

that the wing-pigments are not formed until a short time before emergence. In all the cases of which I have recollection this has been so.

But I imagine that the ratio between the growth of the wing and the metabolism of its pigment is not always the same, nor is that between the wing-formation and the growth of the vital and reproductive organs constant, and herein I believe lies the key to the solution of the problem.

*Rapid metabolism produces darkness of colour, while slow change accompanied by growth gives rise to a larger expanse of wing, on which the pigment is paler, lighter, and often more brilliant.*

The vital and reproductive organs of a butterfly will develop *sooner and at a lower temperature* than the pigment of the wings; and hence in a country where the winters are cold and the summers hot, the hibernating pupæ will have reached a nearly full development by the time the warm weather comes on, except as regards the pigment of the wings. This will undergo very rapid metabolism to be ready by the time of emergence, and the result will be a dusky and small winged form. On the other hand, if the spring comes gradually, and the winter is warm, the wing-pigment will develop more slowly, the wings will have longer to grow, and consequently the vernal brood will be paler even than that of the summer.

And this is precisely what we find; *Pieris virginienensis* is a *pale* spring form taking the place of the *dark oleracea-hyemalis* of the more northern portion of the continent, while *P. rapæ* and *P. brassicæ*, which do not exhibit dusky vernal broods, are natives of Europe, where the winters are milder and the advent of spring more gradual than in North America.

It may here be objected, why are not tropical species, whose development is often excessively rapid, uniformly dusky or black? That they are in many cases darker than their representatives in more temperate regions will I think be admitted, but I would point out that they are not by any means in the same position as North American vernal forms. The vital organs must in any case take a certain time for development, which is always longer than that necessary for the metabolism of the pigment. So that in the case of any summer brood, however rapidly developing, the temperature being high enough to allow the development of the pigment at the same time as the organs of the body, it has ample time for sufficient metabolism—less indeed than in the case of a warm and gradual spring, but more than in that of a frigid winter and quick coming summer, where