	
41.5	.....	1	.....	.....	.....	.....	.....	.....	1
42.5	1	.....	2	.....	.....	.....	.....	.....	3
43.5	.....	1	.....	2	.....	.....	.....	.....	3
44.5	.....	.....	.....	3	2	3	.....	.....	8
45.5	.....	.....	.....	2	2	1	2	.....	7
46.5	.....	.....	.....	.....	4	6	2	.....	12
47.5	.....	.....	.....	.....	3	5	7	.....	15
48.5	.....	.....	.....	.....	1	2	2	.....	5
49.5	.....	.....	.....	.....	.....	.....	1	1	2
50.5	.....	.....	.....	.....	.....	.....	1	1	2
	1	2	2	7	12	17	15	2	58

Table 33. Data for those males which lived more than 66 hours concerning correlation between the Length of the First Posterior Cell and the Breadth of the Wing. Starvation Experiments.

Breadth of Wing

Length of Posterior Cell	31.5	32.5	33.5	34.5	35.5	36.5	37.5	
47.5	2	.....	1	.....	.....	.....	.....	3
48.5	1	2	.....	.....	.....	.....	.....	3
49.5	1	1	.....	1	.....	.....	.....	3
50.5	.....	.....	.....	2	1	.....	.....	3
51.5	.....	.....	.....	1	3	1	.....	5
52.5	.....	.....	1	2	5	2	3	13
53.5	.....	.....	.....	2	5	6	3	16
54.5	.....	.....	.....	.....	6	8	4	18
55.5	.....	.....	.....	.....	1	2	2	5
56.5	.....	.....	.....	.....	.....	.....	1	1
	4	3	2	8	21	19	13	70

Table 34. Data for those females which lived for more than 66 hours concerning correlation between the Length of the First Posterior Cell and the Breadth of the Wing. Starvation Experiments.