# Scientific American.

ESTABLISHED 1845

MUNN & CO., - - - EDITORS AND PROPRIETORS.

PUBLISHED WEEKLY AT

No. 361 BROADWAY, - - NEW YORK.

*TERMS TO SUBSCRIBERS*

One copy, one year, for the United States, Canada, or Mexico ........ $3.00
One copy, one year, to any foreign country, postage prepaid. £0 16s. 5d. 4.00

*THE SCIENTIFIC AMERICAN PUBLICATIONS.*

Scientific American (Established 1845)....................$3.00 a year
Scientific American Supplement (Established 1876) .............. 5.00 "
Scientific American Building Edition (Established 1885). ....... 2.50 "
Scientific American Export Edition (Established 1878).......... 3.00 "

The combined subscription rates and rates to foreign countries will be furnished upon application.
Remit by postal or express money order, or by bank draft or check.
MUNN & CO., 361 Broadway, corner Franklin Street, New York.

NEW YORK, SATURDAY, AUGUST 24, 1901.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.


## TRADE AND HIGHER EDUCATION.

In this latter-day eagerness for supremacy in the markets of the world, it is often charged that, in this country at least, education and the intellectual pursuits which go to make up the higher culture are sacrificed to purely utilitarian considerations—in other words, seeking after gain. That this is not the case may be proved by an appeal to educational statistics. There were, during the scholastic year 1898-99, some 147,164 young men and women pursuing undergraduate and graduate courses at our universities, colleges and schools of technology. Of this number only 43,913 were enrolled as professional students in law, medicine and theology, leaving 103,251 pursuing studies in the liberal arts and applied sciences. In 1880 the number of students was 119,340, and in 1890 118,581, so that the educational advantages and the number of those who embrace them is on the increase, being in direct ratio to the upward trend in our national wealth.

To provide proper educational facilities was one of the first matters which engaged the attention of the founders of our country. Each of the colonies established in the seventeenth century took measures, more or less effective, to provide schools for the children. The Dutch West Indies Company in 1621 charged its colonies to maintain a clergyman and a schoolmaster. There were private schools in the Virginia colony at an early date, and most of the wealthy planters employed tutors in their families. The Governor of the Connecticut colony reported that one-fourth of the annual revenue of his colony was expended in maintaining free schools for the education of the children. Boston had schools as early as 1635, and they were also established in Rhode Island in 1650. With the growth of cities there began the improvement of the schools, the separation of the children into grades, educating primary children of the first year in one class, and those of the second year in another class. Facilities for higher education were not wanting. Harvard was founded in 1636; William and Mary College in 1660; Yale in 1701; Princeton University, then known as the College of New Jersey, in 1746; the University of Pennsylvania in 1751; Columbia University in 1754; Brown University in 1764; Dartmouth College in 1769. Others followed, so that by the year 1800 there were 24 colleges in the United States—8 of them in the New England States, 6 in the Middle States, and 10 in the Southern States. The early legislators, Washington, Madison and John Adams, all used their influence to forward the cause of education, and particularly of higher education. The government assists institutions in various ways, although the actual amount of money which is appropriated is small and most of it goes to agricultural colleges. Still, however, it has made large grants of land from time to time, aggregating in all 13,000,000 acres. A new seat of learning, to be called the Washington Memorial Institution, has recently been organized, both as a memorial to George Washington and to increase, in the Capital of the country, opportunities for higher education as recommended by our first President in his various annual messages to Congress, and to facilitate the utilization of the scientific and other resources of the government for the purposes of research and higher education.

To-day there are 629 universities and colleges and 43 schools of technology in the United States. The total value of the property possessed by institutions for higher education amounts to $342,888,361, a gain of about $31,000,000 over the amount for the preceding year, 1897-1898. The endowment fund amounts to $154,120,590, and the remainder represents the value of grounds, buildings, machinery, apparatus, libraries, etc., used for instruction and research. The total income for the year, excluding benefactions, amounted to $27,739,154 derived from the following sources: Tuition and other fees, $10,924,415; endowment funds, $6,673,389; state and municipal appropriations, $4,287,102; the United States Government, $3,276,731, and from other sources, $2,577,517. The value of gifts and bequests during the year 1898-1899 amounted to $21,925,436. The amounts reported by some of the institutions are as follows: University of California, $757,000; Leland Stanford Junior, University, $11,000,000; University of Chicago, $786,624; Harvard University, $1,544,330; Columbia University, $518,667; University of Pennsylvania, $510,658; Armour Institute of Technology, $750,000.

From these figures it will be seen that our plant for educational purposes is of enormous value and its efficiency is all that could be asked for. In reality some $2,500 is invested for each student who is now enjoying the advantages of any of the institutions of learning, and the work of the graduates of the last two generations shows that our money has been put out at compound interest.

It must not be supposed that all the students, however, are devoting their energies to the very serious problem of fitting themselves for their life work. On the contrary, the majority are pursuing courses which will not materially assist them to earn a living, but which have, of course, an important bearing as regards culture on their future lives. Classical courses claim by far the greater number of students: 35,595 students out of the 147,164 were pursuing such courses, while 21,860 were taking the general culture courses, 9,858 took general science courses, 2,593 received instruction in agriculture, 4,376 were taking courses in mechanical engineering, 2,550 in civil engineering, and 2,320 in electrical engineering; 1,032 students were studying mining engineering, 627 architecture, 9,501 pedagogy, and 6,698 were taking business courses.

Approximately the same figures hold when degrees are considered. Thus the number of degrees conferred during the year for work done was 15,087—10,794 being conferred on men and 4,293 on women, as follows: The degree of Bachelor of Arts leads, with 4,910 men and 1,950 women; then came Bachelor of Science, with 2,410 men and 500 women. The Master of Arts degree came next, with 1,046 men and 197 women. The degree of Doctor of Philosophy was conferred on 299 men and 26 women. Thirty-eight different varieties of degrees were conferred, and in some cases only one candidate received a degree, Musical Doctor, for example. Seven hundred and thirty-five honorary degrees were conferred.

The ratio of students to population is an interesting study. In 1872 the number of students to each 1,000,000 persons was 573; in 1880 it had increased to 770, in 1890 to 850, in 1893 it had increased to 1,037, while in 1899 the number was 1,196. These figures show that the increased prosperity of the country has a very direct effect upon education. When the splendid gifts which have been made to the cause of education in the last ten years are considered, it may safely be said that the desire for gain does not blind our wealthy men to the advantages which accrue to the country by reason of superior educational institutions.

## "SHAMROCK II" AND "COLUMBIA" COMPARED.

For the first time in the history of the America Cup races it has been possible to get a line upon the two boats which will meet off Sandy Hook; for we take it for granted that unless "Constitution" can be brought to the point in which she can beat "Columbia" in a wind of more than 7 knots' strength, the older boat will be called upon for the second time to represent this country in the famous contest. In 1899 "Columbia" met "Shamrock I." nearly a dozen times off Sandy Hook, and during the present season "Shamrock II." has been tested against the old challenger in numberless trials under all possible sailing conditions.

In the present uncertainty as to "Constitution's" full capabilities, we must take "Columbia" as a basis of comparison. In 1899 she beat "Shamrock I." by 10 minutes in an average 8-knot breeze, and again beat her by 6 minutes 16 seconds in a breeze of about 20 knots an hour. Both of these races consisted of windward and leeward work with no reaching. It is generally admitted, both here and in England, that "Shamrock I." suffered somewhat from poor handling, and much more from the fact that her spars and standing rigging were too frail, and failed to keep the sails up to the wind. The only changes, we are now informed, made in "Shamrock I." preparatory to her trials with "Shamrock II." were to reduce her sail-plan and greatly strengthen and stiffen her spars, with the result that her sails set admirably and she no longer carried a lee helm. As the result of the improved set of her sails, her better helm, and the fine weatherly qualities she developed, the experts who have had charge of her trials have assured the writer that she is at least 5 minutes faster over a 30-mile course, the gain being chiefly in windward work. To this may be added a possible gain in speed due to the better handling which she received under her new captain.

In the later trials of "Shamrock II.," when her best trim had been determined, she beat the older boat by the following carefully-timed amounts in good wholesail breezes: Going to windward she gained 3 minutes in 13½ miles, the boats having split tacks to avoid interference; going to leeward in a 17-knot breeze she gained 4½ minutes in 13½ miles, "Shamrock II." being the leading boat; while on a broad reach in a 13-knot breeze, with the wind slightly abaft the beam, she gained 4¼ minutes in 7 miles. This last is certainly a remarkable performance in view of the fact that "Shamrock I.," in a tuning-up trial down the Jersey coast and back, reached for 30 knots at a speed of 13 knots an hour. These results would indicate that "Shamrock II." is about 12 minutes faster in a club-topsail breeze than "Shamrock I." in the form that the latter showed when over here in 1899.

It is reasonable to assume that another season's experience on the part of the very able skipper of "Columbia" and his crew have enabled them to get a few minutes more speed out of "Columbia;" in which case we may look for a contest, should "Columbia" be chosen, which will be worth going far to see. The question of the absolute security of the Cup is dependent just now, evidently, upon what further speed can be developed in "Constitution."

## DANGER TO ST. PAUL'S CATHEDRAL.

It is seldom that modern building operations and engineering works injure a great edifice; so the news that St. Paul's Cathedral, in London, is in danger comes as a painful surprise, for it is one of the most celebrated buildings in the entire world. The report of the architect to the Dean and Chapter states that St. Paul's is cracked from top to bottom, and while the present damage can be readily repaired it shows a condition of affairs which is really alarming. Sir Christopher Wren built the cathedral after the great fire of 1666, when the older Gothic building was destroyed. Unfortunately for his fame as an engineer he failed to drive piles or to excavate deep enough to place its foundation on a firm sub-soil, so that he practically floated the cathedral on a layer of fine clay, or "pot-earth," as he was pleased to call it, resting on a strata of sand mixed with gravel and water; but he knew of the existence of a bed of hard clay some 40 feet below the surface, but did not carry his foundation so far down, owing probably to the smallness of the available funds. It would have been wise, however, to have built a slightly smaller building on a more suitable foundation. The cathedral, with its great dome, has successfully stood for centuries without perceptible damage, and if it were not for the great excavations which have recently been made in its vicinity it would probably remain in its pristine state. Sewer after sewer has been built, causing the foundation to settle. The old underground railway tunnel was some 500 feet away, and this also had its effect, but it is a later tunnel which has caused the present perceptible and alarming damage.

A number of borings have been made for a new underground line on the south side of the cathedral. It is to be hoped that means will be found to alter the course of this line, so that the noble example of Sir Christopher Wren's work may remain intact.

## MODERN STRUCTURAL STEEL.

It is the popular idea that steel is a hard, polished metal like a dagger or a razor, and capable of carrying a cutting edge, but there are steels of various kinds that do not possess the qualities mentioned. Structural steel, for example, such as beams, girders and rough-rolled bars, generally has a much higher tensile strength, elasticity and tenacity than iron, and yet, in physical constitution and external appearance, it differs but slightly from it. Of two bars, one iron and the other steel, put through the same rolls at the same heat, not even an expert could distinguished one from the other if they were laid side by side. Moreover, careful analysis fails to discover the line of actual departure between steel and iron in the lower grades of each metal, or where the metal commences to be steel, so to speak, and stops being iron.

But as between the two metals, iron and steel, there is a vast difference in their endurance and ability to stand severe work, and modern engineers have a very great advantage over their predecessors of half a century ago in the possession of it. In modern open-hearth and other process-steels the amount of fatigue or continuous resistance to crucial strains of long duration which they will endure is simply astonishing—not laboratory, or test-machine strains, but the downright pounding and flogging of daily work, which is far more serious than any testing machine can deliver. This last sets up a certain stress in a straight line, gradually increasing up to failure under it; but the duty imposed upon steel by daily work in a high-speed engine, for example, is not only to resist tensile strains, but torsional and transverse burdens at one and the same time.

Consider the case of a 30,000 horse power marine engine worked under 200 pounds boiler pressure, and making nearly, if not quite, 1,000 feet of piston speed per minute; each one of the details under strain is twisted, pushed, pulled and pounded, as one may say, in all directions at each revolution, possibly 100 times a minute. Does it not require a metal of faultless integrity to hold on, not for one voyage, but for year after year with very few failures? Locomotives making high speed with heavy loads are subjected to still heavier tests of the strength of details, for not only are they driven faster, but they have to sustain shocks and jars which are absent in marine engines; but instances of failure, compared to the number of engines in use, are few.

The physical qualities demanded for steel used in marine boilers by the United States Treasury rules would seem to be very exacting, inasmuch as they require a tensile strength of 60,000 pounds per square inch in the best, an elongation of 25 per cent in two inches for plates of quarter-inch thickness, and that the metal be capable of being bent on itself (doubled over) so that the inner radius of the bend shall be only one and one-half times the thickness of the plate, which must be heated to a low cherry red and quenched in water of 82 degs. F. As a matter of fact American boiler plate will stand much severer tests than this; plates half an inch and even thicker can be bent down flat cold so that the parts touch each other, without showing the least "craze" or fatigue on the inner or outer parts of the bend; withal, they will stand a very high heat for flanging purposes or dishing. We have seen plates flogged in a former by mauls, dished out like the crown of a derby hat, and reduced in thickness from three-eighths of an inch to three-sixteenths of an inch at the finishing edges—over a diameter of four feet—without a flaw in the whole plate. This was stock ordered from the mill, taken as it ran, and by no means a special steel.

Wholly aside from the benefits constructing engineers derive from having such material is the security that engineers in charge of ships feel when running at high speeds. When iron was used this feeling did not exist, for there was never any certainty that there were not internal flaws that would give away suddenly under severe duty; but modern steel is so homogeneous in its structure that the percentage of failure from the cause named is very low.

## AMERICAN ADULTERATED FABRICS AND TESTS.

American looms and dye pits turn out to-day about every variety of fabric for modern need and luxury, and with the rapidly expanding textile industries in cotton, wool, silk, linen, and worsted goods, the time seems approaching when we will be nearly able to supply the world with these products. It was not so many years ago that American looms were comparatively few and unimportant, especially for the more expensive grades of goods, and most of the expensive weaves were imported. But through the introduction of improved machinery and the invention of new methods of weaving and dyeing, we have become within a few decades one of the leading textile manufacturing countries of the world.

Positive genius of a high order has been expended in inventing methods of weaving shoddy and adulterated goods in this country. This has not been with the idea of deceiving or defrauding any one, but simply to meet a legitimate demand. But there should be understood more generally a clear knowledge of the difference between the genuine and adulterated textile goods. If this were thoroughly comprehended, there would be less attempt to deceive, and the purchaser would know what he was paying for. The machinery invented to manufacture these so-called shoddy goods usually adulterate them in the warp yarn and not in the weft. The two-ply yarns are formed by twisting a wool and cotton or silk and cotton yarn together, and if the warp is examined and the yarns untwisted the cotton can be detected. Cotton being the cheapest fiber we have, it is used most extensively in all the adulterated goods. Cotton is cheaper, and also less durable. If the yarns of the warp are removed, and they are tested by fire, it is easy to determine if there is much cotton in the material. In some goods part cotton is better than the pure wool or silk; but in fabrics where it should not be its presence can be detected by burning two or three of the warp yarns. The cotton yarns will flash up quickly and burn rapidly without much odor, but the wool yarns will emit a burnt-hair odor and burn slowly. So sure is this test that it is impossible for any intelligent person to be deceived.

Some of the weaves are so ingeniously put together that it is difficult even for expert buyers and manufacturers to detect the cotton absolutely without some kind of test. The goods are finished off so that they appear as good as the genuine. Expert buyers sometimes test the goods with acids. A sample an inch square of the fabric is taken for the test. This is laid in a porcelain dish, and a 50 per cent solution of sulphuric acid is poured over it. The dish is held over a slow fire for a short time until the cloth begins to undergo a slight change in color. Then, when the solution has cooled off, the cloth will show up the presence of cotton, and also the relative amount in it. The acid solution dissolves the cotton and works havoc with it. If the fabric is all cotton there will be very little left in the dish except a muddy sediment, and if mostly cotton, with some wool in it, the cloth will fall all apart. If it presents a sieve-like appearance cotton is woven in with the wool to a moderate extent. It is only when the fabric comes out of the acid test whole that it can be pronounced all-wool. The effect of the acid on the wool is merely to turn it a dirty red color.

Alpaca, worsted mohair, and shoddy are tested in the same way as wool; but silk will hardly yield so readily to this chemical test. The difference, however, is chiefly in the kind of acid. A 5 per cent solution of nitric acid should be employed for testing silk. Pull from the edge of the silk cloth a number of yarns, making sure that they are from the warp and not from the weft, and dip these one by one in the solution. In this case if they are cotton yarns they will undergo no change, but if they are silk they will turn yellow. If there is any further doubt the weft yarns can be tested in the same way. Any other vegetable fiber besides cotton will show no change when dipped in the nitric acid solution, but silk always will.

In the manufacture of silk goods such tests are quite necessary to-day, for many grades of cheap satins and heavy silks are made which would deceive any except the experts. Some of these have the cotton mixed in with the warp yarns, and by means of patent processes of finishing its presence cannot be detected. Other grades have a cotton back and a pure-silk face. Usually this is so apparent that there is no attempt made to deceive. If such is the case a drop of the acid solution on the back and another on the face would reveal the story. A fiber known as artificial silk is sometimes used to adulterate pure silk goods, and the ordinary silk test described does not affect it. But this so-called artificial silk is a chemical production, and it is so inflammable that it is only necessary to apply a match to a piece of the goods to make it burn violently and reveal the deception.

In linen goods cotton cannot be detected by any of the above tests, and in fact it is here that the greatest difficulty is experienced. Our towels, crashes and heavy damasks are often adulterated with cotton, and it is quite necessary to be able to tell the difference between the pure linen goods and the adulterated. Even pure linen will sometimes pass for pure cotton, so artful are the processes of manufacture. Yet in the case of a handkerchief, a simple process will suffice. Moisten the finger and press it against the handkerchief. If it is pure linen the fabric will absorb the moisture quickly and make it wet on the opposite side. If it is all cotton the absorption of the moisture will be slow, and it will take a good deal to make the wet pass through to the opposite side.

But when the linen fabric has only a portion of its yarns of cotton, it is necessary to resort to an acid test. A 5 per cent solution of caustic potash or caustic soda should be used for this purpose. In half a gill of water dissolve a piece about the size of a walnut. After this has stood a few moments dip the warp yarns of the linen and cotton fabric in it. They should be left in the liquid for about fifteen minutes. The solution will make the cotton yarn contract and, if anything, increase its strength, but it softens and makes very pliable the linen yarns. Thus the material will readily pull apart if all linen, and it will be strong and firm if cotton. By immersing a piece of the fabric in the solution it should pull apart easily if made of part cotton and linen, but remain strong if all cotton.

Mercerized cotton is one of the new process goods that looks a good deal like silk and has a luster all of its own. When it passes as mercerized cotton it is well known, and no deception is intended, but it is often used in knit underwear goods, hosiery and gloves under other names, and thus may sometimes be passed off on the unsuspecting as pure or part silk goods. The silk test, however, will reveal the cotton in the material. More recently successful efforts have been made to dye mercerized cotton. Mercerized cotton is now dyed in nearly all the prevailing shades, but the work is a delicate one and requires careful manipulation. This makes the use of the prepared fabric more general than ever, and also opens the way for deceiving the purchaser who takes his goods on faith from dishonest dealers.

## BARON NORDENSKJÖLD DEAD.

Baron Nordenskjöld, the Arctic explorer and discoverer of the Northeast Passage, died at Stockholm on August 12. He was a Finn by birth, and received a scientific education. He accompanied an exploring party to Spitzbergen in 1858, after having been appointed Professor in the Royal Museum of Stockholm. He made other trips to Stockholm in 1861, 1864 and 1868. He visited Greenland in 1870 and 1875. In 1876 he made arrangements for his successful attempt to accomplish the Northeast Passage. In July, 1878, he started in the "Vega". The vessel wintered near Behring Strait, and was free of ice in July, 1879, reaching Japan on September 2 of that year. In 1883 he made a second voyage to Greenland, and succeeded in penetrating with the ship through the dangerous ice barrier along the east coast of that country south of the polar circle.

## SCIENCE NOTES.

The use of sun bonnets as a head covering for horses in summer is very much on the increase, both in this country and in England. Straw seems to be the favored material, but in England wire framework covered with light calico is also used.

The Council of the University of Birmingham, England, has appointed W. J. Ashley, Professor of Economics at Harvard University, to be the incumbent of the first organizing chair of the future Faculty of Commerce. Such a faculty appears for the first time in university history.

The Agricultural Society of Italy has offered prizes of nearly $200 for a reliable method of ascertaining the quality of sulphur and of mixtures of sulphur with sulphate of copper. Sulphur is largely used in Italy for diseases of plants, and much of the product sold is inferior. The competition is international.

Encke's comet, which has just returned to visibility, was observed by Dr. William R. Brooks at the Smith Observatory, Geneva, N. Y., on the morning of August 11. At that time it was in Gemini about ten degrees west of Castor. Its position at 3 o'clock was right ascension 6h. 35m. 30s.; declination north, 31 deg. 17m. The comet is moving in a southeasterly direction and approaching the sun. On August 11 it was just visible in the 3-inch finder of the 10-inch equatorial, and as the comet is increasing in brightness it will be observable with quite moderate apertures. The comet is globular in form, and at present without a tail. Professor Brooks says that a short tail may be thrown out as the comet approaches perihelion. Encke's comet has the shortest period of any known comet—three and one-third years.

The Census Bureau has made public its figures giving the population by sex, nativity, and color of a group of states, including Indiana, Iowa, Kansas, and Indian Territory, the results being as follows: Indiana—Males, 1,285,404; females, 1,231,058; native, 2,374,341; foreign, 142,121; white, 2,458,532; colored, 57,960. Of the colored 207 are Chinese, 5 Japanese, 243 Indians and the remainder negroes. Indian Territory—Males, 208,952; females, 183,108; native, 387,202; white, 302,680; colored, 89,380. Of those classified as colored 36,853 are negroes, 27 Chinese, 1,107 Indians taxed, and 51,393 Indians not taxed. Iowa—Males, 1,156,849; females, 1,075,004; native, 1,925,933; foreign, 305,920; white, 2,218,667; colored, 13,186, including 12,693 negroes, 104 Chinese, 7 Japanese, and 382 Indians. Kansas—Males, 768,716; females, 701,779; native, 1,343,810; foreign, 126,685; white, 1,416,319; colored, 54,176, including 52,003 negroes, 39 Chinese, 4 Japanese and 2,130 Indians. The Census Office also issued a bulletin on the manufacturing industries of the four Territories of Arizona, New Mexico, Oklahoma, and Indian Territory, showing an aggregate product of $37,897,103. Arizona leads with a product of $21,315,169, of which amount $12,286,517 was the output of the copper smelters. The total product for New Mexico is $5,605,795; for Indian Territory, $3,892,181, and for Oklahoma, $7,083,938.—Bradstreets.

That driest of all the American States, Arizona, has just come into possession of a seaport, observes the Cincinnati Times-Star. A steamship line has been chartered to ply on the Colorado River from the Gulf of California to Yuma. This little city, situated in the midst of an arid desert, and parched by the eternal sun of the Southwest, thus comes into direct communication by sea with the outside world. At the present time only the smaller class of vessels can navigate the lower waters of the Colorado. It is hoped, however, that the work of dredging the stream will be soon undertaken, and that in time the larger seagoing vessels will be enabled to advance to the wharves of Yuma. The opening of Arizona and southwestern California to direct communication with the sea cannot fail to be of immense advantage to this region. The country is extremely fertile. Only a little irrigation is required to make Arizona one of the most productive states in the Union. Irrigation schemes have formerly been hampered, however, by the lack of suitable facilities for the cheap transportation for the state's products to the seaboard. With the opening of a waterway to the sea Arizona should show a marvelous development. What has been done in California can be done again in Arizona. And when the change takes place the opening up of a waterway to Yuma will have played an all-important part in the development of Uncle Sam's great territory.