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Physiological Calorification

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BY,

W. H. Wilkes.

OF

Tennessee.

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CHARLES W. SMITH,
BOOKSELLER AND STATIONER,
NASHVILLE, TENN.

To
Thomas R. Jennings, M. D.,
Professor of
Institutes of Medicine
and
Clinical Medicine,
this
dissertation
is
most respectfully
dedicated.

Physiological calorification.

Heat is one of the most important agents in all nature. All know its great power of counteracting or antagonising the cohesive power by which the particles of matter are held together and thus liquifying and subliming solids and aerating ~~gases~~ liquids; but, of the hidden power which it exerts over the production, nutrition, &c., of all organised bodies, both animate and inanimate, little comparatively is known. Far more evident to our observation are its influences over the inorganic, than its influences over the organic world. All the operations both of the vegetable and animal kingdoms are dependant upon the supply of a certain amount of heat, either from external sources, or generated within the different members of those kingdoms.

It may not be improper, in a dissertation of this kind, to say something of the effects of heat on the vegetable kingdom. That a certain amount of heat is necessary to the production and development of vegetables, is made evident by every-day observation. In hot-houses, the horticulturist can produce the tree, the blossom and the fruit, at all seasons of the year, merely by artificially supplying the requisite quantity of caloric. Again, vegetation is almost entirely absent in climates where the temperature is excessively high or low. Again, the change of size and unhealthy appearance which a plant assumes on being removed from its proper temperature into a different one, show clearly the importance of a definite amount of heat to its proper nutrition and preservation.

Not only is heat important in the vegetable, but when we come to look into the animal kingdom, we find that all the functions of its different tribes are dependant ~~upon~~ upon the maintenance and equalization of their temperatures. It is said, no heat is generated within the vegetable except in certain parts which have not the power of communicating it tho the whole structure; while an animal has the power of generating heat within its own system and of distributing it equally throughout every portion of that system. So, while the vegetable must look abroad to some external source for most of its heat, the animal contains within itself calorifacient powers; though, it is true this power is dependant upon the supply of elements from without from which to manufature its heat. In some classes of animals this power of generating heat is much greater than in others, and consequently, there is great variety in the power which different animals have of enduring the changes of external temperature. Some have little or no power of generating heat within themselves, and such are called cold-blooded animals; others possess this calorifacient power to such an extent as to maintain an equable temperature without being affected by any, except extreme changes of the temperature of the mediums in which they live, and such are termed warm-blooded animals. Man, belonging to the class of warm-blooded animals, being possessed of superior intelligence, may so adapt his clothing and food, as, with the aid of his great, self-regulating, calorifying power, to be more capable of enduring the changes of external temperature, than any other animal: so, that in this, as well as in other respects, man stands at the head of this class of animals. We find that heat is pre-eminently necessary in order to carry on the ordinary processes of human existence. Through its influence all the vital functions are carried-on, so that it is even essential to the continuation of life itself. In fact, in many diseases of exhaustion, the immediate cause of death is the reduction of temperature: hence arises the propriety in such diseases of keeping up the temperature by the application of external warmth and by supplying the pabulum for the internal calorifying power. It has been ascertained by experiments that the mean temperature of the human body is from 98° to 100°. The temperature of the internal parts of the body is somewhat higher than external; thus, where the temperature in the mouth is 100°, it diminishes in direct proportion to its distance from the centre, until at the feet it will be at about 90°. Generally speaking the younger the animal is, the less powerful is its calorifying power; and this is particularly so in the young of the human species. From this arises the necessity of keeping young children properly clothed, instead of giving credence to foolish notion of rendering them hardy by unnecessary exposure. It is difficult to preserve a proper degree of warmth in children born at seven months; and it is said that children, born at the sixth month, can be kept at a proper temperature only by being kept in contact with a living, human body.

The incapability of resisting the changes of external temperature is to some extent common alike to the very young and to the very aged. So we find the aged too should be properly clothed.

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We see that within the system of man (as well as other warm-blooded animals,) some hidden process is continually going-on by which a sufficient amount of calorie is eliminated to keep-up an equable temperature in that system, notwithstanding a large proportion must be constantly thrown off by radiation into the surrounding mediums and lost in the fluids which are continually being exhaled from the body. Several different theories have been proposed to account for the manner in which this heat is produced; but physiologists are now pretty well agreed as to its chemical origin, and place the chemical processes by which it is eliminated, to some extent, under the control of the nervous system. It is a fact indisputable that chemical processes are continually being carried on in the human body with as much accuracy, as those conducted by the most skillful chemist in his laboratory. The decomposition of old compounds and the recomposition of new ones, are processes which occur during each moment of human existence. The particular processes to which the calorification of the human body is due, is the combination of Oxygen with the carbon and hydrogen, sulphur and phosphorus, &c., contained in the body, termed the oxydation or combustion of these elements. It is well known that by whatever process these combinations take place, a certain amount of heat, which before was latent, must of necessity be set free. There can be no doubt in the mind of every careful investigator that precisely the same amount of heat will be eliminated whether this combination with oxygen goes-on slowly, or takes place with great rapidity. When we come to search for the proof of this mode of calorification, there is no lack of evidence. We find that a large quantity of oxygen is taken in at each inspiration, and a quantity of carbonic acid and water thrown-off at each expiration: the oxygen thus taken-in must find carbon and hydrogen within the system with which to unite in order to form the compounds which are exhaled, and by the combinations which thus take place, together with other combinations which take place in forming compounds which are excreted by the kidneys, skin and liver, we may account for all the heat generated within the body.

The oxygen, as before stated, is taken in at each inspiration through the medium of the lungs; at the same time a ceartain amount of carbonic acid is thrown-off, according to the law of the "mutual diffusion of gases". These gases thus exhaled and inhaled are so variable in quantity according to different circumstances, that no correct estimate of the amount can be easily given. It is sufficient for present purposes that the amount of carbonic exhaled is taken as a measure of the quantity of heat eliminated; as it is principally by its formation that heat is evolved. The amount of oxygen taken in, according to Carpenter, is to the amount of carbonic acid exhaled, as 1174 to 1000: this excess of oxygen unites with hydrogen and is exhaled in the form of water; and also, as before stated, a small portion unites with the sulphur and phosphorus which it finds in the body. The carbon and hydrogen with which oxygen unites are obtained, in part, from the gradual decay of the tissues forming the body: from the metamorphosis of the muscular and nervous tissues, which bears a direct relation to the degree in which they are exerted: and in part from the food taken into the stomach. The articles of food required to keep-up combustion in the system belong to the saccharine and oleaginous groups. The amount of oxygen contained in the saccharine group is just sufficient to form water with the hydrogen it contains and the carbon is set free to combine with the oxygen taken-in by the lungs. In the oleaginous group, the proportion of oxygen is still less; so that hydrogen and carbon are both set free and combine with the oxygen in the formation of heat. Dr. Carpenter says, that after an ordinary meal consisting of saccharine, oily and albuminous food, the saccharine is first received into the blood and eliminated from it, next the oleaginous, and, if these be eliminated before a fresh supply of food is taken, a sense of cold, as well as hunger, is experienced. From these facts, we see why it is that warm-blooded animals require a mixture of azotized and non-azotized food; and why it is that the inhabitants of extremely cold regions feed upon whales, seals and other animals loaded with fat. This combination of oxygen with other substances in the production of heat takes place in every part of the system. Calorification then is intimately connected with the functions of digestion and respiration, and depends upon a proper supply of pure air and non-nitrogenous food. It is also intimately connected with the functions of the skin, not only because of cutaneous respiration by which it serves as an auxiliary to the lungs, but also on account of the function of perspiration which serves not only to excrete refuse matter from the system, but, by the evaporation of the fluids excreted from the surface, serves to keep down the temperature to a proper standard.

Not only is heat lost by evaporation, but also by radiation into the surrounding media.

It is said in Kirkes & Paget's work, that "the losses in these two ways will bear, in general, an inverse proportion to one another; the small loss of heat in evaporation in cold climates may go far to compensate for the greater loss by radiation; on the other hand, the great amount of fluid evaporated in hot air may remove nearly as much heat as is commonly lost by both evaporation and radiation in common temperatures". So these two processes are continually exerting their influence to preserve an equilibrium of temperature. It has been before stated, that the processes by which calorification is carried-on, are, to some extent controlled by the influence of the nervous system. When the connection with the cerebro-spinal system is destroyed, the temperature of the part rapidly falls. This may be accounted for by the fact that the waste which occurs during action helps to supply the pabulum for the calorifying power;

in this case no nervous action can take place. When the connection with the sympathetic ganglia is cut-off, the temperature is elevated. This has been accounted for by the fact that the cappillaries are dilated and more blood is admitted into the part. The nervous system, though it influences, has no direct agency in, the production of heat.

There are other causes, besides that of age heretofore mentioned, which modify the degree of temperature; all of which are compatible with the theory here advanced: in fact, most of them, can only be explained by this theory. Some of these may be here mentioned. The time of day has its effect. The heat of body is at its maximum at noon, at its minimum at midnight. Exercise raises, while repose lowers the temperature; showing that muscular action influences the production of heat. Great mental exertion has some effect from the metamorphosis of the nervous tissue of the brain. External temperature has some influence; not so much in man as in other animals, as he adapts his clothing to suit. The temperature undergoes considerable change during disease. Experiments go to show that there is generally a direct proportion between the temperature and the activity of the pulse: this is often not the case, being influenced by causes of which little is known.

Other causes which influence the degree of temperature might be dwelt upon, but enough, perhaps, have already been mentioned.