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THE SCIENTIFIC AMERICAN SUPPLEMENT,

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With 83 Figures and Engravings.

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THE GREEN FIELDS OF THE MOON.

When the moon is at the full, the unassisted eye readily distinguishes on her face certain dark gray spots more or less sharply separated from the brighter portions. Through the telescope these spots appear as broad level spaces, resembling terrestrial seas. Indeed the earlier observers mistook them for seas, and by that name (Latin, *mare*) they are known to this day, They are not seas, however, but ancient sea beds, now probably nearly, if not quite, destitute of water: vast arid basins like the Sahara, or the great interior Utah basin of our own continent.

Examined more closely, these dried-up sea beds—to which Neison applies the irregular but convenient plural *mares*—are seen to have a rolling surface like some of our western prairies, or to be traversed by numerous long ridges, resembling the wave-like sand hills which give so marked and peculiar an appearance to the deserts of Western Australia, the leveler portions being dotted with low mounds interspersed with small crater pits. In many places formations of an apparently alluvial character abound, while the ancient coast lines show distinct traces of water action. Two of these lunar plains—*Mare Humorum* and *Mare Chrisium*—are walled in completely by lofty mountains, presenting stupendous precipices to the vanished sea. The larger mares are more like ocean beds. They run together as terrestrial oceans do, and sometimes merge into the brighter continental regions, without a distinct line of demarkation. In other places they show a rugged coast line, rising into cliffs and peaks, and pierced at times by valleys and ravines.

One of the most conspicuous of these lunar ocean beds, also one of the deepest, is known as the *Mare Serenitatis*. Its area is nearly 125,000 square miles. Within its dark gray border, from thirty to eighty miles wide, is an extensive inner plain which at times presents a fine clear light green tint with a central streak of pure white, the green area lying lower apparently than the gray exterior. The green tint is difficult to catch, except under favorable conditions, and is much weakened by the effect of numerous small white round spots and gray ridges.

Another of the moon's green plains was discovered by Mädler in the *Mare Humorum*, already mentioned. This is one of the smallest as well as most distinctly bordered of the dark gray plains. Its area is 50,000 square miles. The greater portion of its interior is distinctly tinged a dusky green, sometimes very marked, affording a strong contrast with the pure gray of the borders and high enclosing ridges. On the west the green area extends nearly to the edge of the *mare*, but elsewhere, as in the *Mare Serenitatis*, it is separated from the border by a narrow darker gray fringe, except on the northwest, where the gray and green areas merge insensibly into each other.

Still another area of green is observed in the *Mare Chrisium*, one of the most conspicuous of the moon's dark plains. It is completely enclosed and is, perhaps, the deepest of the lunar *mares*. Its area is 78,000 square miles. Its general tint is a gray mixed with an unmistakable tinge of green, especially under high illumination. This verdant hue is seen to best advantage for several days before and after the moon is full.

These and other color changes on the face of the moon—as, for instance, the darkening of the great ring plain of Plato with increasing light, and like changes in certain long winding lunar valleys—led Beer and Mädler to suggest that they would indicate vegetation, were vegetation possible on the surface of the moon. But having accepted Bessel's conclusion that there could be neither air nor water on the lunar surface, and consequently no life, those much respected selenographers could not entertain the hypothesis of lunar vegetation, however strong the evidence might seem.

But Bessel's opinion, as our readers already know, is inconsistent not only with the conditions on which he based his calculations, but also with the results of more recent studies of the state of the moon's surface. So far from being an airless, waterless, unalterable desert, a changeless mass of dead matter, like so much volcanic scoria, the moon is now known to have an atmosphere of considerable volume and density, to present abundant evidence of physical activity and change, and to have in all probability water enough to make life easily possible on its surface.

The moon is dying, but very far from dead. Being so much smaller than the earth, it has run its course more rapidly, but is still a good way off from that goal of ultimate deadness to which so many astronomers have theoretically assigned it. There is not the slightest adequate evidence, Neison says, of the popular view, and "its truth would be admitted by no astronomer who had devoted sufficient attention to selenography to enable him to thoroughly realize the probable present condition of the moon."

Such being the case, the hypothesis that the moon's green plains derive their color from vegetation ceases to be impossible or absurd. The evidence is not of a character to justify a positive assertion that the mythical man in the moon may have abundant pasturage for his cattle; but his case ceases to be absolutely hopeless when a thorough-going selenographer can say, as Neison does, that the moon may possess an atmosphere that must be regarded as fully capable of sustaining various forms of vegetation of even an advanced type; that it does not appear how it can justly be questioned that the lunar surface in favorable positions may yet retain a sufficiency of moisture to support vegetation of many kinds; and that in a very considerable portion of the entire surface of the moon, the temperature would not vary sufficiently to materially affect the existence of vegetable life.

Who can tell but that the aforementioned man in the moon may not follow the plan of the African tribe which Livingstone tells of, and keep himself and his cattle in extensive lunar caverns, where the temperature is uniform and water abundant; driving them forth upon these great green fields for a fortnightly feed when the sun is up for its long days and the grass in good condition? Jules Verne ought not to neglect so inviting a field of exploration.

WORKMEN AND THEIR TEACHERS.

For examples of the lack of definite knowledge upon simple practical subjects, by those who act as judges of workmanship, we need not look far. For instance, if we find in a mechanical newspaper a discussion on the proper manner of putting wheels upon axles, we shall perhaps read as follows: "Make them parallel and bore the hole parallel." "We have tried that, and we had more wheels come loose than we do now when we put them in taper," says another. The truth is that "make them parallel" is correct for good workmanship, and "make them taper" is suitable for inferior workmanship. Who ever heard of a properly designed and constructed parallel axle becoming loose in its wheel, unless from a fracture of the one or the other? If the boring and turning were either out of parallel or out of round, if the tool marks were left too deep, or if the sizes had not allowed the proper amount for shrinkage or the hydraulic pressure, as the case may be, the parallel shaft will come loose; but these defects have no business to exist, and can only exist from a lack of either surveillance or practical knowledge on the part of those in charge of the work.

Another cause for the common ignorance of certain and accurate methods is the unwillingness of a great many of our expert mechanics to impart their knowledge to others. This undoubtedly exists to a deplorable extent, and we have heard it defended upon the plea that business men are not in the habit of bruiting to the world any advantages they may happen to possess in their business facilities; and why should mechanics do so in their business? This is indeed a difficult question to answer upon a business basis, and brings us to the main question, which is how to utilize the knowledge possessed by our most expert artisans, and, by imparting it to our apprentices for their guidance, make superiority and rapid workmanship the rule and not the exception. Much effort has been expended in this direction by various publications, but we regret to say that we very rarely find a book in a machine shop; and need we look far for the reason, which lies not in the backwardness of the press in utilizing the materials at hand, but in the quality of the materials themselves, which do not as a rule commend themselves to those they are intended to benefit? The reasons for this are that, as we have before remarked in these pages, we must look for the science of practice to those who are known from their practical skill; and this course we have endeavored to take in the SCIENTIFIC AMERICAN and the SCIENTIFIC AMERICAN SUPPLEMENT, which have drafted into their service the best known talent in each branch of practical education upon which they have treated. That our efforts have been appreciated is attested by the freedom with which the scientific newspapers of both the United States and of England have drawn upon our columns.

Of the importance of imparting to others the results of the experience of the skilled workman, we will cite the following: Some four years ago there was introduced, from England, a special tool steel, possessing the peculiarity that it did not require any hardening. It was however difficult to forge, since it would crumble to pieces if heated to more than a bright red, and also if hammered at a very low red heat. The writer was one of the first men in this country to try it, and found no noteworthy advantage possessed by it for light lathe or other work. It had no advantages, in fact, as a finishing tool, and but very few for such roughing purposes as the shop in which it was tried afforded Its cost, too, being sometimes as great as that of ordinary tool steel, its use was not considered advisable. A year afterwards it became known that a certain printing press manufactory had adopted this steel, and had speeded up its machinery faster in consequence of the superiority of the new steel. A visit to the establishment failed to elicit from its manager any data or opinion; but first the speed and feed of some of the tools, communicated to the writer by workmen, disclosed that there was "nothing in it," as mechanics say, and a tool made of that steel and at the manufactory in question, lent by one of the artisans to the writer, showed upon experiment that its superiority was confined to heavy cuts on hard metal, circumstances sufficiently unusual to show that the steel was suitable for special purposes only; and hence it was no surprise to learn that its general use had at that factory been discontinued at a subsequent date. However, it was tried, at the suggestion of the writer, upon pulleys, by Messrs. Laffan and Edgar, of New York, who, finding it served excellently well, applied it to turning shafting, and they were so well pleased with its adaptability to their purposes as to adopt it and recommend it to others. On another occasion, the writer was requested to visit one of the United States navy yards to see the excellent results obtained from a certain brand of American tool steel, for which universal merits were claimed; but on inspection, he found the cutting speed on small work to be only about 25 feet per minute, and that on larger work to range between 9 and 12 feet per minute; so that in neither case was the duty obtained from the tools sufficient to form any criterion of their cutting value.

If we turn to written instructions, we shall find tha for no kind of iron work is a speed of more than 25 feet per minute recommended, while in most cases 23 feet per minute is not exceeded. On small work, however, 35 feet per minute is easily attainable, and is by far the most economical. Two

out of every three "authorities" give the cutting speed for cast iron as being less than that for wrought iron, whereas the exact contrary is the fact. Now wherein does the fallacy lie? We have been asked that question by expert workmen, many times over, and we could find no reasonable answer, except that they did not properly forge or temper their tools. No doubt that, in many cases, defects in the shape of the tools may have had something to do with it; but be the cause what it may, one thing is painfully apparent, that the author of the information was ignorant of his subject: as ignorant as the mechanical correspondent who visited Sheffield in England, and came back and exposed his mechanical ignorance a few weeks ago by writing a long article upon the want of progressive ideas among Sheffield manufacturers, adducing as proof that they forged the blades of fine cutlery instead of rolling them, all unconscious of the fact that to the forging belonged a superiority of quality that can under no circumstances be attained by rolling processes.

IS RARE BEEF DANGEROUS?

For several years past hygeists and pathologists have been closely studying the progressive invasion of the *tæniodea* or tape worms in the human species, in order to discover all the causes which lead to the presence of these terrible parasites and the means of preventing them. While many vital points relating to the subject are still in controversy, it has been demonstated that we are attacked by the armed tænia (*tænia solium*) and by the non-armed tænia (*tænia medio canellata* or *inermis*), that the germs of these two entozoa are introduced into the intestinal canal through flesh food, and that the germs of the first usually come from pork and those of the second from beef and mutton. It has furthermore been pointed out, by M. Régnault, that, while the number of attacks of the armed tænia has not notably augmented, those of the non-armed worm are becoming more and more frequent.

The cause attributed to this increase is first the therapeutic use of raw beef, and second, the habit of eating that meat, as well as mutton (the latter, however, in a less degree than the former), in a very rare state. Both beef and mutton contain morbific germs, which might well escape the scrutiny of a much more rigid inspection of market food than obtains here: and these, lodged in some organ of the body, speedily develope into the mature worm. Cooking the meat through thoroughly is a sure safeguard; but on the other hand, there are many who have no relish for well done beef or mutton, and, among the Germans especially, the meat is prepared in various ways without being cooked at all. We have frequently seen raw beef steak served and eaten with the simple accompaniments of pepper, salt, and vinegar. Butchers in New York city chop finely the good meat which is trimmed from joints or bones, and sell it in its hashed state, at a low price, to the poorer classes, who likewise eat it raw, and thus save the fuel required for cooking. As indicated above, physicians often prescribe raw meat to the weak and debilitated, and it is no very uncommon thing to see infants sucking tender pieces of raw steak. Of course all this is dangerous, and the fact, we have reason to believe, is not entirely unknown to those who favor the practice; but on the other hand, there is a general idea that if meat be cooked ever so little, merely warmed through, all peril is obviated. That this is a subtle error will be clear from a brief consideration of the cooking process.

The *rationale* of broiling is the subjection of a large surface of meat to a sudden high temperature. Coagulation of the exterior albumen succeeds, and the juices are prevented from escaping, so that they are cooked with the fibrous part of the meat, enclosed as it were between two shells. Roasting, or rather baking, as it is practised in this country, is virtually the same process, the hot oven being substituted for the coals. Frying accomplishes the same end by the action of highly heated fat. Boiling is just the reverse, as the heat in that case is applied gradually, so that the albumen can be coagulated uniformly through the mass. Now albumen coagulates at 142° Fah., and further heat reduces it to a firm transparent body, so that a piece of beef which is left "unbasted," that is, unmoistened, during the cooking process, and its exterior temperatures not thus kept down, or a steak allowed to cook slowly over a slow instead of a brisk fire, is likely to become encased in a close crust, not inaptly termed "leathery," which tends to prevent the further penetration of heat. It will readily be perceived that thus, although the meat has been subjected to cooking a proper length of time, and although its exterior may appear overdone, a part of its interior may be practically raw, and may never have reached the temperature of 140°, beyond which it has been proved germ life cannot exist. Hence, in such portion of the meat thus prepared, the germs are none the worse for their warming, and enter the body in an active state.

It does not follow, however, from this that we are to interdict that most noble of all dishes, the rare cut of sirloin, but it does follow that we should exercise some greater care in its preparation. And in this respect we have a very safe and simple guide in the two temperatures noted above, or rather in their close approximation. Everybody knows the difference in color and general appearance between meat nearly raw and meat cooked, and is capable of observing the glairy, flabby condition of the former as compared with the firmness of the latter. In one case the albumen has not coagulated, in the other it has. But in the latter instance we know that a temperature of 142° has been attained, and that that is two degrees higher than the germ death point; hence we are thus rendered certain that the danger is obviated, on simple inspection of the condition of the meat, which still is rare enough to satisfy any healthy taste.

It is not difficult to perceive that the ravages of that other fearful parasite, of the hog, the *trichina spiralis*, have been the cause of greater care in the preparation of pork; and as the same thorough cooking which destroys the *trichina* likewise destroys the tænia germ, both evils are obviated at once. Hence we find another cause for the diminution in cases of armed tænia noted by Régnault, while the prevalent neglect of precautions regarding beef and mutton may likewise account for the spread of the affliction attributable to those meats.

It is a curious fact in this connection that a prominent French medical journal (the *Abeille Médicale*) strongly recommends horse flesh to be used raw therapeutically, and asserts that it is much more nourishing than either beef, mutton, or pork. We doubt whether this last assertion will meet with general acquiescence; but if it appears, as our contemporary states, that the horse is not subject to the parasitic affections common to the cattle now used as food, there can be no question but that, from a sanitary point of view, the food value of our superannuated chargers is greatly enhanced. At all events, for some reason the consumption of horseflesh in France is rapidly increasing, as recent statistics show that nearly 30 per cent more of the animals have been slaughtered, for the markets in Paris, during 1876 than were killed last year.

THE "THUNDERER" EXPLOSION.

It will be remembered that, in our recent account of the disastrous boiler explosion on board the new English war vessel Thunderer, we stated, on the authority of the London *Times*, that the casualty was owing to the gross carelessness of not removing the wedges which had held down the safety valves during a previous hydraulic test. Such negligence seemed almost inconceivable, and therefore we are glad to welcome the flat contradiction given by *Engineering* to the *Times* report. The valves were not wedged down, and the similar valves in the unexploded boiler were all in working order when tested cold. Our contemporary points out that the valves of the burst generator, when cold, were $\frac{1}{100}$ inch free in their seats. Around the latter, except at the steam connection, there is a broad flange not heated by direct contact with steam, its under surface being in contact with the air of the fire room, and its upper surface forming the inside of the bottom of the valve weight box. This cool flange, therefore, tended to prevent the expansion of the cast iron chamber. So that the brass valve seat must have had an increased radial expansion inwards. Now taking into consideration the dimensions of the parts, the temperature of the steam, and the coefficient of expansion of brass, it is found that the valve, after the seat had expanded inwards, would be 0·005 inch larger than its seat. The valves were thus obviously fitted too nicely, and through the unequal expansion they set fast. In addition to this the stop valves were shut, and it is known that the steam gage was badly out of order, and these three causes are, in *Engineering's* opinion, amply sufficient to account for the explosion.

LIGHTNING RODS.

"Professor Wise, the balloonist, who has had rare opportunities for studying and observing storms as well as calms, has repeatedly expressed his convictions that lightning rods are useless in electrical storms, but that metal roofs are an absolute protection. He says that during a recent storm several flagstaffs were shivered down to the point of contact with the metal roofs, when the damage ceased, the fluid dispersing over the expanse of metal. This corresponds to hundreds of other cases that he has examined; and he declares his conviction that 'the lightning rod, as a protection in itself, is of no more value than a bodkin would be to ward off the ball fired from a Columbiad.'"—*American Architect and Building News.*

A metallic roof may, in some cases, avert damage to an unrodded building, by facilitating the passage of the electricity to the best wetted portions of the exterior of the structure, to the water leaders, etc., down which the lightning may pass to the earth; a well wetted wooden roof may assist to the same result. Hundreds of unrodded houses, with and without metal roofs, have been struck, and not seriously damaged. But it is nonsense to assume that a good lightning rod, properly connected with the roof and with the ground, has no value. Although unrodded buildings may by chance escape, they are always in danger, and the lives of inmates are in jeopardy.

On the other hand, all experience, the world over, from the year 1752, when rods were first invented by Franklin, to the present time, has shown that conductors are an essential means of safety in thunderstorms, that they preserve human life, and prevent the destruction of property whenever properly applied.

Formerly, when ships sailed without rods, the loss of life and property at sea was appalling. Nearly all vessels now carry rods, and such an occurrence as serious damage to a rodded vessel by lightning is almost unknown. If, like ships, our dwellings and buildings could have the broad expanse of the sea for their rod terminals, they would be as universally exempt from injury by lightning.

We except, however, buildings and vessels containing petroleum, or other substances from which inflammable gases exude. The latter mix with the surrounding air and form an explosive atmosphere of large extent, often reaching above the points of the electrical conductors; and such mixtures will be set on fire by the electricity on its way to and before it can reach the conductor.

In nearly all cases, our house rods are defectively connected with the ground. They are simply stuck down for five or six feet into dry earth; whereas they should be soldered to a water or gas pipe, or be connected with some large extent of conducting material placed underground.

The following valuable and practical hints, as to the proper arrangement of lightning rods, are given by Mr. John T. Sprague, in his excellent treatise upon "Electricity; Its Theory, Sources, and Applications:"

"It must be remembered that lightning is not a mere thread of flame, or confined to the visible line; a large space all round the line takes part in the discharge, and gives up the force previously accumulated in it as tension.

"These principles settle conclusively all questions as to the construction of lightning conductors. Their object should be to connect to earth every portion of a building; and as this is actually possible only with metal buildings, they should connect every salient point and as much of the surface as possible, so as to extend around the building the area of low tension, or artificial "earth" surface opposed to the cloud. Chimneys require especial attention, because they are tubes lined with conducting material, containing warmer air: and if with fires, then extending a comparatively good conducting column of warm air towards the cloud and so inviting a discharge; hence it is that lightning almost always enters a house by the chimneys. All doors and windows causing currents of air should be closed during a thunderstorm.

'The prime essential is a good connection to water; water and gas mains provide the best if the conductor is well secured to them; next to them is the metal shaft of a good pump, in a well constantly supplied by springs; then ponds or ditches. What is required is a large metal surface terminating the conductor, and in contact with a stratum of moist earth, so that a hole sunk into wet gravel, into which the conductor is led, and surrounded with a quantity of coke to increase its surface of contact, will answer, but dry clay, or rock, is not safe. This connection should, if possible, surround the building by means of rods from its various corners, either led to different earths or else continued by a rod round the house to one earth connection. Every piece of metal work above the building should be utilized, such as ridge caps, guttering, and water pipes. They cannot be trusted as conductors because of the joints in them, which offer great resistance, and therefore prevent reduction of tension, but they will help to form a protecting network around the building, especially if strips of copper are soldered across each joint. For the same reason a connection should be led from the bottom of the down pipes from the gutters to the nearest suitable earth, though a very good but variable earth connection is set up from these by the water itself during heavy rain. The lower parts of the bell wires may also be advantageously connected to an earth, such as the nearest gas or water pipes, as several accidents have occurred from their having either received a direct charge through the walls, or having a violent current induced in them.

"The terminals should be attached to all high or salient points, most particularly chimney stacks; if these are wide, and contain several chimneys, it is safer to have two points, though usually one is sufficient; but the kitchen chimney, or any one commonly used, and therefore lined with soot, and containing warm air, should be specially attended to. The points may be made of rods of 1-inch iron drawn out to a point, rising 2 or 3 feet above the building; they are better also for galvanizing. There is no advantage in any of the fancy points, patented or otherwise. The conductor depends upon the size and hight of the building. A factory chimney or church steeple should have a copper conductor of at least ½-inch section, either as a rod or as a wire rope, well protected against injury; for smaller buildings, iron rod may be used instead of copper. In ordinary cases galvanized iron wire of about ¼-inch diameter (such as is used for telegraphic purposes) will answer perfectly, if led separately from various salient points, and carried down the different sides of the house and connected as above described, to the guttering, etc., but for a single conductor at least ½ inch rod should be used. Solid rod is best, as it exposes least surface to rust, for it is the mass or weight of metal which conducts, not its surface, as some suppose; but every joint must be carefully made and soldered, to secure metallic continuity and low resistance.

"It will be seen that conductors should never be insulated from the building, but, on the contrary, as much of the surface as possible should be connected to the conductor. Electrometers, etc., are often surrounded with a cage of wire connected to the earth or to the negative pole of the active source of electricity, in order to prevent them from being affected by external electric disturbances. That is exactly what we require to do with our buildings; an iron house well connected to earth would not only be perfectly safe, but its inmates would scarcely feel any of the effects usually produced on the nervous system by "thundery" weather, except so far as these are due to heat. The object aimed at in a lightning conductor should be to approach that condition as nearly as possible; to obtain an enclosed area within a conducting envelope provided with points and connected to earth."

Life on the Earth.

Professor P. G. Tait, of the University of Edinburgh, in his lectures on recent advances in physical science, lately published, considers the question how long life has been possible on the earth. He concludes that ten millions of years is "the utmost that can be allowed from the physical point of view for all the changes that have taken place on the earth's surface since vegetable life of the lowest known form was capable of existing there." Opposed to this is the view of the most eminent modern geologists, that at least three hundred millions of years have passed away since terrestrial life began.