

EFFECTS OF HUMIDITY DURING GROWTH OF *PIERIS RAPÆ* LARVÆ

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The experiment reported here was similar to one described in a previous article (Gray, 1951). A batch of eggs was obtained from one female *Pieris rapæ* L., which had laid them on leaves of *Hesperis matronalis* L. in a closed pint-sized ice-cream carton with *Myosotis* flowers as food. On June 2, 1953, 70 eggs were counted. On June 7 there were 67 new larvæ.

On June 11 young larvæ were placed in groups of 8 on fresh food plant inside quart-sized preserving jars, known as sealers, in each of which there was a smaller jar (6 oz.) containing a KOH solution, or water, or soil. The KOH solutions were of such specific gravity as to develop relative humidities of 20%, 40%, or 80% (Buxton & Mellanby, 1934). The water and the soil each provided a saturated atmosphere. One group of larvæ was placed in a sealer the lid of which was kept loose, to provide a relative humidity of about 70%, that of the air in the basement in which all of the sealers were kept. Two other groups of larvæ were placed in a closed but well-lighted and aerated under-porch, where the free circulation of air was expected to yield drier and more natural conditions than the basement; of these two groups, one was reared in a closed ice-cream carton, and the other was surrounded with wire gauze, having a lid of colorless cellophane.

The small jars containing the fluids and the soil were capped with lids of cellulose sponge. The food-leaves were cut each with a short length of stem which served to hook the leaf, point downwards, onto the sponge, out of contact with the frass which fell onto the floor of the sealer. The stems of the food-leaves in the carton passed through a hole into the water below, as did those of the leaves in the wire cage.

The larvæ fed until about June 19, when some began to prepare silk mats. They all pupated June 20-23. About half of the larvæ in the sealers pupated horizontally on the lids; one of the ten in the carton did so.

The pupæ remained in their original containers until June 26 and 27, when they were, if possible, cut free from their silk attachments and placed each in a small vial; the vials were placed in numbered large glass tubes, 8" x 1", stoppered with cotton, to await emergence of the butterflies. A few larvæ pupated below the shoulder of the sealer and could not be removed safely; the butterflies emerged from these pupæ inside the sealers.

59 butterflies emerged June 28-July 3; 4 were crippled. Of the 55 whose characters have been used in these analyses, 24 were males and 31 were females. The following characters were measured:

1. Pupal length and breadth, to the nearest 0.5 mm.; the product of these two measurements was divided by 6, to give a "pupal index".
2. Weight of the dry pupal skin to the nearest 0.1 mgm.; the skins were weighed on a Mettler Gram-atic balance.
3. Weight of the butterfly shortly after emergence.
4. Weight of the butterfly after drying at room temperature, 76° F.
5. Radius of the right fore wing to the nearest mm.

The butterflies were weighed first on the author's "wire balance", and, after a week in a calcium chloride desiccator, on the Mettler balance. It was found, however, that after removal from the desiccator, the butterflies gained weight rapidly by the invasion of hygroscopic moisture which rendered these latter weighings unreliable. Comparison of weighings on the two balances, at room temperature, gave close agreement between the values; thus, the average weight of eleven butterflies on the wire balance was 23.1 mgm. and on the Mettler 23.0 mgm. The ranges and mean values were:

No.	Character	Range	Mean
49	Pupal index	10.7—15.8	13.16±.225
49	Pupal skin, mgm.	1.0— 2.0	1.52±.039
54	Imago, fresh, mgm.	40.0—90.0	61.44±.421
55	Imago, dry, mgm.	14.4—29.7	21.63±.454
55	Wing radius, mm.	20.0—26.0	23.50±.191

The values within each character were normally distributed about the mean, over two-thirds of them falling in the modal 50% range. The distribution of paired values in scatter diagrams and statistical analysis for the correlation coefficient between any two of the characters showed that the probability for dependent association was high in all cases.

The purpose of this article is to show that the two different "climates", dry and moist, had some influence on the characters measured. The dry climates are considered to be those provided by the conditions outside, *i.e.*, in the wire cage and the carton, by the 20% and 40% relative humidities, and by the basement air, which had a relative humidity of about 70%. Evidence of one of the effects of the various conditions was found in the state of the frass: that from the 20% and 40% r.h. was smaller, lighter green and drier than the normal that from the 80%, the water, and the soil was black and very wet and packed into a paste; that in the basement air and outside was of normal size, color, and consistency.

After grouping the measurements within each character above or below the mean value for that character, in respect of the different conditions of relative humidity, it was found that most of the specimens having values above the mean were from the dry conditions, and most of those with values below the mean were from the moist conditions. The values were submitted to statistical analysis to ascertain if the differences between the means of those from the two "climates" were significantly different from each other. Application of the *t* test for unequal numbers of unpaired varieties (Goulden, 1952) showed that the differences were significant for each character. The results of these analyses are as follows:

Character	Mean, dry	Mean, moist	<i>t</i> value	P value
Pupal index	13.48	12.47	2.127	.05—.02
Pupal weight	1.685	1.313	4.666	<.001
Weight fresh	64.91	55.26	10.945	<.001
Weight dry	22.64	19.71	2.760	<.01
Wing radius	24.11	22.53	3.874	<.001

With the exception of that for pupal index, the *t* values indicate the probability that these differences would occur by chance once in over one hundred trials (Fisher & Yates, 1938).

The numbers of specimens of emerged butterflies and their mean dry weights (in milligrams) under the different conditions were as follows:

No.	Condition	Mean wt.
6	Porch	22.20
10	Carton	24.12
7	20%	21.70
7	40% r.h.	22.68
6	Basement r.h.	21.77
	Mean of 36.....	22.64
8	80% r.h.	20.82
7	Water	17.87
4	Soil	19.70
	Mean of 19.....	19.71

One of the specimens from the cage under the porch weighed only 14.4 mgm.; if that be omitted from the set, as aberrant, the mean weight of the other five becomes 23.76 mgm.

The temperature of the under-porch was often some degrees higher than that of the basement, reaching 82° F. during the day; the average of the 15 normal specimens in the cage and the carton was 24.00 mgm, and of the 20 in the 20%, the 40%, and the basement relative humidities was 22.03 mgm.; the difference was not significant.

The average dry weights of the butterflies, in sexes, were as follows; figures are milligrams and, in parentheses, the number of specimens:

	Males	Females
Dry condition	24.3 (17)	21.3 (19)
Moist conditions	20.4 (7)	19.3 (12)

The males were thus, on the average, about 13% heavier than the females. The distribution of fresh and dry weights corresponded almost exactly.

Summary

The effects of dry and moist atmospheres on the development of *Pieris rapae* reared on *Hesperis matronalis*, have been compared. The drier conditions yielded larger pupæ with heavier skins, and heavier adults with larger wing-spread. The characters measured were correlated one with another.

References

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