

# THE VICISSITUDE OF WEIGHT AND LENGTH DURING MOSQUITO'S GROWTH.

## A STUDY ON

*Culex pipiens var. pallens.*

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In the previous papers<sup>1,2)</sup> the growth of mosquitoes was observed from the separate standpoints of a morphologist and a biochemist. A study on the mosquito's growth was undertaken in the present paper to discover the similarity and dissimilarity between the morphological and biochemical characters during the course of their development. The markings measurable in length and those measurable in weight were regarded as the morphological and the biochemical characteristics, respectively. *Culex pipiens var. pallens* was used as material.

### MATERIALS AND METHODS

The data of the studies on *Culex pipiens var. pallens* (eggs, larvae, pupae and imagines) which had been reported in the previous papers were available. The measurements were classified into (1) the characteristics measured in weight: body weight, the contents of nitrogen, fat and carbohydrate, and (2) those measured in length: body length, head diameter, siphonal length, and base-to-hair distance of antenna. The body length was estimated by a measure scaled to mm. The wing length was substituted for the body length in imagines, because that was easily measured and approximately equal to this. In pupae the maximum diameter of cephalothorax plus abdomen (inclusive of its paddle) was regarded to represent the body length. In larvae the body was measured with unaided eyes from the top of the head to the end of the abdomen. Eggs were estimated for their maximum length with an ocular micrometer under low-power magnification (100×) of microscope.

### RESULTS AND DISCUSSION

The data obtained in the present study is summarized graphically

in Figure 1, where the vicissitude of the markings measurable in weight and length are presented in relation to the advance in growth stages. On the preparation of this figure special effort was devoted to obtain

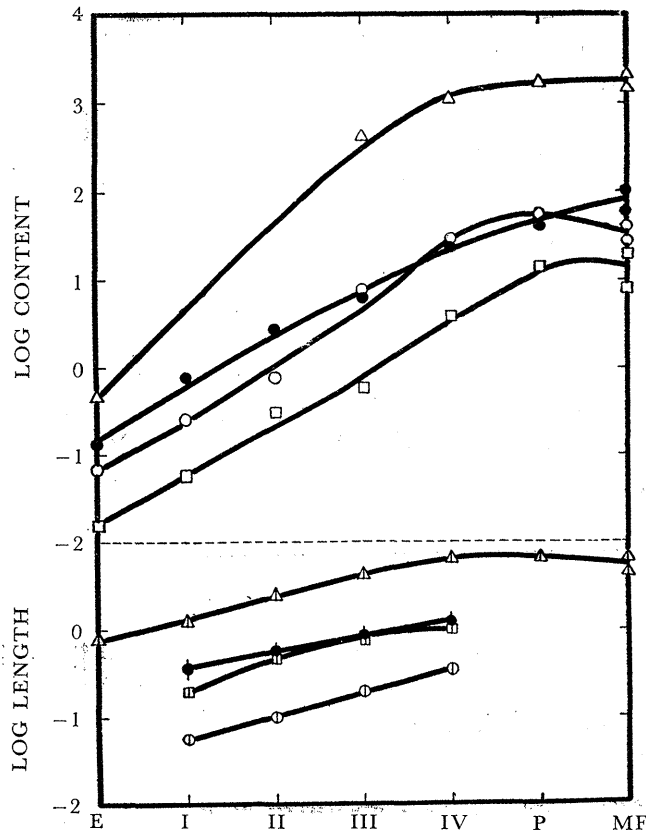


Fig. 1. The vicissitude of the markings measured in weight (r) and length (mm.) during the development of mosquito's growth. E: egg. I-IV: first to fourth instar larvae. P: pupa. M: male imago. F: female imago.  $\triangle$ : body weight.  $\bullet$ : nitrogen content.  $\circ$ : lipide content.  $\square$ : carbohydrate content.  $\blacktriangle$ : body length.  $\bullet$ : head diameter.  $\square$ : siphonal length.  $\odot$ : base-to-hair distance of antenna.

smooth or linear lines, ignoring the delicate variation, so that approximate tendency might be elucidated. The units of length and weight are standardized to mm. and  $\gamma$  (gamma), respectively. The numerical data are converted into their logarithmic number and compared with the growth stages.

The inspection of this semi-logarithmic graph reveals that the quanti-

ty measurable in weight and that measurable in length exhibit linear increase, in the period from the egg to the fourth instar larva in particular, following a law which is expressed in the equation.

$$\log x = kt + a \quad (1)$$

x : quantity measurable in weight or length

t : growth stage denoted by numbers. The numbers 1, 2, 3, 4 and 5 represent the egg and the first to fourth instar larvae, respectively.

k and a : constants.

The equation is identical with the law of increase in the cell volume during cell division or that of the augmentation of body weight in milk cows and domestic fowls<sup>3)</sup>. This implies that the mosquito grows in a manner quite similar to the growth of higher animals during the period of egg and larvae at least.

The development of an imago from a pupa is entirely different therefore, because imago is smaller than pupae in both length and weight, i. e., interruption of increase or even diminution occurs at the step from pupa to imago. This indicated, in the author's opinion, that the appearing of an imago from a pupa does not constitute a part of growth in the mosquito's life in the strict sense, but it forms the stage of metamorphosis.

The comparison of the quantity measurable in weight with that measurable in length discloses that the former forms an ascending line with larger inclination than does the latter. Its interpretation is that the mosquito undergoes a growth more conspicuously in body weight and contents of nitrogen, fat and carbohydrate than in body length, head diameter, siphonal length and base-to-hair distance of antenna. This is exemplified by the comparison of the following increase rates.

	Larvae				
	Egg→1st inst.	1st inst.→2nd inst.	2nd inst.→3rd inst.	3rd inst.→4th inst.	4th inst.→pupa
Carbohydrate	3.7	5.6	1.8	7.5	3.1
Body length	1.8	1.9	1.6	1.5	1.0

As pointed out in the previous report, the head diameter enlarges in a geometrical progression with the common ratio of about 1.5 at every ecdysis. The geometrical progression is comprised in equation (1) as one of its special cases. The usefulness of the siphonal length and the base-to-hair distance of antenna as criteria for the determination of larval

instars is due to their narrow range of variation in each growth stage which prevents overlapping between the adjacent instars, although they do not form geometrical progressions. A quantity which is liable to a wide variation, such as the body length of *Culex pipiens* var. *pallens*

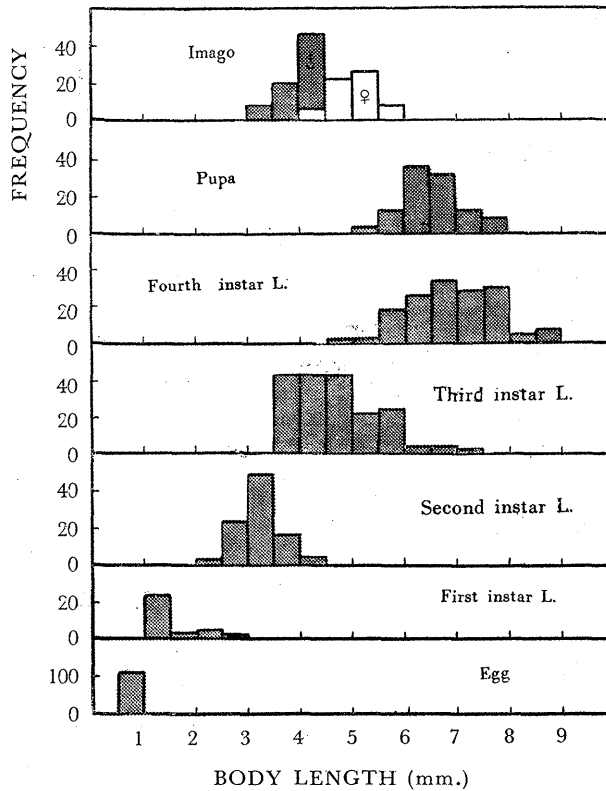


Fig 2. Body length of *Culex pipiens* var. *pallens* (in mm.)

which is illustrated in Figure 2, is not available for the purpose of distinguishing growth stages, because overlapping obscures the demarcation.

Inasmuch as the quantity measured in weight increases more steeply on ecdysis than that measured in length, it seems that the former is less susceptible to overlapping even when it may have a considerable variation in a particular growth stage. The possibility of the determination of mosquito's growth stages by the measurement of either their body weight or their contents of nitrogen, fat and carbohydrate may thus be warranted theoretically, although it is not available for practice because analysis of an individual egg or larva is unfortunately beyond the capacity of the present microtechnique of biochemistry.

## SUMMARY AND CONCLUSION

Body weight and contents of nitrogen, fat and carbohydrate (quantities measured in weight) as well as body length, larval head diameter, siphonal length and base-to-hair distance (quantities measured in length) were studied on *Culex pipiens* var. *pallens* throughout its whole course of growth, and the following results were obtained.

1) This species followed approximately the law of growth which was expressed by

$$\log x = kt + a$$

x : quantity measured in weight or length

t : growth stage denoted by numbers (The numbers 1, 2, 3, 4 and 5 represented the egg and the first to fourth instar larvae, respectively)

k and a : constants

during the period of larval stage.

2) The development of imago from pupa did not seem to constitute a stage of mosquito growth, because it entailed diminution in quantity. This step ought to be regarded as metamorphosis.

3) The quantity measured in weight increased more steeply than the quantity measured in length during the whole course of the mosquito's growth.

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