American association for the advancement of science: these were, Messrs. Newton, Lesley, Newcomb, Asa Gray, Cope, Hilgard, Putnam, James Hall, J. W. Langley, Morse, Eaton, N. H. Winchell, Wormley, Thurston, Eddy, Springer, and John Trowbridge.

It was prepared by Mr. W. Curtis Taylor of Philadelphia,[1] who had never seen a composite before preparing it; and it is therefore less successful than might otherwise be expected. As in the previous composites published by us, it makes a younger and handsomer man than the average of those whose faces enter into it. The average age of these seventeen gentlemen can hardly be less than fifty.

THE YACHT PURITAN.

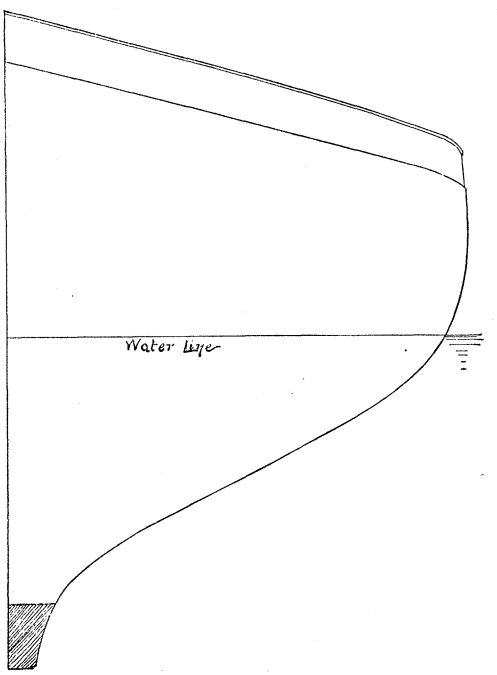
THE yacht Puritan, which has just raced so successfully with the New-York sloop Priscilla, was designed by Mr. Edward Burgess of Boston with a view to combine the speed of the ordinary type of American sloop with the weatherliness of the English cutter. The race for the Goelet cup at Newport, Aug. 3, seems to show that we have, at last, a successful compromise. Puritan measures 93 feet on deck from the fore side of stern to the aft side of her long and slender taffrail. Extreme beam, 22 feet 7 inches. Draught, 8 feet 4 inches. Displacement, 105 gross tons. The lead keel weighs 25 tons; and 20 tons of lead are stowed inside, four or five tons of which are run into the garboards. The centre-board is 21 feet long and 10 feet deep. The spar measurements are: mainmast, 78 feet; topmast, 44 feet; boom, 76 feet; gaff, 47 feet; bowsprit, 38 feet (outboard). Lower-sail area, 5,500 square feet.

Many yachting critics predicted that Puritan would not carry her sail; that her lead keel, combined with so much beam, would make her very uneasy in a seaway; and that, like other compromises, she would be slow. Her record so far has, however, been entirely satisfactory. In the Newport race, while the fastest cutter yet built in America — Bedouin — plunged into every sea, finally losing her bowsprit, Puritan never put her bowsprit under, and beat the cutter *one hour* in the twenty-mile thrash to windward.

Puritan's rival, Priscilla, is undoubtedly a very fast craft; and with her rig reduced, she may yet prove a troublesome antagonist, with her five feet extra length.

The success of both boats, which a new book on the America's cup calls 'experiments,' points to a brave defence of the cup, and holds out good hope that it may still remain on this side of the Atlantic.

The midship section of Puritan, given herewith, is published for the first time. Her longitudinal section shows a rather deep forefoot with a rocker keel and raking stern-post. Both fore and after bodies are unusually fine.



The load water-line shows about five inches hollow.

The picture, showing Puritan under lower-sails and club-gaff topsail, is reproduced from a photograph taken by N. L. Stebbins in the Eastern yacht race, June 30, when she beat the next boat in her class nearly half an hour over a short course.

[1] We are indebted to the courtesy of this gentleman for the opportunity of reproducing it.

THE PRESIDENT'S ADDRESS.[1]

MY FRIENDS: I have the honor to address you this evening as an association of representatives of American science in all its branches, — as students of the sky and all its elemental forces, of the earth and all its mineral constituents, of the animal and vegetable kingdoms in their past and present ages, of the history and constitution of the human race, — and I may be easily pardoned for some trepidation in view of the draughts you may have drawn in advance on my

[1] Address to the American association for the advancement of science at Ann Arbor, Aug. 26, 1885, by Prof. J. P. LESLEY of Philadelphia, the retiring president of the association.

slender exchequer. I have lain awake o' nights, like my predecessors, reflecting how I should meet my liabilities. And like them, no doubt, I find myself poorer than when, a year ago, I contracted them. You would scorn to receive in payment my promissory notes or mortgages on my castles in Spain. You will accept nothing but gold and silver, in bullion or in coin; and that is what troubles me.

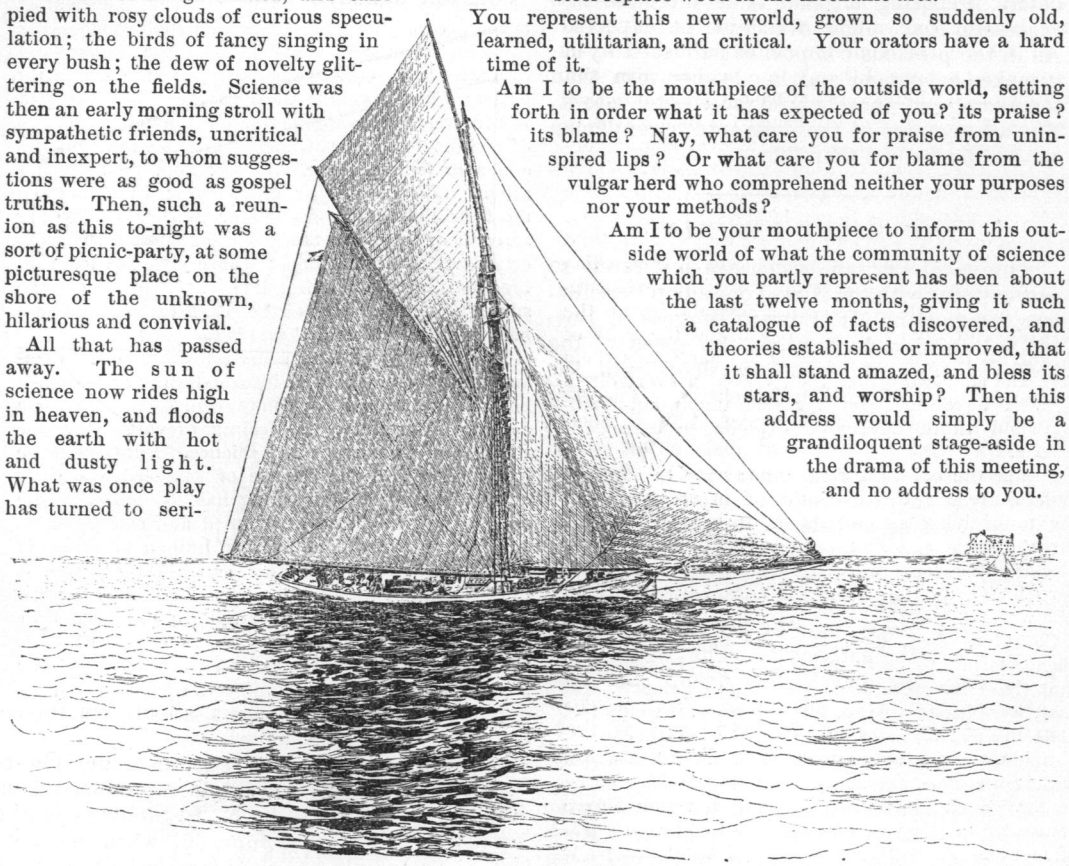
There were once halcyon days for orators: the world of knowledge limited, and canopied with rosy clouds of curious speculation; the birds of fancy singing in every bush; the dew of novelty glittering on the fields. Science was then an early morning stroll with sympathetic friends, uncritical and inexpert, to whom suggestions were as good as gospel truths. Then, such a reunion as this to-night was a sort of picnic-party, at some picturesque place on the shore of the unknown, hilarious and convivial.

All that has passed away. The sun of science now rides high in heaven, and floods the earth with hot and dusty light. What was once play has turned to serious toil. Shadows are short. Objects present themselves in well-defined and separated shapes for critical examination. The few and early risers have become a multitude. The tumult of occupations distracts the studious observer. No one lends ear to chit-chat. All are hurried. Critics abound. "Say what you want, and go; or tell us something absolutely true and useful," is the introduction to every conversation. Morning, noon, and night, men demand, not the agreeable, but the necessary. The age of romance in science is part of the forgotten past. The new world has grown gray-haired in fifty years, intolerant of the irresponsibility, the sportiveness, the poetry, the music, the superstitions, the affections, of its youth; dealing only in hard facts, and in their causes and consequences; weighing and measuring all things; analyzing all things; collating, comparing, and classifying; insisting upon investigation at all points; formulating rigid laws; scoffing at the unseen and unknowable; and transmuting the fear of God and the hopes of heaven into a zeal for the exact determination of the units of force, and a confident expectation that railroads will soon traverse all the unoccupied regions of the earth, and malleable steel replace wood in the mechanic arts.

You represent this new world, grown so suddenly old, learned, utilitarian, and critical. Your orators have a hard time of it.

Am I to be the mouthpiece of the outside world, setting forth in order what it has expected of you? its praise? its blame? Nay, what care you for praise from uninspired lips? Or what care you for blame from the vulgar herd who comprehend neither your purposes nor your methods?

Am I to be your mouthpiece to inform this outside world of what the community of science which you partly represent has been about the last twelve months, giving it such a catalogue of facts discovered, and theories established or improved, that it shall stand amazed, and bless its stars, and worship? Then this address would simply be a grandiloquent stage-aside in the drama of this meeting, and no address to you.



THE YACHT PURITAN, AFTER A PHOTOGRAPH BY STEBBINS.

Must I, then, speak to you as a fellow-worker in science, contributing some fresh gift to our common stock of truths? But that would be better done, if done at all, by reading a paper on the subject in the section to which I properly belong.

I did, indeed, hesitate a while before I rejected a temptation to discuss before you this evening one or two subjects on which I have reflected for many years, — for instance, the important *rôle* which the chemical solution of the limestone formations has played in the grand drama of the topography of the globe; the absolute inconstancy of the ocean-level; the function of variable deposition in closed basins in elevating the plane at which coal-vegetation repeated itself; the influence which anticlinals and

synclinals *en échelon* have exercised in originally directing, and afterwards perpetually shifting, the systems of river-drainage, as the general surface became lower and lower through erosion; the extraordinary differences in the amount and rate of erosion in different parts of the same region, due to the various heights and shapes of the plications, — but a deep sense of insufficiency for properly handling such great subjects deterred me from the attempt. They demand the largest treatment, the fullest illustration, and the long coöperation of many minds. All the great transcendental questions of science remain open to research; not one of them has as yet been answered satisfactorily; all answers have been premature, and most of what has been published for such seems to me puerile; yet the disposition to deal in transcendental science seems to grow daily stronger. There are no laws, however, against initiation into Alpine clubs. If men choose to run fatal risks for notoriety, let them do so, in the name of all that is chilly and unprofitable; but let them not pretend, that, when they reach the summit of some Jungfrau or Matterhorn, their demon of adventure shows them all the kingdoms of the world of science, and the glory of it; for, in fact, the inaccessible sky surrounds them still, and clouds obstruct their vision in every direction. I have no fancy for such mountain-climbing, and think lightly of exploits so barren of results.

I seize the occasion, rather, to awake to your remembrance some thoughts of common interest, which the multiplying avalanches of facts and theories threaten to bury out of sight, as the pure ice of the glacier gets covered over with a sordid sheet of *débris*, perpetually tumbling from the cliffs between which it flows.

Consider, then, first, that the final cause of a glacier is not to carry moraines, lateral or medial; that these are mere accidents of its existence; and that, were it endowed with intelligence, it would feel little interest and less pride in the heterogeneous, variable, and for the most part useless, burden, which it cannot escape, and throws away at the close of its career. Such are the loads of science which we are compelled to carry forward through life, in the forms of fact and theory; misshapen, accidental droppings upon us from our local surroundings; fragmentary specimens of knowledge, of which we construct our confused and shapeless heaps of learning, most of which is of little use, either to ourselves or to the world. The life of the glacier is an elaboration of the universal moisture into snow, nevé, and pure ice, by a slow process of internal constitution; and such is the happy destiny of the true man of science, worked out in wisdom of character, apart from all accidental accumulations of learning, and mainly irrespective of them.

Let us avoid the sacrifice of character to science. As the saying of Jesus of Nazareth, that the sabbath was made for man, not man for the sabbath, has rung through the centuries, a tocsin of alarm to rouse mankind to resist ecclesiasticism, so let the warning cry fill the air of our association, from meeting to meeting, that science is our means, and not our end. Self-culture is the only real and noble aim of life. And as the magnificence, beauty, and utility of a glacier, as a perpetual reservoir of solid moisture, is not gauged by the size, arrangement, or constitutional features of its moraines, neither is the greatness and usefulness of the philosopher measured by his amount of the knowledge of the physical fact-and-theory science of the times.

Of all kinds of intellectual greatness, the greatest is achieved by the philosopher who stands before the thinking world as a model of scientific virtue; deaf to flattery; insensible to paltry, hostile criticism; patient of opposition; dead to the temptations of self-interest; calmly superior to the misjudgments of the short-sighted; whom nothing diverts from the endeavor to live nobly, and to whom noble means are as indispensable as noble ends; in whom the most brilliant successes foster neither vanity nor arrogance; to whom fame is unimportant, and poverty a trivial circumstance; whose joys, like fragrant breezes from an encircling landscape, come from the surrounding friendship of the general world, to whose best interests the noble heart is forever loyal.

Another subject for serious reflection is the over-accumulation of scientific information. To broach it before such an assembly may seem to require some apology. Certainly, the feeling prevails, that the world cannot have too much science. But the science of learning and the science of knowledge are not quite identical; and learning has too often, in the case of individuals, overwhelmed and smothered to death knowledge. The average human mind, when overstocked with information, acts like a general put in command of an army too large for him to handle. Many a vaulting scientific ambition has been thus disgraced. Nor is this the only danger that we run; for the accumulation of facts in the treasury of the human brain has a natural tendency to breed an intellectual avarice, a passion for the piling-up of masses of facts, old and new, regardless of their uses. In the great game of our spiritual existence, facts are mere counters with which to play the game. A million of them are worth nothing, unless the player knows how to play well the game; and when the game is over, the worthless counters are swept back into the drawer. And the danger pursues us to higher and higher planes of science. Not only the avarice of facts, but of their explanations also, may end in a wealthy poverty of intellect, for which there is no cure. Even the sacred fires of research may be allowed to burn too long, until, in fact, they turn the investigator into a mere miser of ideas. As for those who are not themselves original investigators, but busy themselves incessantly in appropriating the secretions of research at second hand, how often it happens that the richest additions of reliable theories to the stock of their ideas, even to a point where they suppose themselves, and are supposed by others, to know all the conclusions arrived at by past and present inquirers, leave them as thinkers just what they were at first, — incompetents; mere ill-hung picture-galleries; disarranged museums; complicated inventions

which will not work; costly expeditions for discovery, frozen fast and abandoned in the polar ice.

A certain temperance in science is obligatory from another point of view. As mere wealth of possessions cannot guarantee happiness, neither can a superfluity of learning insure wisdom. When the body from overfeeding grows plethoric its vital energies subside and its life is endangered. The intellect may be mischievously crammed with science. How much we know is not the best question, but how we got what we know, and what we can do with it; and, above all, what it has made of us. The tendency of training now is to subordinate the soul to that which should be merely its endowment and adornment; to turn the thinker into a mere walking encyclopedia, text-book, or circle of the mechanic arts; not to produce the highest type of man. What ridiculous and pitiable creations are these! — an authority in physics who cannot speak the truth? a leader in natural history who is given over to the torments of envy? a god in chemical research sick of some false quotation? a youthful prodigy of mathematical science tottering with unelastic steps and outstretched arms to grasp his future fame? Yet no one will deny that the intemperate pursuit of any branch of science has a tendency to produce such characters, by elevating to undue importance the individual accumulation of scientific facts and scientific theories, to the neglect and depreciation of that spirit of truth which alone can inspire and justify an earnest study of the material universe. I beg you to reflect that it is as true of science as of religion, that the mere letter of its code threatens its devotee with intellectual death, and that only by breathing its purest spirit can the man of science keep his better character alive, — that indefinable spirit which, in its intimate and essential nature, has little to do with the number of facts discovered, or theories accepted; a spirit which merely exercises itself in research, and accepts discoveries as delightful accidents; a spirit which walks the paths of science, not as if they were turnpikes converging upon some smoky and squalid focus of toil-wearied population, but as if they had been gravelled and flower-bordered for it through some princely park; a spirit of natural and cultivated nobleness, sweetened by boundless friendship for the world and all that lives therein; just and true to all men worthy or unworthy, proud without vanity, industrious without haste, stating its own griefs as lightly as an angel might, and generously bringing help to the discouraged and forlorn. In every one of us there is this genius, if we did but know it; and, as Emerson well says, the moral is the measure of its health.

I have been saying, then, that we should pursue science, like any other business of this life, with a distinct and unwavering intention to ennoble our own characters. It were a trite addition to propose that the pursuit be made ancillary to the public good. 'The love of science' is a phrase which has been greatly glorified in popular discourse; and if the phrase be confined to its true meaning, — a zealous admiration for all that is beautifully true and useful in nature, — it cannot harm us in the practice of our profession. But when the imagination has exhausted itself in transcendental ecstasies over an ethereal sentiment so named, but undescribed except in poetry, what wiser or better thing can we say of any branch of physical or natural science, cultivated by our association, than that its votaries are knowingly or unknowingly bettering the condition and character of mankind? Every advancement in science is, of its own nature, an improvement of the commonwealth. Every successful study of the laws of the world we inhabit inevitably brings about a more intelligent and victorious conflict with the material evils of life, encouraging thoughtfulness, discouraging superstition, exposing the folly of vice, and putting the multitudes of human society on a fairer and friendlier footing with one another. The arts of philanthropy are, therefore, as direct an outcome of science as the lighting of the public streets, or the warming of our homes. Cruelty and shame are products of the night. The daylight is a friend to friendliness. The progress of civilization and the progress of science are alike typified by the progressively brilliant and general illumination of cities. So, in old times, human sacrifices and piracy ceased wherever the worship of the Tyrian Melcarth yielded place to the philosophy, belles-lettres, and fine arts of the genial and beautiful Delphic Apollo, the civilizer, the far shiner, the sun of Grecian righteousness, whose initiated became the educators of the modern world.

And yet these two magic words, 'initiation,' 'education,' have meanings directly the reverse of one another, — the one a *going in* to learn the secrets of esoteric doctrine, unsafe for publication because immature; the other a *being led out* from ignorance to knowledge, from helplessness to the active performances of life. The idea of universal education is wholly modern; in fact, a product of the century in which we live. It is democracy in the world of intellect. It is the doctrine of equal human rights applied to the possessions of the human brain. It is the apotheosis of common sense. It demands the distribution of knowledge in adequate quantity and quality to all who live and all who are to live upon the earth. How this is to be accomplished, is the greatest of the questions of the day; and it especially concerns us as members of an association for the advancement of science.

I do not intend to discuss the subject, to define the quantity and quality of knowledge adequate for the various classes of human society, or to propose any plans for its distribution. All I wish to say about it is, that it seems to me nature limits both the responsibilities of teachers and the rights of learners more narrowly than is commonly supposed. The parable of the sower is a good reference for explanation. Most of the surface of the globe is good for little else than cattle-ranches or sheep-farms; and the large majority of mankind must, in all ages, be satisfied with the mere rudiments of learning: what they want is unscholastic wisdom with which to fight the fight of life, and they must win it for themselves. Only a limited number of persons in any community can acquire wealth of knowledge; and the only thought

on which I wish to insist is this: these few must also get it for themselves, and, moreover, must work hard for it.

It is a hackneyed aphorism, that there is no royal road to knowledge, although an incredible amount of pains has been taken to make one. Nature, in this affair as usual, has been a good, wise mother to us all; for it is not desirable to make the acquisition of knowledge easy; for the main point in scientific education is to secure the highest activity of the human mind in the pursuit of truth; an activity tried and disciplined by hardship, and nourished on hardy fare. The quantity of food is of less importance; every thing depends on establishing a good constitutional digestion. The harder the dinner is to chew, the stronger grows the eater. Canned science, as a steady diet, is as unwholesome for the growing mind as canned fruits and vegetables for the growing body. The wise teacher imitates the method of nature, who has but one answer for all questions: "Find it out for yourself, and you will then know it better than if I were to tell you beforehand."

But who can be a wise teacher who has not been wisely taught? The spirit of this scientific age favors a universal manufacture of condensed milk to ease and cheapen the toil of bringing up its infants. It finds the bottle of literature more convenient than the breast of nature. It prefers a large family of puny children to a few young heroes. The stalwart ancients exposed their unfit offspring to the wolves; we moderns exhaust the resources of art to preserve their worthless and painful lives.

This is the spirit which invents a thousand futile plans for compacting the universe to a size so small, and a shape so simple, that it can be grasped without much effort by the tiniest and feeblest hands. Will it be an unpardonable crime for me to say that I recognize the same spirit in the present popular rage for an over-classification, unification, and simplification of science; for ultra-symmetrical formulae, and excessive uniformity in nomenclature; with an avowed reference to ease of learning and convenience of teaching, the saving of time in the acquisition of facts, and the diminution of brain-waste in collating them for use; in one word, to the making of science easy, in despite of the inexorable decree of nature, that it always shall be and always ought to be difficult? For the genius of the creation is visibly hostile to that uniformity, symmetry, and orderly simplicity which the text-book endeavors to establish. No logical consistency for her! No stiffening of the fact-producing energies into fact formularies will she endure. Hardly has a manual issued from the press but it is mutilated by her puckish fingers. No sooner has some school of theorists erected a stately structure in simple grandeur, than it is shattered by the lightning of a new revelation. There is no rest, no peace, in our believing. Our libraries contain little else than such spoiled palimpsests; the broad fields of science are covered with such ruins; and those who have grown old in travelling far and wide across them would find little cause for singing paeans to the exploits of science were it not for the fact that the function of science is not to organize nature, but by the laborious study of nature to organize the human mind, and inform it with the very genius of nature, original, unsymmetrical, indefinable, unclassifiable, changing its attitudes and operations every instant, and escaping easily from all the toils of scholastic unification which we spread for it. The work of the student cannot be simplified, cannot be made easy, if it is not to fail in its great purpose, the production of a genuine man of science. The foolish nurse thinks it her duty to carry the child always in her arms; but the test of a good education is the ability of the child to carry its nurse; and this it can only attain to through the discipline of toil; toil which at first conceals itself under the gracious guise of sports, gymnastics, and adventures, and afterwards takes the shape of experimental failures and useless constructions, but all as free, untutored, and original as the laughing, wasteful, and ungovernable pranks of nature. But I have followed long enough, perhaps you will think too long, this train of thought: let me suggest another.

It is a familiar fact, that great discoveries come at long intervals, brought by specially commissioned and highly endowed messengers; while a perpetual procession of humbler servants of nature arrive with gifts of lesser moment, but equally genuine, curious, and interesting novelties. The excitement of the pageant incapacitates us for reasoning rightly on its meaning. From what unknown land does all this wealth of information come? Who are these bearers of it? and who intrusted each with his particular burden, which he carries aloft as if it deserved exclusive admiration? Why do those who bring the best things walk so seriously and modestly along, as if they were in the performance of a sacred duty for which they scarcely esteem themselves worthy; while those who have little to show, or things of inferior or doubtful value, strut and grimace magnificently, as if they felt themselves the especial favorites of nature, push to the front, speak loudly to the multitude, and evidently deem themselves entitled to uncommon honors?

In this procession of science, in this interminable show of discovery, two facts arrest attention: first, the eager gaze of expectation which the crowd of lookers-on direct towards the quarter from which the procession comes, and their unaccountable indifference to what has already passed; and secondly, the wonderful disappearance, the more or less sudden vanishing out of the very hands of the carriers, of a large majority of the facts and theories of which they make so pompous an exposure; few of them, however, seeming to be aware that thereby they have lost their right to participate in the pageant, and should retire from it into the throng of spectators, at least until good fortune should take pity on them, and drop some new trifle at their feet to soothe their wounded vanity.

You will not suspect me of depreciating the value of any real discovery, be it merely the finding of a Californian bird on the shore of Massachusetts Bay, or detecting, with the naked eye, the blazing of a

variable star before any telescope had noticed it, or finding some Hadrosaurus bones in a New Jersey marl pit, or a Paradoxides at the Quincy quarries? Such accidents have all the importance of trumpet-notes sounding to boots and saddle. But, after all, the trumpeter is only a trumpeter, although he may imagine himself the colonel of the regiment, or a general in the army. And, indeed, it has happened that to such accidents science has owed some of her best physicists and naturalists. But it was not these, their first and therefore most enjoyable discoveries, that made them what they afterwards became; nor had they at the outset even the right to an opinion on the value of their finds. Years of strenuous and unrenowned exertion had to follow, in which they published little or nothing new, but gathered up the old, and rediscovered, by experiment and observation, what the records of the past preserved.

What I deprecate is the claim to special attention made by inexperienced stumblers on forgotten or unnoticed facts, remarkable or otherwise, on the sole ground of the discovery. I deprecate the folly of the youth who, because he has found a spear, leaps into the empty chariot of Achilles, and, calling on the Grecian host to follow him, lashes the horses for an immediate attack on Troy; nor finds it out until he is half way across the plain, that he rides alone, and to destruction. I feel no admiration, no respect, for the audacity with which our young recruits of science rush unpanoplied into the thick of a discussion involving the greatest thinking of the age. They act like animals at a conflagration. I hear on all sides a noisy tumult of untrained intellects. Shall such themes as the nebular hypothesis, the probable solidity or fluidity of our planet, the metamorphosis of rocks, the origin of serpentine or petroleum, the cause of foliation, the stable or unstable geographical relationships of continent to ocean, the probable rate of geological time, the conditions of climate in the ages of maximum ice, the probable centres of life-dispersion, the unity or multiplicity of the human race, the evolution of species, be babbled over by men, the amount of whose efficient work in any branch of science is measurable with a foot-rule; while those whose entire lives have been but one exhausting struggle with the shapes which people the darkness of science speak with bated breath and downcast eyes of these great mysteries?

There is a shibboleth by which tyros in science can always be detected, — their habitual employment of the words 'doubtless,' 'certainly,' and 'demonstrated.' To their inexperience of the universality of error, every new statement in print over a name noted in science, reads like a revelation of the absolute; and every conclusion at which they themselves arrive, after a more or less superficial study of the limited number of facts which accident has given them the opportunity to observe, seems a conclusion too real to be impugned. I love the remembrance of my youth, but I regret its dogmatic impertinences. Young votaries of science draw their inspiration from the maxim which best suits them, — 'try the value of old truths by new discoveries.' The veterans of science reverse the rule, and test all new discoveries by a world of half-forgotten facts and well-established principles. The advancement of science is accomplished by the push and pull of these two ruling motives. No science were possible if the aged could suppress the youthful, or the youthful could extirpate the aged. But as surely as the agnosticism of age is a witness to the weariness of fruitless speculation, so surely the confidence of youth that every movement must of necessity be forward is a proof of insufficiency.

Let the military art instruct us. The raw recruit is satisfied if old Blücher waves his sword shouting Vorwärts! But the sobered veteran is prepared to see in flank movements, in retreats, in halts and intrenchments, steps of the campaign as necessary as any charge at double-quick on hostile lines, or a steady march in column into the enemy's country. Let us suppose that in the last twelvemonth not one surprising discovery in any region of the globe has been made; that a hundred previously reported facts have been examined and pronounced untrue; a hundred printed memoirs, widely read and criticised, been proved mistaken or absurd; a hundred long-accepted generic or specific names, fossil or recent, have been expunged from the lists; and that others, like Halysites catenulata, or Spirifer disjuncta, have lost their characteristic values; suppose any amount of doubt to have been thrown upon any number of popularly accepted theories, by failures in applying them to practise, like the theory of the anticlinal location of gas-wells; in a word, suppose any amount of smashing in any department of the great crockery-shop of transcendental or applied science, — what does it imply but the tendency of all inquiry, observation, investigation, and experiment towards the betterment, which is the only true advancement, of science? As in the animal kingdom, the peaceful kinds are offset and held in check by analogous carnivores, for fear of over-population; so in the world of thought, the constructive theorists are perpetually preyed upon by a corresponding class of natural enemies, the destructive critics, which keeps the field open and the air sweet. The destruction of effete knowledge is the perennial birth of that science which cannot be destroyed. But, in recognizing the fact, we should remember that there is a science of items and a science of fundamentals, which bear a relation to each other, like that which subsists between the individuals of a species and species *per se;* and that an indefinite multiplication of individuals may go on without any visible modification of their specific character. The population of Europe has grown in the last century from a hundred and fifty to three hundred and twenty millions of souls; but they are the same Teutons, Celts, and Sclaves as ever. On the other hand, the curve of population for France is almost a horizontal straight line; but their national ad-advancement has been phenomenal. What I wish to illustrate is this evident truth, that not by the mere increment of number of facts learned, not by the mere multiplication of discoverers, teachers and students of those facts, but by the elevation of our aims, by the enlargement of our views, by the refinement

of our methods, by the ennoblement of our personalities, and by these alone, can we rightly discover whether or not our association is fulfilling its destiny by advancing science in America. If, unhappily, our meetings should rather tend to cultivate a love for *bric-à-brac* in science, if the stimulation and gratification of a quasi-animal curiosity for scientific novelties be fostered, if our discussions should become hot-beds of a more vigorous vegetation of personal vanity, intellectual pugnacity, lust for notoriety, literary jealousies, conceited reclamations, petty ambitions, or pecuniary schemes, how is our day and generation to be benefited or improved? If our attention become restricted to the details of the creation, and to the smaller manœuvres of the forces of nature; or if, on the other hand, we become habituated in the indulgence of vague generalizations, suggestions of possible theories, and half-completed or merely sketched and outlined hypotheses, — how are we ourselves, as workers of science, to escape deterioration?

I cannot shake off a suspicion that we talk and write too much; that the whole world talks too much; and that the golden time for silence is precisely then when we come together to talk. Were each of us to utter only what he absolutely knows, what he is quite sure of, what he has unimpeachable facts in sufficient number to confirm, — what a sudden illumination would overspread our meetings, glorifying our science, and re-inspiring us all! But I turn from the Utopian fancy, and invite your attention to a very different theme.

There is a topic which I think should be frequently considered by all who engage in scientific pursuits; and by none so earnestly as by those who are ambitious to reach the higher points of view, from which to survey and describe those systematic combinations of phenomena which are more or less panoramic: I allude of course to generalizers or discoverers of natural laws, and the professional teachers of such laws; while those who deal in itemized science, the mere observers of isolated facts, discriminating specimens and naming genera and species in the animal, vegetable or mineral worlds, and especially such as occupy themselves with geographical and geological studies in detail, stand in less need of having it pressed upon their attention, because in their case it insists upon its own necessity.

I allude to what is technically known among experts as 'dead-work.'

This topic has to be treated in the most prosaic style. To describe dead-work is to narrate all those portions of our work which consume the most time, give the most trouble, require the greatest patience and endurance, and seem to produce the most insignificant results. It comprises the collection, collation, comparison and adjustment, the elimination, correction and re-selection, the calculation and representation — in a word, the entire first, second, and third handling of our data in any branch of human learning, — wholly perfunctory, preparatory, and mechanical, wholly tentative, experimental, and defensive, — without which it is dangerous to proceed a single stage into reasoning on the unknown, and futile to imagine that we can advance in science ourselves, or assist in its advancement in the world. It is that tedious, costly, and fatiguing process of laying a good foundation which no eye is ever to see, for a house to be built thereon for safety and enjoyment, for public uses or for monumental beauty. It is the labor of a week to be paid for on Saturday night. It is the slow recruiting, arming, drilling, victualling, and transporting of an entire army to secure victory in one short battle. It is the burden of dead weight which every great discoverer has had to carry for years and years, unknown to the world at large, before the world was electrified by his appearance as its genius. Let us examine it more closely: it will repay our scrutiny. Those of you who have been more or less successfully at work all your lives may get some satisfaction from the retrospect; and those who have commenced careers should hear what dead-work means, what its uses are, how indispensable it is, how honorable it is, and what stores of health and strength and happiness it reserves for them.

My propositions, then, are these: 1°. That, without a large amount of this dead-work, there can be no discovery of what is rightly called a scientific truth. 2°. That, without a large amount of dead-work on the part of a teacher of science, he will fail in his efforts to impart true science to his scholars. 3°. That, without a large amount of dead-work, no professional expert can properly serve, much less inform and command, his clients or employers. 4°. That nothing but a habitual performance of dead-work can keep the scientific judgment in a safe and sound condition to meet emergencies, or prevent it from falling more or less rapidly into decrepitude; and 5°, That in the case of highly-organized thinkers, disposed or obliged to exercise habitually the creative powers of the imagination, or to exhaust the will-power in frequently recurring decisions of difficult and doubtful questions, dead-work and plenty of it is their only salvation; nay, the most delicious and refreshing recreation; a panacea for disgust, discouragement and care; an elixir vitae; a fountain of perpetual youth.

In expanding these propositions, I would illustrate them in some such homely ways as should make them seem near and familiar principles of conduct; and of course I can only do this out of the experience of my own life, and from observation of what has happened in the limited sphere of one department of scientific inquiry; but that should suffice, seeing that work is work, and science science, however various may be minds and their pursuits.

First, then, is it so that scientific truths cannot be discovered without a large amount of preliminary dead-work? Surely no one in this assembly doubts it who has established even one original theory for himself, or won for it the suffrages of judges capable of weighing evidence. Now the immense disproportion in numbers between theories broached and theories accepted is the best proof we could have, not only of the value and necessity of dead-work, but of the scarcity of those who depend upon it as a prepara-

tory stage of theorizing. And, moreover, not theories only, but simple statements of fact believed and disbelieved, that is, finally accepted or finally rejected, exhibit the like numerical disproportion, and betray a general carelessness or laziness of observers; at all events, their manifest lack of appreciation of the value and necessity of the dead-work part of observation, which imperatively must precede any clear mental perception of the simplest phenomenon, before the attempt is made to establish its natural relationships, and present it for acceptance as a part of science.

A geologist travels far to collect fossils at a particularly good locality, stops there a day or two, fills his valise, and returns to publish a paper on it. What is his paper worth? Were he first to spend a week in making himself acquainted with the whole vicinity, a second week in making measured sections of all the cognate outcrops in the neighborhood, a third week in carefully differentiating the specific horizons, and a fourth week in verifying their reliability, and in correcting his first mistakes, then, surely, whatever labor he should afterwards expend upon his collection of life-forms would have its full value; and any paper he might write would be an important contribution to his branch of science.

I have known men settle to their own satisfaction some of the greatest problems in geology by a flying reconnoissance; triumphantly overturning a mass of accumulated science slowly brought to demonstration by many years of conscientious dead-work, which they did not seem to think it worth their while to verify. I have known men reclassify the elements of a geological system by a few sections, not a single one of which was properly measured by them, or could be properly put on paper in a graphic form for precise comparison. I have known men make what they called a geological map, without having run a single instrumental line themselves; with every outcrop inaccurately placed; with only here and there an accidental note of strike and dip, and even this not oriented with a close approximation to precision; covering a region requiring the study of many months, with a few weeks of what they fondly called field-work; and basing on such a map generalizations of the first rank, for which they expected the world of science to give them credit; which in the long run it certainly will, but not the kind of credit they anticipate.

Now, the experience of a long and active life of science has trained me to regard all such work as careless work, lazy work. Not that such workers are lazy men in the common meaning of the word; on the contrary, they are busy, bustling, active, energetic, indefatigable men; in fact, too much so. In science, there is a laziness of quite another definition; namely, a chronic dislike, a deep-seated disability, for the dead-work which first disciplines to accuracy, then makes patient and cautious, and finally bestows the clearest intelligence and largest comprehension of phenomena. And this fatal laziness is fostered by a strange misunderstanding, a fancy, sometimes a downright conviction, that the dead-work of science can be done for us by some one else, so as to save our time and strength for speculation, for thought, for fine writing; can be done by menials, employees, assistants, colleagues, special experts, — by any one rather than by ourselves. Can we not in fact often find it already done for us, and even better done than we could do it? Then, why not let inferior minds occupy themselves with this laborious and time-consuming address of special skill? Can we not, for instance, hire transit-men to lay out and measure our sections, and artists to draw them? Why should a paleontologist take the pencil between his own fingers in studying species, when he has trained photographers and lithographers at his command? Why waste precious weeks and months in tramping and climbing, in measuring and plotting, while glory calls us, and the scientific world is impatiently waiting for our conclusions? Thus possessed by the demon of scientific haste, we continually spoil our own performances, and disappoint the expectant, but not at all impatient world. Could our vanity permit us to know the fact, the impatience is entirely our own, and, if indulged, is sure to be roundly punished.

No; dead-work cannot be delegated. The man who cannot himself survey and map his field, measure and draw his sections properly, and perfectly represent with his own pencil the characteristic variations of his fossil forms, has no just right to call himself an expert geologist. These are the badges of initiation; and the only guaranties which one can offer to the world of science that one is a competent observer, and a trustworthy generalizer. Nor has one become a true man of science until he has already done a vast amount of this dead-work; nor does one continue in his prime, as a man of science, after he has ceased to bring to this test of his own ability to see, to judge, and to theorize, the working and thinking of other men. But enough of this.

My second proposition was, that no teacher of science can be successful who does not himself encounter some of the dead-work of the explorer and discoverer; who does not discipline his own faculties of perception, reflection, and generalization, by field-work and office-work, independently of all text-book assistance; who does not himself make at least some of the diagrams, tables, and pictures for his class-room, in as original a spirit, and with as much precision of detail, as if none such had ever been made before, and these were to remain sole monuments of the genius of investigation. What the true teacher has to do first and foremost, is to wake up in youthful minds this spirit of investigation *ab initio*. The crusade against scholastic cramming promises to be successful; but the crusade against pedagogic cramming has hardly yet been organized. How is the scholar to be made an artist if the teacher cannot draw? The instinct of imitation in man is irresistible. Slovenly drawing on the blackboard — sufficient evidence of the teacher's imperfect information and inaccurate conception of facts, the nature of which he only thinks he understands — can do little more than raise a cold fog of suspicion in the class-room, by which the tender sprouts of learning must be

either dwarfed or killed. But even slovenly diagrams are preferable to purchased ones; for whatever diminishes the dead-work of a teacher, enervates his investigating, and thereby his demonstrating, powers, and lowers him toward the level of his scholars.

Were I dictator, I should drive all teachers of science out into the great field of dead-work; force them to go through all the gymnastics of original research and its description; and not permit them to return to their libraries until their note-books were full of their own measurements and calculations, sketch-maps and form-drawings, severely accurate and logically classified, to be then compared with those recorded in the books. What teachers fail to keep in mind is this: that learning is not knowledge; but as Lessing says: Learning is only our knowledge of the experience of others; knowledge is our own. No man really comprehends what he himself has not created. Therefore we know nothing of the universe until we take it to pieces for inspection, and rebuild it for our understanding. Nor can one man do this for another; each must do it for himself; and all that one can do to help another is to show him how he himself has morsellated and recomposed his small particular share of concrete nature, and inspire him with those vague but hopeful suggestions of ideas which we call learning, but which are not science.

My third proposition was, that an expert in practical science can command the respect and confidence of his professional fellows, and, through their free suffrages, build up his own reputation in the learned and business worlds, only in exact proportion to the amount of good dead-work to which he voluntarily subjects himself. For, although the most of it is necessarily done in secrecy and silence, enough of it leaks out to testify to his honest and diligent self-cultivation; and enough of it must show in the shape of scientific wisdom, to make self-evident the fact that he is neither a tyro nor a charlatan. More than once I have heard the merry jest of the Australasian judge quoted with sinister application to experts in science. When a young colleague, just arrived from England, asked him for advice, he answered: Pronounce your decisions, but beware of stating your reasons for them. Many an ephemeral reputation for science has been begot by this shrewd policy; but the best policy to wear well is honesty; and honesty in trade means selling what is genuine, well-made, and durable; and honesty in science means, first, facts well proved, and then, conclusions slowly and painfully deduced from facts well proved, in sufficient number and order of arrangement to exhaust alike the subject and the observer. Reap your field so thoroughly that gleaners must despair. Fortify your position, that your most experienced rival can find no point of attack. Lay your plans with such a superfluity of patient carefulness that fate itself can invent no serious emergency. Demonstrate your theory so utterly and evidently that it shall require no defender but itself. Die for your work, that your work may live forever. Forget yourself, and your work will make you famous. Enslave yourself to it, and it will plant your feet upon the necks of kings, and your mere Yes or No will become a law to multitudes. This is what the dead-work of science, when well done, does for the expert in science.

My fourth proposition — that only the habitual performance of dead-work can preserve the scientific intellect in pristine vigor, and prevent it from becoming stiffened with prejudices, inapt to receive fresh truth, and forgetful of knowledge already won — hardly needs discussion. Human muscles become atrophied by disuse. Men's fortunes shrink and evaporate by mere investment. I pray you to imagine what I wish to say; for it all amounts to this — that the grass will surely grow over a deserted foot-path. Let me hurry to the close of this address, which I have found too serious a duty for my liking, and perhaps you also have found it too personal a preachment for yours. One more suggestion, then, and I have done.

My fifth proposition was, that the wearied and exhausted intellect will wisely seek refreshment in dead-work.

The physiology of the brain is now sufficiently well understood to permit physicians to prescribe with some assurance for its many ills, and to regulate its restoration to a normal state of health. Its tissues reproduce themselves throughout life if no extraordinary overbalance of decay takes place, if there be no excessive and too long continued waste. For the majority of mankind, nature provides for the adjustment between consumption and reproduction of brain-matter, by the alternations of day and night, noise and silence, society and solitude; and also by the substitution of the play of fancy in dreams, for the work of the judgment and the will in waking hours. We follow the lead of nature when we seek amusement as a remedy for care. We bring into activity a rested portion of the brain, to permit the wearied parts of it to restore themselves unhindered.

This is the rationale of the pathological treatment of the brain. Tell an over-worked president of a railway company, who falls asleep at the director's meeting, that he must *rest*, or die of softening of the brain, and he will smile a sad reply, that he *cannot rest*. He is right, thus far: he cannot rest his whole brain; but he can rest the cerebellum, — the seat of the will power, — by bringing into higher activity, and more frequent exercise, the upper and frontal lobes. Let him stop thinking of leasing rival lines, and read novels, and play billiards. Let him ride some youthful hobby, revive his practise on the violin, cultivate flowers, keep a stud and kennel, bury himself in Greek and Latin literature, collect pictures, minerals, do any thing which will really interest him, and keep him out of the way of railroad men and railroading; and do it with his might, with enthusiasm, even to fatigue; and do it for at least four years, and by that time his cerebellum will be all right again.

Now what the unintermitting responsibilities of the railroad official do for the destruction of the constitution of his cerebellum, just that the over-strained exercise of the creative imagination does

for the demoralization of the brain of the man of science, especially if it be, as it commonly is, accompanied by business anxiety. And his only way of escape from a predestined break-down is through the monotonous, but interesting occupation of his perceptive faculties in the field, and at his office table. In both he will enjoy that solitude which resembles sleep, in being a medicine for the weary brain. But it is a solitude peopled with unexceptionable friends; in which care sleeps, and pleasure wakes; a solitude in which the soul multiplies itself by alliance with all the possibilities of number, and all the actualities of form; a solitude from which a man returns to the society of his fellow-men, sainted by the blessing of nature, and equal to the duty of existence.

In conclusion, I must express the wish that this meeting of our association may be as delightful and as useful as any that it has ever held. Those who remember how hard we used to work at them, what a harvest of mutual confidences we used to gather at them, and what a glow of fresh enthusiasm we carried away with us from them, will know what such a wish implies. Those who come fresh to this meeting will find themselves made at home in half a dozen worlds of science at once. That is the particular character and special charm of this association, wherein it differs from all local societies, and from all conventions of workers in special branches of science and art. And, as each meeting furnishes a panoramic view of the present state of human knowledge as a whole, so, at each meeting, the old and the young in science are mingled in such friendly and confidential intercourse, that the prospect extends both backwards to the beginnings of inquiry, and forwards to its possible achievements. All good tradition is precious; and so is well-trained current inquiry, and so is sound prophetic calculation. At such a meeting as this, we enjoy the rare privilege of assisting at all three; and, when we scatter to our homes, we can hardly fail to take with us something effectual for lightening and sweetening another year of work.

STANLEY'S KONGO.

FOUR hundred years ago, a Portuguese navigator, sailing along the western shores of Africa, discovered the mouth of a mighty river, which, for many years, was known as the Rio Padrão, or Pillar River, flowing through the kingdom of Kongo. In 1578, however, Lopez described it as the Zaire — a corruption of the native word for river. The Portuguese still call it the Zaire; but English map-makers, since the early part of the seventeenth century, have used the word Kongo as a designation of either the whole or a part of its lower course. There is no good reason for this: but, of all things, geographical names are the least susceptible to reason; and Kongo seems destined to drive out all other appellations, and to spread over the whole course of the river and surrounding country.

The early voyagers confined their explorations to the mouth of the river; and the first attempt, of which we have reliable information, to penetrate inland along its banks, was made by an Englishman, Capt. Tuckey, in 1816. Thirty white men started on this ill-fated expedition: eighteen died almost immediately; and the remainder returned to England, after having been on the river three months, and having explored it for the comparatively short distance of one hundred and seventy-two miles, the greater part of which was by water. This terrible loss of life deterred others from penetrating the unknown regions by the Kongo route. In 1867, however, David Livingstone, travelling westwards from Lake Nyassa, found the Chambezi River, which he afterwards traced to Lake Bangweolo, or Bemba. Thence, under the name of Luapula, it flowed into Lake Mweru, and was met with again at Nyangwe as the Lualaba. Thus much Livingstone had discovered before he died on the shores of Lake Bangweolo. His remains were lovingly escorted to the ocean by his negro servants, and were interred in Westminster Abbey with befitting ceremony. Stanley — then known as the correspondent of the *Herald*, who had penetrated to Lake Tanganika in a successful attempt to find Livingstone — was one of the pall-bearers. Not long afterwards, he strolled into the office of the London *Daily telegraph*. While talking with some of the staff, the editor, Edwin Arnold, entered. The conversation turned upon Livingstone and his work. Suddenly Mr. Arnold, who had been fascinated by the explorer's eye, asked him if he could and would complete the task. As a result of this interview, Stanley reached Nyangwe in October, 1876. He followed the Lualaba to the sea, and proved that the Zaire of the Portuguese, the Kongo of Tuckey and the English map-makers, and the Lualaba, Luapula, and Chambezi of Livingstone, were one and the same river. He then returned to Europe, and soon found himself at the head of an expedition to open the heart of the Dark Continent to the trade of the civilized world *via* the Kongo. These two volumes contain the history of that work.

The estimated length of the Kongo[1] — from its mouth in the Atlantic, to its source in the Chibale Hills, a little to the east of the southern end of Lake Tanganika — is 3,034 miles,

The Congo, and the founding of its free state. By HENRY M. STANLEY, *with illustrations and maps.* 2 vols. New York, *Harper*, 1885. Pp. 28+528, and 10+483. Illus., maps. 8°.

[1] The total estimated length of the Amazon is 4,000 miles; of the Mississippi, 3,160; and of the Missouri-Mississippi, 4,265. — cf. *Imperial Gazetteer*, 1876.