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Some twenty thousand of the subscribers to the SCIENTIFIC AMERICAN and SCIENTIFIC AMERICAN SUPPLEMENT will find printed on the wrappers which envelope this week's papers the information that their subscriptions are about to expire, coupled with a request that the same may be renewed for the coming year. But one number of either journal, besides the present issue, remains to complete the volume; and as it is our fixed rule not to send papers after the term subscribed for is ended, those desiring the weekly visits of our papers to continue without interruption; will therefore serve themselves by remitting as soon as possible. At the same time they will, in so doing, greatly favor the publishers, as the latter are thus enabled to form proper estimates as to the magnitude of the edition which it will be necessary to print at the commencement of the year. The rates of subscription to either journal or to both combined remain as heretofore.

The success of the SCIENTIFIC AMERICAN SUPPLEMENT has proved so genuine, and its circulation risen so greatly beyond our anticipations, that we shall continue its publication and use our best endeavors to increase its value. As to the programme and plans which we have in hand for rendering both SCIENTIFIC AMERICAN and SUPPLEMENT indispensable to workers in every branch of art, of industry, and of science, the reader will find them fully detailed in the advertising pages of this issue.

Those who have taken the papers through newsdealers are recommended to continue to do so, and those in the habit of procuring their papers weekly from the stands will find them there as of old; and those who neither subscribe for nor buy the SCIENTIFIC AMERICAN nor its SUPPLEMENT may peruse them both on file in any working men's reading room in the country, or in the library of any institution of learning in the world.

A handsome subscription list will be sent as usual on application by those desiring to form clubs.

THE EXTENSION OF SENSE.

In "What the Coming Man may be" we considered, not long ago, some of the possibilities of humanity in respect to the development of man's moral and intellectual faculties; and seeing, with the hero of Locksley Hall, that the thoughts of men are widened with the process of the suns, we looked forward to a time when faculties such as Shakespeare, Newton, Mozart, Michael Angelo, and other men of great genius enjoyed shall be the common inheritance of the race: a time when the average man shall as far surpass the highest men of today in moral and intellectual force as the latter do the lowest savages or the most brutal of our prehistoric ancestors.

In his suggestive address before the American Chemical Society, Dr. Draper touched another aspect of the question, the extension of man's faculties of sense. Referring to the two well known classes of nervous fibers—those which gather the impressions of external things and convey them to the nerve centers, and those which transmit the dictates of the will from within outwards—he observed that, in the improvement of the capabilities of one of the former by telescopes, microscopes, and other sight-aiding contrivances, we have an earnest of what may hereafter be done as respects the four other special organs of sense: while as concerns the second class, the increase of man's power is not less remarkable. The resolves of the will may already be transmitted beyond us with even a greater velocity than in the living system itself, and that across vast terrestrial distances and beneath the sea. "Telegraphic wires are, strictly speaking, continuations of the centrifugal nerves, and we are not without reason for believing that it is the same influence which is active in both cases."

The learned lecturer might have added that the extension of sight by no means exhausts the improvements of special sense already arrived at. In range and delicacy of action, the aural apparatus of the skilled musician surpasses that of the savage even more than his visual organs do: while the extension of sight by means of lenses is all but paralleled in hearing by means of modern acoustic apparatus. Already we may here by telegraph the intonation of a speaker, or the notes of an instrument, many miles away; the entanglements of sound are analyzed by the inventions of Helmholtz as completely as those of light are by means of the prism; while by Kœnig's apparatus the eye is constrained to do the work of the ear, sounds inaudible by the ear are, so to speak, heard by the eye, and the range of human knowledge and capacity for investigating Nature, are thereby vastly extended.

In a scientific point of view, Dr. Draper goes on to say, such improvements in the capabilities of the organs for receiving external impressions, such extensions of the distances to which the results of intellectual acts and the dictates of the will may be conveyed, constitute a true development, an evolution none the less real though it may be of an artificial kind. "If we reflect carefully on these things," he adds, "bearing in mind what is now known of the course of development in the animal series, we shall not fail to remark what a singular interest gathers round these artificial developments—artificial they can scarcely be called, since they themselves have arisen interiorly. They are the results of intellectual acts. Man has been developing himself. He, [so far as the earth is concerned, is becoming omnipresent. The electrical nerves of society are spread to a plexus all over Europe and America: their commissural strands run under the Atlantic and Pacific."

When shall this line of development have an end? In his reach of sense-perception, his mastery of time and space, his ability to foresee and control the course of Nature, making the powers of earth and air to serve him and do his bidding, the man of today surpasses the gods of yesterday. Who shall say what the man of tomorrow may not be?

It is high time to cease canting about the degeneracy of of man in these latter days. Those who spend their lives among the dreams of the ancients, knowing nothing of the powers and achievements of modern man, may be pardoned for proclaiming their own inferiority; but they have no call to speak for the real men of the real world about them, the men who are doing the world's work, at the same time steadily lifting humanity to higher and yet higher planes of capacity and power.

In spite of those who persist in facing backwards, denying that scientific progress is any measure of human evolution, the progressive development of human force and faculty is a reality. Where the ancient athlete could strike a blow of a hundred pounds, the modern mechanic can deal one of as many tuns; the steam hammer, the rifled cannon, the rock-rending dynamite being as truly human as the muscle on his shoulder. In creating them, man has added to his personal power as truly as if he had increased by so much the forces of his right arm. The telescope, the microscope, and the spectroscope are extensions of his eye. The resonator, the manometric cell, and the electric sounder are additional ears. The electric telegraph enables him to be and to act in a thousand places at once. Indeed all that science and art have done to make man master of the conditions and forces of Nature may be considered so many extensions of his organic endowments.

Yet, much as has been accomplished in this direction, much as the civilized man excels the savage in scope and reach of faculty and force, the scientific development of human capabilities has but just begun. As Dr. Draper happily expresses it, we have in what has been done merely an earnest of what the future has in store. In the direction of taste and smell, the Universe is almost entirely unexplored. Properly disciplined and aided by mechanical and other means of increasing their range and acuteness, these senses may prove as efficient in the exploration of Nature, as serviceable for the mental and material advancement of humanity, as either sight or hearing. Already we have an intimation of what discipline may do for the sense of touch in the exquisite tactile sensibility of some blind people, in the extreme sensitiveness of the bat's wing and the antennæ of insects: and even greater promise is held out by taste and smell as exhibited in the chemist's ability to distinguish thereby many sapid or odorous substances, in quantity too small to be otherwise detected. Still more strikingly are the possibilities of these senses manifested in certain nervous states produced by drugs or disease, especially that condition of exalted sensibility known as hyperæsthesia. And it is quite possible that, as the microscope, acting externally, increases the natural acuteness of vision, so the range and acuteness of the senses excited by contact may be correspondingly increased by substances acting interiorly through the nervous system.

It is true that such exaltations of sense-perception are apt to be attended with mental disturbances more or less disqualifying the subject for logical thinking; but we cannot pronounce it impossible for chemistry to discover or produce compounds capable of bringing about the one state unattended by the other: in other words, capable of heightening in any desired degree the acuteness of any sense without deranging at the same time the proper balance of the purely mental faculties. Besides, a telescope or a microscope in the hands of an untrained savage is quite as puzzling in its action, as confusing in its results, as the direct testimony of our senses is under hyperæsthesia. And it seems not less reasonable to suppose that the mind may learn to adjust itself to the new conditions of perception as readily in the one case as in the other. In either event—the discovery of other means of exalting sense, or the education of the mind to act normally under such new conditions—an enormous extension of human faculty must result; and the coming man may find therein the means of surpassing us, as signally as we do the most brutish of barbarians, in our power of penetrating the secrets of Nature and turning them to our advantage.

THE GREAT CYCLONE IN BENGAL.

If the disasters which have overtaken the unfortunate inhabitants of Bengal, India, had occurred in ancient times, we should now possess traditions of punishments inflicted by an offended deity, besides which the legends of the Flood, Sodom and Gomorrah, and the Egyptian plagues would be altogether inconsiderable. The population of the province is now as numerous as that of the United States. Through the failure of the rice crop in 1878, owing to protracted droughts, a famine occurred which killed off the people by the hundred thousand, and the deaths would undoubtedly have reached millions had not the British Government exerted itself to send immense quantities of food among the starving cultivators of the land. Now comes one of the most terrible hurricanes ever experienced in that land of typhoons and fierce storm; and official reports tell us that over 250,000 people have fallen victims to the three great

storm waves which have submerged the country for over 3,000 square miles.

The cyclone, which occurred on October 31 last, arose in the Bay of Bengal, and took a northward course, wrecking several large vessels which lay in its track. It just missed Calcutta, but struck Chittagong, which lies in the most northeasterly corner of the bay, stranding every vessel in the harbor and nearly destroying the town. Meanwhile the storm waves submerged the great islands of Hattiah, Sundeep, and Dakhin, lying in one of the mouths of the Ganges, covered several smaller islands, and then flowed over the land for five or six miles toward the interior.

It appears that the immense waves were projected with astonishing velocity. Up to 11 o'clock on the night of October 31, Calcutta despatches reporting the storm said that no especial danger was anticipated, but before midnight the waters had overrun the land to a depth of 20 feet.

An examination of the map shows that the islands mentioned are situated near an estuary of the river Megna, and they owe their origin to the deposition of soil washed down by the Ganges. They constitute part of the Sunderbunds, as the low, marshy land thus produced is called, from its being covered with the "sunder" tree; and the district is not only the hottest but probably the most unhealthy portion of British India. Malaria reigns everywhere, and the forests and jungles abound with tigers and other ferocious beasts. The English Government for some time past has labored to reclaim the islands, and has offered strong inducements to settlers to cultivate the ground, which is rich and extremely fertile. These efforts have resulted in the clearing of a large portion of the territory, and the raising thereon of valuable crops of cotton, rice, sugar cane, mulberry trees for silkworm food, and timber: while the population of Dakhin, the largest island of about 800 miles in extent, has increased to 240,000, and those of Hattiah and Sundeep together number some 100,000 inhabitants.

Of course the devastation in this district has been complete. The country is dead flat; and the people, when the wave burst upon them, had no place of safety but in the tree tops. And there such as were able found their way, sharing their refuges with the wild beasts, birds, and serpents. Houses by the thousand were utterly swept out of existence, and the only relics of human habitations afterwards found, were cast up on the Chittagong shore, ten miles distant.

The Calcutta *Government Gazette* says that, "wherever the storm wave passed, it is believed that not a third of the population survived. The islands have barely one fourth of their former inhabitants." All the cattle were destroyed, and the stench of the decomposing remains has already generated an outbreak of cholera which it is feared will prove general. The British Government is taking steps to relieve the distress which prevails.

AN INDIAN DUST STORM.

In his clever account of Bannu, a district in the Punjaub, Thorburn describes a dust storm on the great plain of Marwat, a phenomenon of such imposing force and grandeur as to be well deserving of the important position lately accorded it, by American scholars, among the great geological agents.

Marwat, the bed of an ancient lake, is now a vast treeless plain of undulating, sandy down, bordered by a region of soft loamy clay, deeply furrowed by watercourses, and overlaid by a layer of gravel and smooth, rounded stones, called "hell stones" by the people, because of their black and scorched appearance, the effect, probably, of natural sand blast attrition. Seen in autumn or in a year of drought, it appears a bleak, howling wilderness, fit home for the whistling, heat-laden dust storms that often sweep across its surface in the hot months; but in late spring, after a few timely showers, it presents an interminable sea of wheat, the vivid green of which gives place here and there to streaks and patches of darker shaded grain.

The approach of a dust storm over this place in the dry season, and witnessed from one of its boundary hills, is a grand and impressive sight. At first but a speck on the distant horizon, it rapidly elongates until it stretches from east to west, a mighty, threatening wall a thousand feet high and thirty miles in length. Nearer and nearer it comes, phantom-like, its rushing noise being inaudible to the spectator. Now one wing is pushed forward, now another, nearer still: and now the birds—kites, vultures, and a stray eagle or two—circling its front are visible, and one by one the villages at the foot of the hill are enveloped and hidden from the eye: a few minutes more and the summit of Shekhbudin, till then bathed in sunshine and sleeping in the sultry stillness of the June morning is shrouded in yellow, scudding clouds. Vanished is the grandeur of the scene in a moment, and nought remains but the stifling, begriming dust, flying and eddying about in all directions, penetrating everywhere. Outside nothing can be seen but a darkness which can be felt, and nothing is audible but the whistling of the wind and the flapping of bungalow chicks: but inside the lamps are lighted, and a quarter of an hour is idly passed, until the storm, which generally expends its fury on the hillsides, subsides or passes on.

LOW FLYING BALLOONS.

In his very excellent report, recently made, on the progress of aeronautics, to the British Aeronautical Society, of which he is secretary, Mr. Francis W. Brearey says:

"It is singular that no one has taken advantage of an ascertained fact to put the balloon to more pleasurable, because more prolonged, use than has hitherto been attempted." After instancing how a boat may be caused to travel with the current of a stream by simply using a pole to push it clear of the banks, he adds: "There is every probability that, with a balloon so balanced, a push with a long pole would send it up spinning for fifty feet or more, and one might traverse a few hundred yards before it neared the earth and required another push."

Shortly before undertaking the ascension in which he lost his life, Mr. Donaldson, the well known aeronaut, described to us his experience in just such balloon sailing. He stated it as his belief that, if ever the time came when people would step into balloons as readily as they now do into railroad cars, the air ships would not sail above the clouds, but would skim close along the surface of the ground. He gave many reasons for this view—notably increased safety and economy, since balloons could be made much smaller, as they would not require a large amount of gas to keep them afloat, and there would be little difficulty in stopping to replenish the supply when exhausted. He had found no trouble in balancing a balloon at four feet above the ground, and at keeping it accurately at that hight for hours. He told us, further, that he frequently traveled along country roads in this way during calm weather, using a pole to push himself along when there was no wind, or to guide himself when being wafted by a breeze. As an instance of how exactly a balloon can be balanced, he stated that, while thus sailing over a road, he carelessly dropped overboard about a quarter of a loaf of bread, whereupon the air ship sprang aloft a hundred feet or more. We asked him how he avoided wagons and similar obstacles in his path without discharging ballast, and so losing equilibrium? "Jump over them" was his answer. "A good strong push downwards on my guiding pole has sent me flying over many a tree in which I thought I was sure to be entangled." This flea-like mode of progression was a favorite mode he had of astonishing rustics.

Mr. Brearey's paper is published in full in SCIENTIFIC AMERICAN SUPPLEMENT, No. 50; and among other remarkable facts, it notes that a one horse power engine can be made to weigh only thirteen pounds. There are also descriptions of Moy's steam flying locomotives and others of the most nearly successful efforts toward solving the problem of aerial navigation.

THE RADIOMETER NOT A LIGHT MOTOR.

The immense quantity of evidence in the shape of experiments on the radiometer, which has been accumulated by the principal physicists of Europe, leaves no reasonable doubt but that the claim that the apparatus is driven by light is unfounded. It is maintained by our correspondent, M. Delsaulx, that the radiometer is an electrical engine; a majority of observers pronounce it simply a machine driven by heat. So long as it is decided that the radiometer is actuated by forces which are intrinsically perfectly well understood, leaving the problem merely one of determining how the same are applied, the whole subject sinks at once to secondary importance. It was only because the apparatus appeared to demonstrate the ponderability of light, and hence was an apparent serious contradiction to the undulatory theory, that it has excited the close attention of the scientific world.

Dr. Frankland's recent experiments on the radiometer are among the most conclusive that have been made, as showing the true source of its motion. The disks of his instrument were of aluminum, polished on one side and blackened on the other. They were extraordinarily sensitive, and continued rotating often for twenty minutes after the sun had descended below the horizon. Placing this radiometer in a room where the conditions were such that it remained motionless, Dr. Frankland enclosed its globe in his hands so as to cut off light from the disks. Yet they at once began to rotate, polished side in advance. On withdrawing his hands, the motor, after the lapse of two or three minutes, stopped: then after another brief interval, it resumed in the opposite direction for a short time. There was rotation set up without the aid of light, and clearly due to the temperature of the investigator's hands.

The next experiment was exactly the converse, and involved testing the apparatus under light destitute of heat. It is well known that the moon, although reflecting the sun's rays, sends but a very small amount of heat to the earth. With a lens 3 feet in diameter, concentrating the lunar rays on a thermoscopic pile, Melloni proved that the deviation of the needle was from 0° 6′ to 4° 8′, according to the phase of the moon. This indicates so extremely small a heating power that it is practically inconsiderable, and is destitute of any known effects upon the earth. Dr. Frankland therefore exposed his radiometer to bright moonlight, but it did not stir. Then, with a powerful lens, he rendered the intensity of the rays 200 times greater, and directed the brilliant image of the moon, produced at the focus, directly upon one of the disks of the radiometer. Not the slightest movement was appreciable, although the light was kept unaltered for over a quarter of an hour.

Dr. Frankland's conclusions sum up the true facts regarding the radiometer in brief terms. He says: that light is not necessary to the motion of the instrument: that light does not contribute to its motion unless (by absorption) it be transformed into heat, which did not take place (or occurred in an unappreciable degree) for moonlight: that the movement of the disks is due to the unequal heating of the two faces of each disk, the cooler face always preceding the hotter one. When the globe is taken in the hands, the blackened face of each disk absorbs heat rapidly, while the bright side reflects it. Thus the surfaces of the black disks remain hotter than the metal situated below, but soon communicate their heat to said metal. If the hands be withdrawn, the thermal conditions are reversed: the black face, being a better absorbant and at the same time a better radiator, cools much more quickly, and hence the opposite motion of the mill already described.

THE LIMITS TO PHYSICAL CULTURE.

We have frequently had occasion to dwell upon the fact that, while moderate physical culture is a great benefit, indeed a necessity, to ensure a proper balance of mental and bodily powers, and consequent health and longevity, physical overculture is a great evil, leading to results diametrically opposite to those sought to be attained. At one end of the series is a constitution weak and unfitted to resist disease or the effects of labor, on the other an organization strained to its utmost and ready to yield under the slightest addition to the stress. Obviously between these extremes there must be a mean up to which all culture is beneficial, and beyond which all is overculture. The question is, however, whether that mean is in the nature of a personal equation for every one, differing for each individual constitution, or whether it is possible to formulate general laws, true for all systems. The tendency of modern investigation, in all cases relating to the science of life and of living, is favorable to the latter view. Mr. Charles Darwin sends out his formulated questions the world over, and deduces results from the replies proportionally considered. Candolles does the same in his elaborate investigations into the antecedents of scientific men; the statistics relative to the recruits for our army we have shown, in recent articles, to admit of valuable deductions relative to our national characteristics; and we might add numerous examples, all showing that that which is proved true, on the average, for a large number of persons, may with reason be assumed to be true of an entire class, or even a race, when surrounded by generally similar conditions of life.

Now in the case of physical culture, the point specially to be determined by actual physiological investigation is to what extent the body may be benefited. This known, any one may easily discover for himself when the limit is reached, and will understand that to carry his training still further is a positive disadvantage and injury. Such an investigation has lately been made by Dr. Burcq of Paris, in the *Ecole de la Faisanderie*, a gymnasium where are drilled the soldiers who are destined to be the gymnastic instructors of the French army. No better set of men could be selected for examination, for the reason that each individual is virtually intended hereafter to serve as a model for others, and therefore his physical culture is brought to the best possible state. Dr. Burcq continued his investigations with the utmost care and minuteness, for six months, during which period the progress of over a thousand men was closely watched and criticized. As a general result, he tells us now that gymnastic exercises:

1. Increase the muscular forces up to 25 and even up to 38 per cent, at the same time tending to equilibrate them in the two halves of the body.

2. Increase the pulmonary capacity at least one sixth.

3. Increase the weight of men up to 15 per cent, while on the other hand diminishing the volume. This augmentation exclusively benefits the muscular system, as is demonstrated by its elevated dynamometric value.

And Dr. Burcq further observes that, during the first half of the six months' course at the school, the increase of force was most markedly noted.

To Dr. Burcq's admirable studies upon this body of trained gymnasts may be added those of M. Eugene Paz, who for a long period has been observing the results which methodical physical exercise produces in certain invalids and in a large number of people of various callings, notably artists, literary and business men, and others whose muscles are normally less voluminous than those of the picked soldiers at the *Faisanderie* School.

By means of a variety of ingenious mechanical apparatus, and by a course of investigation wholly different from that of Dr. Burcq, M. Paz reaches precisely the same results. He notes especially the increase in weight and decrease of volume of the body, above referred to, and also the augmentation of pulmonary capacity. Three operatic singers who were rigorously trained for a year attained a maximum lung power corresponding exactly to an increase of one sixth. It follows, therefore, that Dr. Burcq's results may be considered in the light of a general law, and likewise as a guide to what is correct physical culture. In this view, we commend them to the attention of college authorities and students.

English Views of our Silk Industry.

At a meeting of silk weavers at Macclesfield, England, the headquarters of British silk manufacture, considerable dissatisfaction was expressed that no steps had been taken to exhibit English silks at the Centennial, the speaker stating that, were the United States once made aware of the excellence of the goods, the 60 per cent duty on them, imposed by our laws, would probably soon be removed. The Centennial correspondent of the *Macclesfield Courier*, himself an expert in silk, denounces their expressions as "false and foolish." After mentioning that the reduction in cost of labor is fast removing the chief obstacle with which American manufacturers have to contend, he says to his countrymen: "We shall find that the ample labor saving appliances and greater intelligence of the work people will bring us face to face with a competition such as we have never yet dreamed of, and I venture to say that before long England, mother of free trade as she is, will find herself compelled to impose a duty on the importation of American silks, in order to protect her manufacturers from being beaten in their own markets."