them the vital forces are not derived wholly from the chemical changes going on within them, but are in part, and sometimes in great part, obtained directly from this very temperature, and the light that usually accompanies it.

It would seem that in plants, though light by its action on carbonic acid and ammonia supplies them with a great part of their food: heat is the force which, by its passage through the living tissue being changed to vital force, has to perform in great part the assimilative and nutritive functions. I say in great part, for in the union of the elements that had been set free by the agency of light, some force must be evolved, though this from the feebleness of union in the bodies formed must be small in amount (Law I) I am free to confess that I am not very clear on this point in my own mind. And here a question (alluded to above) arises of great interest and importance. In those bodies as starch, sugar, lignine, cellulose, etc., etc., which constitute the great mass of plants, and in which hydrogen and oxygen are in the proportion to form water, and where they are derived from water, are they in any degree separated? that is, has the affinity exercised by them in water been weakened when they are combined with carbon to form these new bodies.* I have no doubt that this must be answered in the affirmative, and if so the result is obvious, we must have a force to effect this decomposition beyond the force that is evolved in the formation of the new body (Law IV). If then to supply any of these needs plants are dependent upon heat, as, to fulfil their other wants they are on light, it is clear that a certain amount of heat will be required for any given amount of growth and development exhibited by the plant; that is, a quantitative relation must exist between the force supplied and the vital force put forth which depends upon it; and this is seen to be the case in the most striking manner, for according to Bousingault "the same annual plant in arriving at its full development and going through all the processes of flowering and maturation of its seed, everywhere receives the same amount of solar light and heat, whether it be grown at the equator or at the temperate zone, its rate of growth being in a precisely direct ratio to the amount it receives in any given time."

Very much the same thing is seen in the case of the lower cold-blooded animals though what is the nature of the relation existing here between the physical and vital force, I do not pretend to say; it may be that the former merely furnishes a necessary condition for the evolution of the latter from other sources; or it may be changed into it directly; or again the heat may alter its form and becoming chemical force may so pass into the vital; be this as it may, the relation exists and is well seen in the case of the *Crustacea*. For 1, the variety of their form and organization (which may be regarded as so many varied manifestations of

* A carefully conducted experiment, such as I do not know has ever been performed would readily settle this question—for if the H and O are separated, as I suppose, a given quantity of dry wood would yield more heat in its combustion than would as much charcoal as there was carbon in the wood in its combustion; but if the affinity between them is not at all lessened it would yield less, for we should have to subtract from the amount of heat evolved by the carbon, the strength of the affinity existing between the H O and the C in the wood. Is it not the union of the oxygen and hydrogen in wood, forming water, without the participation of carbon in the combustion, that constitutes the main part of the process in the formation of charcoal by suppressed combustion?