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ON THE

EFFECTS OF HIGH TEMPERATURE

UPON THE

PUBLIC HEALTH,

AND ON

MEASURES OF PREVENTION.

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ON THE EFFECTS OF HIGH TEMPERATURE UPON THE PUBLIC HEALTH OF NEW YORK, AND ON MEASURES OF PREVENTION.

One of the most prolific sources of a high sickness and death rate in New York is developed during the summer quarter. It is a matter of common observation among physicians that diseases are not only more frequent, but are also more fatal in the city during the months of June, July, August, and September, and especially during July and August, than during the other months of the year. The records of the Health Department for these months show a large increase of deaths from nearly all diseases, except, perhaps, acute affections of the respiratory organs. The effect of this increased death rate during the summer months upon the total mortality of the year, is very striking. The death rate of New York varies from 28 to 32 in the 1,000 population; the mortality being from 26 to 32,000. If, however, the course of mortality did not fluctuate, but continued the same average for the summer quarter as for the remaining three quarters of the year, the total mortality would be reduced to 23 to 25,000, which would give a death rate of about 24 in each 1,000 population. In other words, not far from 3 to 5,000 persons are annually destroyed in New York by fatal agencies which are engendered during the summer months. It becomes, therefore, a matter of the utmost importance to the public health to determine, and if possible remedy the unhygienic conditions which are quickened into such fatal intensity and activity during the hot season of the year.

If we carefully compare the daily mortality and temperature record of any year, we find a remarkable correspondence during the summer months between them. As the temperature rises or falls, the mortality gradually increases or declines; the temperature, however, generally maintaining the advance in the fluctuation. The mortality record follows the fluctuations of the heat record with as much precision as effect follows cause.

The following table illustrates the mortality of the months of high temperature compared with that of the cooler months:

TABLE OF MONTHLY MORTALITY FOR 1871.

Date.	Diarrhœal Diseases.				Consumption.	Diseases of the Respirat'y System.	All Zymotic Diseases.
	Under 1 Year.	Under 2 Years.	Under 5 Years.	All Ages.			
January............	50	55	58	82	333	366	541
February	47	51	56	75	385	336	475
March	75	80	83	96	407	365	476
April...............	82	91	97	108	371	396	554
May	101	117	121	140	345	316	584
June................	387	430	436	467	292	168	798
July	809	990	1020	1100	337	145	1433
August	464	565	687	762	317	146	1126
September.........	267	394	409	462	328	216	791
October............	114	148	154	190	345	275	522
November	59	70	72	89	308	264	460
December..........	57	62	64	82	359	330	504

From this and the following table it is apparent that heat exerts a most decided influence upon the general mortality of New York. Authorities who have most thoroughly studied the causation of insolation or sun-stroke, regard heat as the chief or only element.

Oberniem,* "from observation of four cases of sun-stroke, and from thirty-three experiments on animals exposed to artificial heat, traces all the effects to the augmented temperature of the body, which cannot cool by evaporation from the surface and lungs, as usual. He puts down as necessary conditions, a high external temperature; internal conditions, as of marching, running, which augments bodily heat, and the absence of water."

Wood,† in his interesting study of sun-stroke, regards heat as the sole exciting cause of this affection. He says: "In regard to the etiology of the disease, my own experience is, that the only absolutely necessary, and the ever-present, immediate cause, is heat, solar or artificial."

Humidity does not appear to exert any very marked effect upon mortality. There can be no doubt that great humidity diminishes evaporation from the surface of the body, and to that extent interferes with the process of cooling; but as an element affecting mortality, it has not proved important. Mac Lean remarks: "There is no agreement among observers as to the effects of extreme dryness or moisture in increasing or diminishing the effects of heat. Insolation has been observed in both conditions." He adds: "It cannot be

* Parkes' Hygiene.

† *Thermic Fever.* Philadelphia, 1872.

doubted that heat, and, speaking generally, heat long continued, is the true exciting cause of this formidable affection."

TABLE OF WEEKLY MORTALITY AND TEMPERATURE FOR 1872.

Date.	Diarrhœal Diseases. Under 1 Year.	Under 2 Years.	Under 5 Years.	All Ages.	All Diseases of the Nervous System.	All Diseases of the Respiratory System.	All Zymotic Diseases	Highest Range of Thermom'tr in Sun. Average Weekly.
January 6	13	14	14	17	39	60	104	63° 0'
" 13	18	19	20	22	49	67	139	66 6
" 20	18	21	21	25	49	77	137	61 5
" 27	7	8	8	10	52	82	144	65 8
February 3	16	16	17	22	57	99	171	55 7
" 10	12	13	14	21	72	95	171	64 2
" 17	7	7	8	13	76	19	146	70 4
" 24	9	9	9	12	58	113	167	78 3
March 2	13	13	14	15	60	115	175	68 5
" 9	10	10	10	15	81	129	146	61 1
" 16	7	7	11	15	88	108	139	68 9
" 23	21	21	21	25	91	112	183	65 5
" 30	12	14	14	15	77	113	187	73 5
April 6	15	16	16	22	115	123	216	81 0
" 13	20	24	24	27	101	99	235	74 9
" 20	31	35	37	41	59	111	205	83 0
" 27	31	32	33	35	77	88	232	97 0
May 4	20	24	25	28	61	130	208	93 7
" 11	24	32	32	37	109	90	272	107 7
" 18	31	32	32	34	72	82	234	101 3
" 25	30	33	38	42	71	81	236	99 5
June 1	28	32	32	35	65	54	282	97 7
" 8	44	46	46	47	54	57	211	89 3
" 15	52	55	59	65	60	48	241	112 0
" 22	139	148	152	154	74	52	299	116 7
" 29	245	285	291	300	71	39	438	103 3
July 6	499	504	618	653	355	57	827	122 5
" 13	362	438	448	481	91	39	585	113 4
" 20	302	389	403	423	65	35	530	114 2
" 27	219	287	298	329	61	27	421	132 0
August 3	142	191	203	227	55	37	324	102 5
" 10	139	188	199	220	51	34	320	111 8
" 17	164	233	248	273	99	30	377	112 0
" 24	151	222	241	267	84	21	344	117 0
" 31	95	153	166	182	48	32	263	112 3
September 7	99	140	149	167	42	40	242	103 0
" 14	91	122	127	142	49	45	236	106 0
" 21	64	90	98	112	42	41	298	91 8
" 28	55	80	81	94	52	33	285	96 3
October 5	53	63	65	79	40	37	157	108 1
" 12	42	59	60	70	44	46	169	97 3
" 19	35	50	56	64	43	54	146	84 4
" 26	35	49	51	56	44	65	149	82 3
November 2	21	32	34	47	78	72	129	89 4
" 9	29	33	35	46	38	55	138	81 1

In order to fully understand the influence of heat and its effects upon the public health, we must first inquire as to the conditions regulating the temperature of the body in health and disease.

I.—Temperature of the Animal System in Health.

Normal Temperature of the Body.—The temperature of the animal system in a state of health is not a fixed quantity. It has a certain limited range, which depends upon internal and external conditions not at variance with health or the physiological state of the animal under consideration. This range seems to be less in man than in other warm-blooded animals.

The range of temperature in man in health, as established by careful experiment, is fixed at 97.25° F. to 99.5° F.* Any degree of temperature above or below these extremes, unless explained by special circumstances not affecting the normal condition of the person, is suspicious of disease. This comparatively fixed temperature in health is a remarkable feature of the living animal. It may be subjected to a temperature much below, or much above the extremes given, and still maintain this equilibrium by means of processes of compensation inherent in its constitution. The production of heat in the body is the result of chemical agencies, operating in the digestion of food, and in tissue changes. In the healthy adult animal waste and supply are so nicely balanced, that whatever the amount of food taken, the previous weight of the individual will be regained in twenty-four hours. Hence the degree of special heat produced normal to the animal will be maintained with slight variations under unvarying circumstances. But this fixed temperature is maintained also by the constant loss of heat. This loss takes place by radiation from the surface, by transmission to other bodies, by evaporation, and by the change or conversion of heat into motion. The surface of the body furnishes the principal medium for the loss of heat by the first three methods, viz., radiation, transmission, and evaporation. It is from the skin that heat is radiated from the body into the surrounding air, that it is conducted to colder objects, and that the evaporation of an immense secretory surface takes place.

It is estimated that 93.07 per cent. of the heat produced, escapes by the process of radiation, evaporation, conduction, and mechanical work. (*Barral.*) The remaining heat units are lost by warming inspired air and the foods and drinks taken, and by the loss in urine and fæces. This balance in the production of heat is so nicely balanced in man, that the range of normal temperature is very slight, being only about three degrees. There are apparently other subtile influences ("regulators of warmth") at work to preserve this temperature equilibrium, which are not well known. For if the production of heat is by any means increased, compensative losses of heat quickly occur, and the equilibrium is soon restored. And if the loss of heat is unusually increased, the compensative production soon begins, and the equilibrium is again effected. The important fact to be borne in mind is that in the human organism, when in health, and not subjected to too violent disturbing causes, the production and loss of heat are so balanced, that the temperature is maintained at an average of 98.6° F., the extremes being 97.25° F. and 99.5° F.

* Wunderlich's Thermometry.

"The temperature of the body," says Parkes, "is the result of the opposing action of two factors: 1st, of development of heat from the chemical changes of the food, and by the conversion of mechanical forces into heat, or by direct absorption from without; and 2d, and opposed to this, of evaporation from the surface of the body, which regulates internal heat. So beautifully is this balance preserved, that the stability of the animal temperature in all countries has always been a subject of marvel. If anything, however, prevents this evaporation, * * * then, no doubt, the temperature of the body rises, especially if, in addition, there is muscular exertion and production of heat from that cause. The extreme discomfort always attending abnormal heat of the body then commences. * * * In experiments in ovens, Blagden and Fordyce bore a temperature of 260° with a small rise of temperature (2½° F.); but the air was dry, and the heat of their bodies was reduced by perspiration; when the air is very moist, and evaporation is hindered, the temperature of the body rises rapidly; even 7° to 8° F."

Condition Affecting the Temperature of Healthy Persons.—It is important to notice some of the conditions which most affect the temperature of persons in health.

Age.—The temperature of the young and of the very old is higher than the middle aged. The infant at birth has a temperature of from 99° F. to 100° F., and it maintains a temperature of 99° and upwards for several days. The variations of temperature from other causes are much greater in children than in adults, as also are the normal daily variations of temperature. About the sixtieth year the average temperature of man begins to rise, and at the eightieth year it resembles that of childhood. This rise of temperature in the aged in whom the heat-producing conditions are feeble, is conjectured to be due to diminished loss of heat from the skin, owing to a less supply of blood.

Daily Variation.—It is an established fact that the bodily temperature has a regular diurnal variation. The lowest temperature is in the morning, and the highest in the afternoon. The daily maximum occurs between 4 and 9 P. M., and the daily minimum between 2 and 8 A. M. The lowest temperature is about 6 A. M., and from that time the temperature rises until late in the afternoon. (*Ogle.*)

Rest and Activity.—In sleep the variations of temperature are reduced to their minimum. Although there is an apparently wide difference in the temperature of the body during rest and activity, yet it would seem that "the final difference of temperature during rest and during labor, is extremely trifling." (*Wunderlich.*) This appears to be due to those compensating actions, "regulators of the temperature," or modifying conditions on which an equilibrium of temperature is maintained in health. During labor large quantities of cold air are inspired, and cold drinks imbibed, evaporation from the surface goes on more rapidly, and given quantities of heat are converted into muscular force or action. Thus, though the production of heat is greater in labor than in rest, yet the loss of heat is correspondingly increased, and the equilibrium of temperature is, if not maintained, very quickly restored.

Decomposing Substances.—The introduction into the blood of decomposing substances, as pus, animal matters, and the products of fever and inflammation, give rise to elevation of temperature. When putrid matters are injected under the skin of animals, there is a rise of temperature, which reaches its maximum within twenty-eight hours, and is followed by a decline to the normal standard. But if this injection is repeated several times, death occurs with a high temperature. (*Billroth.*) The air of towns contains emanations in hot weather from all the sources of animal and vegetable decomposition, and the inhalation of air so vitiated, brings in contact with the blood the products of decomposition in a highly divided state. The breath is charged with organic matters to which heat imparts the same activity. The air in close and heated places, as in tenement houses, workshops, school-houses, hospital-wards, and other rooms where many persons congregate for hours together, becomes charged with organic matters in addition to various gases. If the temperature of such places is increased, whether by the sun or by artificial means, these organic matters undergo decomposition with the production of poisonous agents, which give rise to fatal elevations of temperature among the young and old, and those enfeebled by disease.

Cold.—Cold is applied through a medium, as air, water, &c. Its direct effect is the abstraction of heat, but its secondary effect is the production of heat. As the cooling process goes on, the blood recedes from the skin, and is no longer exposed to the cold, and at the same time the external secretions are diminished. If the cold is withdrawn before the process of cooling has too much lowered the system, reaction takes place, the blood returns to the surface in larger quantities than before, and the temperature reaches a higher point than normal, but soon returns to its natural standard. If, however, the cold is intense and continued, the temperature will steadily sink, in spite of compensating agencies, and death will finally ensue. The depressing effects of cold air depends much upon the amount of moisture there is in it, and whether it is still or moving. Cold dry air is far less cooling than cold moist air; and cold air at rest, than cold air in motion. Cold, applied through the medium of water, is much more depressing than where air is employed, and running water abstracts heat much more rapidly than standing water.

Heat.—Heat, like cold, is applied through such agents as air, water, &c. When heat is applied we witness the same effort to preserve an equilibrium of temperature, as in the use of cold. While the primary effect of heat is to raise the temperature, the secondary effect is to cool the body by relaxing the blood-vessels of the skin, and thus inviting the blood to the surface, and in the same manner increasing the secretions and their evaporation. If, however, the heating process is continued beyond the power of the regulating forces to control the temperature, the heat of the body gradually rises, and death ensues when it reaches 110° to 115° F. Hot moist air is much more heating than hot dry air, partly owing to the diminished evaporation under the former circumstances, but chiefly on account of the direct application of heat through a more solid medium.

Baths.—The effect of bathing upon the heat of the body varies with the temperature of the bath. If the water is very cold the production of heat is greatly increased, and the temperature of the body is not diminished. If the bath is 68°-73° F. the production of heat is increased three or four times; if 86° F. it is twice the usual amount; if at blood-heat it is but slightly increased. (*Liebermeister.*) If, however, cold is applied locally, as to the hands, feet, nose, the temperature of the part may be reduced 6° or 7° F. A cold sitz bath will reduce the temperature of the whole body 2° F., but there is a rise after the bath. A hot bath is at first followed by a rise of temperature, and this is succeeded by a corresponding fall. The phenomena of temperature witnessed in the employment of baths are not yet fully explained. It is, however, sufficient for our purpose to notice that the cold bath at once rapidly abstracts heat from the body, and thus suddenly reduces temperature. It also constringes the vessels of the skin, and forces the blood to the internal organs, and while it thus removes the mass of blood from further contact with the cold medium, it stimulates to activity the functions of internal organs, and heat is produced as a secondary effect. A cold bath, therefore, first reduces temperature, and secondly elevates it above the normal standard, and the equilibrium is restored by a gradual return from an elevated to the normal temperature. A hot bath, on the contrary, first communicates heat, and thus elevates the temperature; but this is immediately followed by a relaxation of the skin and its vessels, the blood is withdrawn from the deeper organs, the secretions of the skin are increased, evaporation becomes active, and the cooling process gradually restores the normal temperature. A hot bath, then, at first elevates the temperature, secondly depresses it, and the equilibrium is restored by a gradual rise to the normal standard. "Every diminution and elevation of temperature which momentarily occurs through thermal application, is therefore only transient, and is speedily neutralized by the altered warmth production; * * a high temperature (of the body) commonly follows a cold bath; and after a warm bath, on the other hand, increased coolness is noticed; and in tropical countries, and very hot seasons, no means of cooling is so lasting as a bath or a douche of very warm water." (*Wunderlich*)

These are but few of the many examples which might be adduced to illustrate the nature of the agencies by which the normal temperature of the body is affected. It must be borne in mind, however, that whatever these agencies are, so long as the body is in a state of health, there is a regulating power that tends to preserve an equilibrium of temperature. However extreme the fluctuations may be, there are compensative functions and methods of adjustment capable of quickly restoring the normal condition.

It is very evident that in an organism having such complicated functions as that of man, and subject to such a multitude of adverse influences, the balance between health and disease must be very nicely adjusted. Too great an elevation or too great a depression of temperature, may destroy the "regulation power," and disease or death may be the consequence. Or, on the other hand, this "regulation power" may be weakened or destroyed by causes generated within the body, or received from without, and the heat-producing agencies are then under other influences, and may prove powerfully destructive forces.

II.—Temperature of the Animal System in Disease.

It is important in this connection to notice also the effects of disease upon the temperature of the individual affected. And in the first place it may be stated that idiosyncrasy, or constitutional peculiarities, have a considerable influence upon the power of the system to regulate the temperature. The degrees of mean bodily temperature, which different persons maintain in health, aside from age, sex, and other pecularities, is not the same. This variability has been attributed to the special constitution or habit of body of individuals. If in any individual there is a diminished power of maintaining in health a normal mean temperature, we must conclude that when such persons are unduly exposed to agencies which increase the temperature of the body, as high solar or artificial heat, fatal effects must be the result; while persons of more power of compensation would pass unharmed. And still further, it must follow that those diseases which tend to destroy the agencies which regulate temperature, must act more promptly, and with much greater effect upon those of feeble constitution, than upon those who have great power of maintaining an equilibrium.

The first peculiarity which we notice in regard to temperature in disease, is that there are daily fluctuations, as in health, but much more extreme. It may be stated, in general, that the remission of temperature in diseases occurs in the morning, and the exacerbation in the afternoon and evening; the minimum is reached between 6 and 9 o'clock in the morning, and the maximum between 3 and 6 o'clock in the afternoon. In many diseases the minimum temperature is not below 98°, and generally is one or two degrees above that point, while the maximum has no definite limit, and may reach the dangerous height of 107°. It will be noticed that the exacerbation occurs in the afternoon, or that part of the day when the temperature of the air is at its maximum. The effect of various diseases upon the bodily temperature may be seen by the following illustrations: In typhoid fever it is 102° to 104°; in typhus fever, 102° to 104°; eruptive fevers, as measles, small-pox, &c., 102° to 104°; scarlet fever, 104°; pneumonia, 104°. (*Wunderlich.*) In some non-inflammatory diseases, it is true, the temperature may fall even as low as 71° and 72°. (*Roger.*)

When other conditions, therefore, than health exist, there must be greater liability to fluctuations of bodily temperature of a dangerous character, and hence, a predisposition to the effects of heat. If, for example, the secretions of the skin are diminished or prevented, the cooling process of evaporation is correspondingly diminished, and the power of preserving the normal temperature is markedly lessened. Simpson says: "Every man seized with sun-stroke, and who could answer questions, informed me that he had not perspired for a greater or less extent of time—sometimes not for days—previous to being attacked, and that he had enjoyed good health as long as he perspired, but that on this perspiration being checked he felt dull and listless, and unable to make much exertion without making a great effort." It was noticed that the heat of the surface became much increased. These predisposing causes are, therefore, very numerous, especially in cities and among the poor. We shall notice only two or three of the more important:

1. Exhaustion from fatigue, or overwork, especially in a heated atmosphere, powerfully predisposes to sun-stroke. By far the greater number of cases which enter hospitals in this city are laborers stricken down while at their work, late in the day. Marked examples of sun-stroke following fatigue are furnished among soldiers, especially in tropical climates.

2. Intemperance is an important predisposing element in a large number of cases of sun-stroke in this city. Although alcoholic liquors have the effect when first taken of lowering the bodily temperature, yet in habitual drinkers the power of regulating the temperature seems to be diminished, and the drunkard, whether soldier or civilian, is the first to fall a victim to high heat.

3. Persons confined in impure air, as in tenement houses, badly ventilated workshops, barracks, etc., suffer severely from the effects of heat. The air is charged with noxious impurities, gases, and organic matters, and is almost irrespirable. Carbonic acid, one of the most fatal poisons, exists in dangerous quantity; "the carbonic acid of the air increases with the activity of life, and with artificial warming and lighting, as well as with animal and vegetable decay. * * It has been a question, if it really does any active harm, or is only negative to life. * * I am inclined to think that carbonic acid has an injurious influence in small amount."*

A review of the preceding facts warrant the following conclusions:

1st. The temperature of the human system is fixed in health at a mean of 98° F., and has a range of about three degrees, the equilibrium being restored by certain compensating functions. There is a daily fluctuation of temperature, the minimum being in the morning, and the maximum in the afternoon. This normal fixed temperature may be elevated or depressed by the temperature of the air to a point which will cause death. When the temperature is elevated, death may occur with all the symptoms due to heat.

2d. The temperature of the body is elevated in disease, the compensating functions or "regulation power," is weakened, and the morning and evening fluctuations are the same as in health. High external temperature much more sensibly affects the temperature of the sick, than the well, and may raise it to a point at which exhaustion or true sun-stroke may prove fatal.

* Angus Smith.

3d. A temperature of 54° F. is the medium temperature of the air best adapted to the public health, for at that temperature the decomposition of animal and vegetable matters is slight, and the normal temperature of the human system is most easily maintained. Every degree of heat above that point, adds to the indirect and direct effects of heat upon the body. When the temperature is maintained at 70° F. and upwards, the indirect effects of heat become very marked upon the general mortality; and when it is maintained at 80° F. and upwards, the direct effects of heat are added to the indirect.

TABLE SHOWING THE RELATIVE MORTALITY WHEN THE TEMPERATURE IS ABOVE AND BELOW 70° F.

	1867		1868		1869		1870		1871		1872	
	Deaths.	Days	Deaths.	Days	Deaths.	Days	Deaths.	Days	Deaths.	Days	Deaths.	Days
Average daily mortality when the thermometer was above 70°, for the months of June, July, August and September	75 3/4	64	86 65/73	73	77 5/37	74	92	86	91 4/13	65	117 13/43	86
Average daily mortality when the thermometer was below 70°, for the months of June, July, August and September	61 25/29	58	61 33/49	49	64 1/3	48	67 2/3	36	56 33/57	57	77 3/4	36
Average of total daily mortality for the months of June, July, August and September	69 9/61	122	76 45/61	122	72 1/61	122	84 35/61	122	75	122	105 67/122	122

How High Temperatures Affect the Public Health.

We have next to consider in what manner high temperature affects the public health.

1. *Indirect Effects of Heat.*—The indirect effects of heat appear in the production of deleterious gases or vapors which vitiate the air, and render it more or less injurious to health. Decomposition of all forms of refuse animal and vegetable matter proceeds with far greater rapidity during the summer quarter than during other months of the year. And the rapidity of the decomposition depends upon the daily fluctuations of temperature.* As this putresence progresses, gases are evolved, which fill the air, and especially the stratum nearest the earth.

As many of these gases are proven to be poisonous, and productive of

* "I was led to consider one of the effects of heat when working on the gases of putrefaction. It was then perfectly clear that the putrefaction proceeded exactly as the temperature rose, not ceasing at a little above 138° F., perhaps approaching nearly 140° F."—Angus Smith, *Air and Rain*. London, 1872.

various forms of disease when inhaled, it follows that one source of increased summer mortality is due to the decomposition of the waste animal and vegetable matters, which, in the various forms of refuse, are so plentifully found in cities. Thus many of the diarrhœal diseases, fevers, and similar affections, are believed to have their origin at this period.

To these effects should be added the damage to food from continued high heat. Milk retailed through the city, the sole or chief diet of thousands of hand-fed infants among the poor, undergoes such changes as to render it not only less nutritious, but also hurtful to the digestive organs. The vegetables and fruits in the markets rapidly deteriorate, and become unfit for food; meats and fish quickly take on putrefactive changes, which render them more or less indigestible. Hence, with the rise of the summer temperature derangements of the digestive organs begin early to be manifest, first in infants and children, and subsequently in adults. As the season advances these affections, of various types and degrees of severity, become almost universally prevalent, and give to our sickness and death rate their immense preponderance during the summer quarter.

2. *Direct Effects of Heat.*—In the direct action of heat upon the human system we have the most powerful element in the production of our great summer mortalities. While fatal sun-stroke represents the maximum direct effect of solar heat upon the human subject, the large increase of deaths from wasting chronic diseases and diarrhœal affections; of children under one year of age, and persons upwards of 70 years of age; shows the sad effects of the prevailing heat upon all who are debilitated by disease or age. The derangements of the functions of the system which follow this pressure of external heat upon the normal conditions may extend to every organ of the body. The nervous system is rendered more susceptible; the digestive organs are enfeebled; the action of the heart is increased. The more immediate effects of heat upon the animal system have been made the subject of careful study, and should be noticed in this connection.

It is established that when solar or artificial heat is continually applied to the animal, the temperature of the body will gradually rise until all the compensating or heat regulating agencies fail to preserve the eqilibrium, and the temperature reaches a point at which death takes place. This degree of animal heat varies much with different species of animals, and with different animals of the same species. In the experiments of Wood* the temperature of rabbits dying from the effects of heat varied from 111° to 114°; in a dog it was 130¾°; and in a pigeon 120°. As the normal temperature of these animals is higher than that of man, it is not probable that the latter would survive the same high bodily temperature. In general, a temperature of 107° in any disease would be regarded as indicating an unfavorable termination. The following degrees of temperature have been recorded by different observers of persons suffering from sun-stroke, viz.: Dowler, 113°, 109°, 106°, 104°, and 110° after death; Levick, 109°, 109°, 106°, 105°, 112° after death; Wood, 108°, 109°, 104°, 106°, 109-110° after death.

* Thermic Fever.

Wood performed a series of experiments to determine the degree of heat required to destroy the functions of the brain, and concludes: 1. That a temperature of the brain of from 113° to 117° F. is sufficient, if maintained, to produce death in a short space of time in mammals, by arrest of respiration. 2. That the chief symptoms induced are insensibility and convulsions, preceded by exceedingly rapid respirations and action of the heart, and unaccompanied by any general rise of temperature. 3. That these symptoms come on very quickly in all cases, at times with absolute abruptness. He attributes the fact that a temperature of 113° to 114° F., is fatal to the brain of a cat, and 117° F. to that of a rabbit, to the difference in excitability of the nervous system of the two animals, and adds: "The brain of a man is much more highly organized, and no doubt correspondingly more sensitive than that of a cat, and if a temperature below 113° F., is fatal to the brain of a cat, whose normal temperature is 102½ ° F., it seems very certain that the temperature of some cases of insolation (113° F.) is sufficient in itself to cause death in man, whose normal temperature is 99° F."

The nature of the changes which heat produces when so applied as to produce dangerous or fatal results, has been variously explained by authors. But recent investigations seem to establish certain conclusions which it is important to notice. Oberniem gives two forms of sun-stroke, viz., the asthenic, where the elevation of the temperature of the body brings on early collapse; and sthenic, when the bodily temperature attains a great height, and then suddenly the attack comes on, with more or less reaction. In the former case there is a pale face and a copious sweating, and cold skin, (this is the heat asphyxia of some authors); in the other there is the red face, the injected eyes, the sobbing breathing, convulsions, delirium, &c.* The asthenic form here noticed is described by Wood as "exhaustion" by heat, and is quite different from the sthenic form, which he denominates " thermic fever."

In the first, or the *Asthenic Form,* high temperature proves injurious, and also fatal, by what is termed exhaustion. This effect is more often seen in persons feeble from debilitating diseases or age. The symptoms are those of extreme prostration; the pulse is quick and feeble; the skin is cool and moist; and the patient has the appearance of one suffering from fainting. The *post-mortem* examination reveals a relaxed condition of the heart.

In the second, or *Sthenic Form, Insolation, Sun-stroke, Heat-stroke, Thermic Fever,* it has been established that heat may cause death by its effects upon,—1st, the nervous centres; 2d, The muscular system; and, 3d, the blood. Wood applied heat directly to the heads of animals, and concludes from his experiments:—That symptoms come on very quickly in all cases, at times with absolute abruptness. "There is a marked resemblance of the nervous symptoms given in these cases, to those most noticeable in sun-stroke." The author remarks, however, that the general symptoms were not those of insolation; and this fact, in his opinion, proves that sun-stroke is not so much due to the direct effects of heat upon the head, as to the general rise of the temperature of the whole body. The effects of high heat

* Parkes' Hygiene.

upon the muscular system is believed by Vallin, to be due to the coagulation of the myosin (muscular juice,) which results in muscular rigidity. This accounts for the rigidity of the heart found after death from insolation, and the rapid *post-mortem* rigidity which always occurs in these cases. Wood concludes:—1. Excessive rigidity of heart due to a coagulation of its myosin, is a very pathognomonic lesion of sun-stroke. 2d. That in most cases it is a *post-mortem*, rather than an *ante-mortem*, phenomenon, occurring directly after death. 3. In certain cases, the so-called cardiac variety of sun-stroke, death is probably due to a sudden *ante-mortem* coagulation of the cardiac myosin and consequent instantaneous arrest of the heart's action. 4. That the muscles after death from heat fever, very soon become rigid, sometimes do so instantly, and that such rigidity is of the same nature as ordinary *post-mortem* rigidity. 5th. That while it is conceivably possible that death from asphyxia may occur from coagulation of the myosin of the diaphragm and other respiratory muscles, it is exceedingly probable that in man death never does actually occur from such causes." The changes found in the blood seem to be due to the effects of the fever induced by the heat. It is very dark owing to a diminished amount of oxygen, and is not coagulable.

Wood states that death from sun-stroke "is frequently due in a great measure to a slow, gradual deterioration of nerve, muscular, and hæmic organization; and in such cases the fatal result may be brought about without being caused by the temperature without, in other words, the lethal nerve heat point being reached."

Causes of High Temperature in New York.

Observation has established the important fact, that the temperature of large and closely populated towns is higher than the surrounding rural districts. This is due to a variety of causes, the chief of which are the removal of vegetation, the drainage of the soil, and the covering of the earth with stone, bricks, and mortar; the aggregation of population to surface area; the massing together of building; and, finally, the vast multiplication of sources of artificial heat in dwellings, workshops, and manufactories. The difference between the mean temperature of the city at Cooper Institute and at the Arsenal, Central Park, for a single month, illustrates this fact.

Another striking difference between the temperature of these two points of observation is that the range is much greater at Central Park than at Cooper Institute, the temperature falling at night more at the former than at the latter place. The effect of vegetation is to lower the temperature at night, while brick and stone retain the heat and prevent any considerable fall of temperature during the twenty-four hours. But New York has all the conditions of increased temperature above given intensified. It has a southern exposure; below Fifty-ninth street almost the entire surface is stone and brick; it is destitute of vegetation; its buildings are irregularly arranged, but crowded together so as to give the largest amount of elevation with the least superficial area; ventilation of courts, areas, and living-rooms, is sacrificed, and finally its population is crowded into ill-constructed buildings, some wards having the largest population to surface area of any city in the civilized world. These conditions necessarily cause a constant production of artificial heat of an unlimited amount. When the summer temperature begins to rise, it is so much constantly added to the amount of artificial heat already existing. The temperature of the whole vast mass of stones, bricks, and mortar gradually increases, with no other mitigation and modification than the inconstant winds and occasional rain-storms.

The effect of this increase of temperature upon the refuse and filth of the streets, courts, and alleys, upon the air in close places, and in the tenement houses, and upon the tenants themselves, is at once perceptible. The foul gases of decomposition fill the atmosphere of the city, and renders the air of the close and unventilated places stifling; while languor, depression, and debility fall upon the population like a wide-spread epidemic.

The course of sickness now changes, and the physician recognizes that a new element has entered into the medical constitution of the season. The sickly young, the enfeebled old, those exhausted from wasting diseases, whose native energies were just sufficient to maintain their tenure upon life, are the first to succumb to this new pressure upon their vital resources. Diarrhœal diseases of every form next appear, and assume a fatal intensity, and finally the occurrence of sun-stroke, (or thermic fever), determines the maximum effects of heat upon the public health. The sickness records of dispensaries, and the mortality records of the Health Department, show that a new and most destructive force is now operating, not only in the diseases above mentioned, but also in nearly all the diseases present at that period. Fevers, consumption in its later stages, and puerperal affections, all run a more rapid course, and are far less amenable to treatment.*

REMEDIAL MEASURES.

The question which we have to determine is, as to the best methods of protecting the present and future population of New York from the evil consequences of high summer temperatures. The facts regarding the temperature of the individual in health and disease, the conditions which influence the bodily temperature, and the direct and indirect effects of heat upon the animal system, suggest the necessity of securing, if possible, the following results:

First. The moderation of the temperature of the atmosphere.

Second. The daily regulation and equalization of bodily temperature by artificial means.

To accomplish the first object of equalizing the temperature of the city, the following measures are suggested:

First. The supply of an adequate number and variety of shade-trees.

Second. The introduction of water to such an extent as to admit of free flushing of all the streets and gutters daily.

* An eminent German physician has made the observation, that during the hot summer months ordinary fevers are far more fatal, owing to the addition of the heat of the air to the heat of the body.

I.—The Supply of the City with Shade-Trees.

The sanitary value of trees has been greatly underestimated. With the most ruthless hand man has everywhere and at all times sacrificed this most important element in natural scenery. He has found, however, that by this waste of the forests, he has not improved his condition. The winters are colder, the summers hotter, the living springs cease to flow, the streams are disappearing, the earth is deeply frozen in winter, and parched in summer.* But what is of more serious importance, grave diseases, like consumption, typhoid, and other low forms of fever, diphtheria, diarrhœal affections, etc., become frequent and fatal. Unaware of the causes which have rendered an old homestead unhealthy, the occupant is often forced to find a more congenial home. Thus large areas of the globe have, by the destruction of the forests, been rendered almost uninhabitable. Other sections have, by the same vandalism, been reduced to the condition of barren wastes.

The sanitary effects of trees, so far as they relate to the subject of this paper, may be considered under the following heads :

First. Equalization of the temperature and humidity.

Second. Rendering innocuous deleterious malarial emanations from the soil.

Third. Purification of the atmosphere.

1.—*The Effect of Trees on Temperature and Humidity.*—It is a matter of common observation that the temperature in a forest, a grove, or even a clump of trees, is cooler in summer and warmer in winter than the surrounding country. Man and animals alike seek the shade of groves and trees during the heat of the day, and are greatly refreshed and revived by the cool atmosphere. The difference between the temperature of the air under and among the branches of a single tree, densely leaved, and the surrounding air, on a hot day, is instantly realized by the laborer or traveler who seeks the shade. The thermometer in the sun and shade shows a difference of 20, 30, and 40 degrees, and in the soil a difference of 10 to 11 degrees. The reverse is true in winter. The laborer and traveler exposed in the cold of the open country, find in the forest a degree of warmth quite as great as in a building but imperfectly inclosed. Railroad engineers inform us that they have occasion to use far less fuel in passing through forests in winter than in traversing the same distance in the open country. When the ground is frozen two or three feet deep in the fields, it is found above the freezing point in the forest.

Forests and even single trees, have, therefore, a marked influence upon the surrounding temperature, especially during the summer, and they evidently tend to equalize temperature, preventing extremes both in summer and winter. Hence they become of immense value as sanitary agencies in preserving equality of climatic conditions.

* The question, however, remains unsettled how far the improvement of country districts by agriculture affects the temperature. From recent investigations by Daniel Draper, Meteorologist to the Park Commission, it appears, that in the vicinity of New York, Philadelphia, and Boston, the average general temperature has not changed during the last fifty years.

It is believed by some vegetable physiologists that trees exert this power through their own inherent warmth, which always remains at a fixed standard both in summer and winter. "Observation shows" says Meguscher,* "that the wood of a living tree maintains a temperature of from 54° to 56° F., when the temperature stands from 37° to 47° F., above zero, and that the internal warmth does not rise and fall in proportion to that of the atmosphere. So long as the latter is below 67° F., that of the tree is always highest; but, if the temperature of the air rises to 67° F., that of the vegetable growth is the lowest." Since, then, trees maintain at all seasons a constant mean temperature of 54° F., it is easy to see why the air in contact with the forest must be warmer in winter and cooler in summer, than in situations where it is deprived of that influence.†

Again, the shade of trees protects the earth from the direct rays of the sun, and prevents solar irradiation from the earth. This effect is of immense importance in cities where the paved streets become excessively heated, and radiation creates one of the most dangerous sources of heat. Whoever has walked in the streets of New York, on a hot summer's day, protected from the direct rays of a midday sun by his umbrella, has found the reflected heat of the pavement intolerable. If, for a moment, he passed into the dense shade of a tree, he at once experienced a marked sense of relief.

Trees also have a cutaneous transpiration by their leaves. And although they absorb largely the vapor of the surrounding air, and also the water of the soil, they nevertheless exhale constantly large volumes into the air. This vaporization of liquids is a frigorific or cooling process, and when most rapid, the frigorific effect reaches its maximum. The amount of fluid exhaled by vegetation has been, at various times, estimated with more or less accuracy. Hales‡ states that a sun-flower, with a surface of 5.616 square inches, throws off at the rate of 20 to 24 ounces avoirdupois every twelve hours; a vine, with 12 square feet of foliage, exhales at the rate of 5 or 6 ounces daily. Bishop Watson, in his experiments on grasses, estimated that an acre of grass emits into the atmosphere 6.400 quarts of water in 24 hours.

It is evident, therefore, that vegetation tends powerfully to cool the atmosphere during a summer day, and this effect increases in proportion to the increase of the temperature. The influence of trees heavily leaved, in a district where there is no other vegetation, in moderating and equalizing the temperature, cannot be overestimated. The amount of superficial surface exposed by the foliage of a single tree is immense. For example, "the Washington Elm, of Cambridge, Mass., a tree of moderate size, was estimated several years since to produce a crop of 7,000,000 leaves, exposing a surface of 200,000 square feet, or about five acres of foliage."

Trees regulate the humidity of the air by the process of absorption and transpiration. They absorb the moisture contained in the air, and again return to the air, in the form of vapor, the water which they have absorbed

* Man and Nature. G. P. Marsh, New York. 1872.

† It is interesting to notice, in this connection, the remark of Angus Smith, already quoted, that a temperature of 54° F. is important in the decomposition of animal and vegetable matter.

‡ Public Parks. By John H. Rauch, M. D. Chicago, 1869.

from the earth and the air. The flow of sap in trees for the most part ceases at night, the stimulus of light and heat being necessary to the function of absorption and evaporation. During the heated portions of the day, therefore, when there is the most need of agencies to equalize both temperature and humidity, trees perform their peculiar functions most actively. Moisture is rapidly absorbed from the air by the leaves, and from the earth by the roots, and is again all returned to the air and earth by transpiration or exudation. The effect of this process upon temperature and humidity, is thus stated by Marsh: "The evaporation of the juices of the plant by whatever process effected, takes up atmospheric heat, and produces refrigeration. This effect is not less real, though much less sensible in the forest than in meadow and pasture land, and it cannot be doubted that the local temperature is considerably affected by it. But the evaporation that cools the air, diffuses through it, at the same time, a medium which powerfully resists the escape of heat from the earth by radiation. Visible vapor or clouds, it is well known, prevents frosts by obstructing radiation, or rather by reflecting back again the heat radiated by the earth, just as any mechanical screen would do. On the other hand, clouds intercept the rays of the sun also, and hinder its heat from reaching the earth." Again, he says, upon the whole, their general effect "seems to be to mitigate extremes of atmospheric heat and cold, moisture and drought. They serve as equalizers of temperature and humidity."

2.—*Effects upon Malarial Emanations.*—The power of trees, when in leaf, to render harmless the poisonous emanations from the earth, has long been an established fact. Man may live in close proximity to marshes from which arise the most dangerous malaria with the utmost impunity, provided a grove intervene between his home and the marsh. This function of trees was known to the Romans, who enacted laws requiring the planting of trees in places made uninhabitable by the diffusion of malaria, and placed groves serving such purposes under the protection of some divinity to insure their protection.

3.—*Purification of the Atmosphere.*—The process of vegetable nutrition consists in the appropriation by the plant or tree of carbon. This element it receives from the air in the form principally of carbonic acid, and in the process of digestion the oxygen is liberated, and again restored to the air, while the carbon becomes fixed as an element of the woody fiber. Man and animals, on the contrary, require oxygen for their nutrition, and the supply is in the air they breath. Carbon is a waste product of the animal system, and, uniting with the oxygen, is expired as carbonic acid, a powerful animal poison. A slight increase of the normal quantity of carbonic acid in the air renders it poisonous to man, and continued respiration of such air, or a considerable increase of the carbonic acid, will prove fatal. The animal and vegetable world, therefore, complement each other, and the one furnishes the conditions and forces by which the other maintains life and health. "Plants," says Schacht, "imbibe from the air carbonic acid and other gaseous or volatile products exhaled by animals, developed by the natural phenomena of decomposition. On the other hand, the vegetable pours into the atmosphere oxygen, which is taken up by animals and appropriated by them. The tree, by means of its leaves and its young herbaceous twigs, presents a considerable surface for absorption and evaporation; it abstracts the carbon of carbonic acid, and solidifies it in wood fecula, and a multitude of other compounds. The result is that a forest withdraws from the air, by its great absorbent surface, much more gas than meadows or cultivated fields, and exhales proportionally a considerable greater quantity of oxygen. The influence of the forests on the chemical composition of the atmosphere is, in a word, of the highest importance."*

In large cities, where animal and vegetable decomposition goes on rapidly during the summer, the atmosphere is, as already stated, at times saturated with deleterious gases. At the period of the day when malaria and mephitic gases are emitted in the greatest quantity and activity, this function of absorption by vegetation, is most active and powerful. Carbonic acid, ammoniacal compounds, and other gases, products of putrefaction, so actively poisonous to man, are absorbed, and in the process of vegetable digestion, the deleterious portion is separated and appropriated by the plant, while oxygen, the element essential to animal life, is returned to the air. Trees, therefore, in cities, are of immense value, owing to their power to destroy or neutralize malaria, and to absorb the poisonous elements of gaseous compounds, while they emit the oxygen.

The conclusion from the foregoing facts is inevitable that one of the great and pressing sanitary wants of New York City is an ample supply of trees. It is, in effect, destitute of trees; for the unsightly shrubs which are planted by citizens are, in no proper sense, adequate to the purpose which we contemplate. Its long avenues, running North and South, without a shade-tree, and exposed to the full effect of the sun, are all but impassible at noonday in the summer months. The pedestrian who ventures out at such an hour finds no protection from an umbrella, on account of the radiation of the intense heat from the paved surface. Animals and man alike suffer from exposure in the glowing heat. Nothing mitigates its intensity but the winds, or an occasional rain-storm. And when evening comes on, the cooling of the atmosphere produced by vegetation does not occur, and unless partially relieved by favoring winds or a shower, the heat continues, but little abated, and the atmosphere remains charged with noxious and irrespirable gases. It is evident that shade-trees, of proper kinds, and suitably arranged, supply the conditions necessary to counteract the evils of excessive heat. They protect the paved streets and the buildings largely from the direct rays of the sun; they cool the lower stratum of air by evaporation from their immense surfaces of leaves; they absorb at once the malarious emanations and gases of decomposition, and abstract their poisonous properties for their own consumption; they withdraw from the air the carbonic acid thrown off from the animal system as a poison, and decomposing it, ap-

* *Les Arbres*, quoted by Marsh.

propriate the element dangerous to man, and give back to the atmosphere the element essential to his health and even life.*

And we may add that cultivated shade-trees in New York would be an artistic and attractive feature of the streets. Every citizen enjoys trees, as is evident from the efforts made to cultivate them throughout the city.

But it is idle to attempt to supply the city with suitable trees and ample shade, until the whole control and management of this service is placed under a qualified authority. If it is left to individual citizens to select their own trees, and cultivate them as they may think proper, there will be no improvement upon the present system. Fortunately we have in the Department of Public Parks a commission fully and admirably qualified to assume the entire control of the trees of New York. This body could be empowered to select and plant the trees, and afterwards to cultivate and protect them. In granting the requisite powers to this commission, the Legislature should authorize the planting of trees in all streets and public places, with suitable protection, and make interference with trees in the city, except by the agents of the commission, a penal offense. In wide streets and avenues, the planting of a row of trees in the centre of the street might be left to the discretion of the commission.

II.—The Introduction of River-Water for Cleaning.

An examination of the daily temperature and mortality record shows some remarkable fluctuations due to the effects of rain-storms. The fall of temperature on the occurrence of rain on a summer's day is sometimes ten degrees, and it remains reduced for twenty-four hours or more. A corresponding fall of the mortality rate takes place on the following day, and it remains reduced until the temperature again rises. It has often been remarked, also, that wet seasons, or those noted for frequent rain-storms, have the least mortality.

The action of a rain-storm in the reduction of temperature is twofold: First. The air is washed by the rain, and both cooled and purified. At the same time the attending movement of the winds changes the atmosphere, removing the hot and stifling air of the town, and replacing it from the ocean of fresh cool air from country places, or from the sea. Second. The evaporation of the freshly fallen rain from the heated surfaces of the city, as the paved streets, the brick walls, the metal roofs of the buildings, is a refrigerating process, and tends powerfully to cool the lower stratum of the air.

Though we cannot extemporize rain-storms, and secure the benefits to be derived from them in the purification and cooling of the atmosphere further than would be effected by an abundant supply of vegetation, yet we may daily flush the streets, gutters, courts, alleys, etc., with fresh water. By this simple sanitary act, we can daily cleanse the city of all the surface filth not removed by the scavengers, and cool the atmosphere by the evaporation attendant upon the free use of water. By no other method can the city be

* The late Dr. Francis remarked that he had noticed a marked increase in the fatality of diseases in sections of the city after the removal of trees and all vegetation.

preserved in a suitable state of cleanliness during the summer, than by the daily and free use of water. The broom of the scavenger is wholly inadequate to the purpose: it removes only the more gross substances, and leaves the finely divided and infinitely more putrescible and poisonous materials to be vaporized, and poison the air, or be driven by the winds into every recess.

Competent engineers find no practical difficulty in supplying the city with water from that exhaustless reservoir, the river. The water from this source is well adapted for the purpose of cleaning the streets, gutters, and sewers.

Among the plans for utilizing the river-water for sanitary and other purposes, that devised by Wm. E. Worthen, Esq., Sanitary Engineer, to the Metropolitan Board of Health,* demonstrates, not only the practicability of the scheme, but also its economy. He proposed to divide the city below 59th street into two districts, by 14th street; each district was to have a pumping-engine station: the lower at the corner of Canal and Walker streets, and the upper, on the reservoir, at 40th street. The water was to be conveyed to the pumping-stations by brick conduits, delivering by gravitation into wells. There were to be two pumping-engines at each station, each of the daily working capacity of 6,000 gallons per minute, and in case of necessity, 9,000 gallons per minute; one engine only to be in use; the other to be a reserve-engine, in case of accidents. The pumps were to draw their supply by gravitation from a well, fed by a 4-feet brick conduit from the river, and deliver the water into a stand-pipe under a head of 100 feet above tide-level; the distribution thence to be through mains. The total cost of construction was carefully computed, and found not to exceed $4,000,000, and the cost of maintenance $130,000 annually. Although this plan was submitted as a sanitary measure, and designed simply to secure thorough cleanliness during those months of the year when the Croton supply is deficient, Mr. Worthen suggests that this new water supply may still further be utilized. In the first place, it would supply the Fire Department with water to any extent it might require, and, having such forcing power through the medium of the pumps, fire-engines would not be required. Street cleaning and the Fire Department could be under one management. In the second place, hydraulic power could be furnished to the commercial districts through the distributing or service pipes, which would be of immense advantage, and would surpersede the present costly and clumsy machinery in use. A similar system has been introduced into London, at a great expense, for the express purpose of supplying the commercial portions of the town with hydraulic power in hoisting lifts, etc. It is estimated that the rental of such water-power would in itself pay the interest on the cost of construction and maintenance, and leave a surplus which would in time extinguish the entire debt, and thenceforth be an important source of revenue. Finally, such a water supply would furnish the requisite conveniences for public baths, the next great sanitary want of the people of New York, to which we shall allude. Baths could be cheaply constructed and maintained in every part of the tenement house districts, and the water, being derived from the river, would be sufficiently impregnated with

* See Report Met. Board of Health, 1869, page 568.

salt at certain stages of the tides to yield the medicinal virtues of sea-bathing.

Whatever other advantages might be derived from the contemplated exhaustless river supply to the city, the importance of this measure to the public health would far surpass all other considerations. The whole paved surface could be daily thoroughly washed with streams of water thrown with immense force; the gutters would be flushed with such volumes of water, as would cleanse them of all filth and obstructions; and the sewers would be converted into living streams of water, which would remove all the now stagnant sewage, and destroy the poisonous sewer gases, which find their way upward into dwellings, and are so fatal to health and even life.

III.—Artificial Means of Regulating Bodily Temperature.

In the discussion of the normal temperature it was noticed that there is a daily fluctuation, the minimum occurring in the morning, and the maximum in the afternoon. It was also remarked that within given limits the animal had an inherent power of regulating its temperature and preserving an eqilibrium compatible with health. When, however, high heat is too long continued, these compensating functions may be unable to maintain the normal condition; the temperature then rises, and the heat may prove fatal. It was also noticed that the animal temperature has the same daily fluctuation in disease as in health, but that in sickness, for the most part, the temperature regulation-power is weak, and the sick are, therefore, much more susceptible to the evil effects of high heat, especially in the latter part of the day.

It becomes a sanitary question of much importance to determine whether any measure may be taken to supply artificial means to the people, by which the normal bodily temperature may be so regulated or preserved as not to reach a dangerous point during those periods of the day when the temperature of both the external air and of the animal system reach their maximum. It is evident that if at this critical portion of the twenty-four hours the temperature regulation-powers of the system could be strengthened, so that the cooling processes of the body would equal the heat produced, plus the external heat, no harm could come to the individual from excessive heat, whatever the disease might be, or the degree of temperature of the air.

The measure best adapted to accomplish this most desirable result is THE BATH. It has been stated, in considering the conditions which affect the temperature of the body, that a warm bath is a powerful agent in reducing the temperature of the animal system, and that its effects are long continued. The warm bath produces this effect largely by promoting the circulation in the skin, and thus increases evaporation from the surface—a refrigerating process. The blood is withdrawn from the internal organs, and remains exposed to the cooling effects of the evaporation for a long period.

Bathing, as a measure for the promotion of public health, was better understood and far more highly appreciated by the ancients than it is by the moderns. The ruins of the ancient cities of the East generally show the most ample provisions for public baths. These baths were frequently made sacred, and were dedicated to the gods. The public baths of Rome illustrate the importance attached to this provision for the health and comfort of the people. At one period that great metropolis had eight hundred and fifty public baths, with arrangements for heating water sufficient to accommodate 285,000 persons. The baths of Diocletian were of such capacity that 18,000 persons could bathe at the same time. The public baths were open from 2 o'clock until dusk, that portion of the day when their cooling effects are most required; and notice was given of the bathing time by the ringing of a bell. The people then rushed to the baths to enjoy themselves while the water was yet warm, and all classes frequently mingled together, not excepting the nobility, or even the Emperor, who was sometimes found among the bathers. The water for these baths was brought by enormous aqueducts from great distances. "Water of every grade of temperature abounded; and even that of the sea and of the sulphurous fountain of Abula, near Tibur, was introduced. Within the vast precincts of the thermæ were found temples, palestræ, for the sports of running, wrestling, boxing, pitching the quoit and throwing the javelin; and extensive libraries, architecture, sculpture, and painting exhausted their refinements on their establishments, which, for their extent, were compared to cities; incrustations, metals, and marble were all employed in adorning them. Those of which the most numerous remains are still visible, are the baths of Titus, Antoninus Caracalla, and Diocletian. In the order of time these were of subsequent erection to the thermæ of Agrippa and Nero. Of the magnificence of the baths of Agrippa, the relation, friend, and counselor of Augustus—an idea may be formed from the circumstance of the Pantheon serving as a vestibule to them. By his will he bequeathed his gardens and the baths, which went by his name, to the Roman people, and he appropriated particular estates to their support, in order that bathing might be attended with no expense to the public."*

What a melancholy contrast to such enlightened public zeal in behalf of the health of its people does New York present! Surrounded with water which can be readily utilized, with a population half of which at least never bathe for want of facilities, this city has but two public baths. These baths are entirely unfit for the purposes here contemplated, and deserve to be mentioned only to the shame of our municipal government.

It has been alleged in palliation of our neglect to supply the masses of the people with adequate means of bathing, that there is no popular appreciation of baths in this country. There is ample proof of the absurdity of that statement. Boston has for several years been supplied with public baths, and they are patronized by all classes, especially the poor, during the summer months, in a most liberal manner. The number of bathers annually increases, and the baths are so conducted as to render them nearly or quite self-supporting, and yet no tax is imposed which prevents the poorest person from enjoying their benefits. The two contemptible apologies for public baths, which

* Bell on Baths.

New York supports, are overcrowded during the summer. This fact proves that if adequate provision were made for the accommodation of the people, there are few persons who would not bathe daily.

But to secure an adequate supply of public baths some department of the City Government, like the Board of Health, or the Department of Public Works, must be empowered to erect and conduct them in such a manner to supply all classes of inhabitants. They should not be confined to the river-front, but should be distributed over the entire city, with suitable isolation of the sexes. If river-water is introduced as proposed for cleansing, there would be an ample supply of water.

GENERAL CONCLUSIONS.

Among the measures adopted to diminish the mortality of New York, due to excessive heat during the summer months, the following are recommended:

I. *The Cultivation of Shade-Trees in the Streets.*—An adequate supply of shade-trees would tend to accomplish this object by protection from the direct rays of the sun; by preventing the paved surfaces from becoming heated; by enveloping the city with an immense evaporating surface which tends, powerfully, to cool the lower stratum of the air; by equalizing humidity; by the absorption of malarial emanations from the earth; by purifying the air in its absorption of gases deleterious to man, and the emission of gases necessary to his existence. In order to provide the city with the requisite number and variety of trees, and to properly and economically cultivate them, the Department of Public Parks should be charged with the care of all trees now in the streets of the city, and also be empowered, under proper regulations, to plant and cultivate trees in all of the public streets.

II. *The Supply of River-Water for Cleansing.*—The thorough flushing of the entire paved surface of the city daily so as to remove to the sewer all animal and organic matters before putrefaction has made any considerable progress, and at the same time the cleansing of the sewers with immense volumes of river-water, would have two most important results: 1. There would be no saturation of the air with the gases of putrefaction, due to high heat, now so destructive to health and life, especially of the young and feeble. 2. The lower stratum of the air would be so cooled by evaporation as to greatly diminish the temperature during the heated portion of the day.

III. *An Adequate Supply of Public Baths.*—The maintenance of public baths in such numbers, and so distributed throughout the city as to enable every inhabitant to bathe during the afternoon and evening, would greatly mitigate the effects of high temperature: 1. By directly reducing the temperature of the body. 2. By maintaining a diminished temperature through the increased evaporation from the surface, which would follow thorough cleansing of the skin.