of the northern ocean, as is volcanic *débris*, but that the chief portion of the material consists of the solid matter carried out to sea by drift-ice and glacial rivers.

M. E. WADSWORTH.

THE NATURAL HISTORY OF IMPLEMENTS.[1]

"WHEN will hearing be like seeing?" says the Persian proverb. Words of description will never give the grasp that the mind takes through actual sight and handling of objects; and this is why, in fixing and forming ideas of civilization, a museum is so necessary. One understands the function of such a museum the better for knowing how the remarkable collection formed by Gen. Pitt-Rivers came into existence. About 1851 its collector, then Col. Lane Fox, was serving on a military sub-committee to examine improvements in small arms. In those days the British army was still armed (except special riflemen) with the old smooth-bore percussion musket, the well-known 'Brown Bess.' The improved weapons of continental armies had brought on the question of reform; but the task of this committee of juniors to press changes on the heads of the service was not an easy one, even when the Duke of Wellington, at last convinced by actual trial at the butts, decreed that he would have every man in the army armed with a rifle-musket. Col. Fox was no mere theorist, but a practical man, who knew what to do and how to do it; and his place in the history of the destructive machinery of war is marked by his having been the originator and first instructor of the School of musketry at Hythe. While engaged in this work of improving weapons, his experience led his thoughts into a new channel. It was forced upon him that stubbornly fixed military habit could not accept progress by leaps and bounds, only by small partial changes, an alteration of the form of the bullet here, then a slight change in the grooving of the barrel; and so on, till a succession of these small changes gradually transformed a weapon of low organization into a higher one, while the disappearance of the intermediate steps, as they were superseded, left apparent gaps in the stages of the invention, — gaps which those who had followed its actual course knew to have been really filled up by a series of intermediate stages. These stages Col. Lane Fox collected and arranged in their actual order of development, and thereupon there grew up in his mind the idea that such had been the general course of development of arts among mankind. He set himself to collect weapons and other implements till the walls of his house were covered from cellar to attic with series of spears, boomerangs, bows, and other instruments, so grouped as to show the probable history of their development. After a while this expanded far beyond the limits of a private collection, and grew into his museum. There the student may observe in the actual specimens the transitions by which the parrying-stick, used in Australia and elsewhere to ward off spears, must have passed into the shield. It is remarkable that one of the forms of shield which lasted on latest into modern times had not passed into a mere screen, but was still, so to speak, fenced with. This was the target carried by the Highland regiments in the low countries in 1747. In this museum, again, are shown the series of changes through which the rudest protection of the warrior by the hides of animals led on to elaborate suits of plate and chain armor. The principles which are true of the development of weapons are not less applicable to peaceful instruments, whose history is illustrated in this collection. It is seen how (as was pointed out by the late Carl Engel) the primitive stringed instrument was the hunter's bow, furnished afterwards with a gourd to strengthen the tone by resonance, till at last the hollow resonator came to be formed in the body of the instrument, as in the harp or violin. Thus the hookah or nargileh still keeps something of the shape of the cocoanut-shell, from which it was originally made, and is still called after (Persian, *nárjíl* = cocoanut). But why describe more of these lines of development when the very point of the argument is that verbal description fails to do them justice, and that really to understand them they ought to be followed in the series of actual specimens? All who have been initiated into the principle of development or modified sequence know how admirable a training the study of these tangible things is for the study of other branches of human history, where intermediate stages have more often disappeared, and therefore trained skill and judgment are the more needed to guide the imagination of the student in reconstructing the course along which art and science, morals and government, have moved since they began, and will continue to move in the future.

[1] Extract from a lecture on anthropology, delivered Feb. 21, at the University museum, Oxford, by E. B. TYLOR, D.C.L., F.R.S. From *Nature* of May 17.

THE INTELLIGENCE OF THE AMERICAN TURRET SPIDER.

AT the meeting of the Academy of natural sciences of Philadelphia, June 19, Rev. Henry C. McCook exhibited nests of Tarentula arenicola Scudder, — a species of ground spider of the family Lycosidae, properly known as the turret spider. The nests in natural site are surmounted by structures which quite closely resemble miniature old-fashioned chimneys composed of mud and crossed sticks, as seen in the log cabins of pioneer settlers. From half an inch to one inch of the tube projects above ground, while it extends straight downward twelve or more inches into the earth. The projecting portion, or turret, is in the form of a pentagon, more or less regular, and is built up of bits of grass, stalks of straw, small twigs, etc., laid across each other at the corners. The upper or projecting parts have a thin lining of silk. Taking its position just inside the watch-tower, the spider leaps out, and captures such insects as may come in its way. Nests had been found at the base of the Alleghany Mountains near Altoona, and in New Jersey on the seashore. In the latter location the animal had availed itself of the building-material at hand by forming the foundation of its watch-tower of little quartz pebbles, sometimes producing a structure of considerable beauty. In this sandy site the tube is preserved intact by a delicate secretion of silk, to which the particles of sand adhere. This secretion scarcely presents the character of a web-lining, but has sufficient consistency to hold aloft a frail cylinder of sand when it is carefully freed from its surroundings. A nest recently obtained from Vineland, N.J., furnished an interesting illustration of the power of these araneids to intelligently adapt themselves to varying surroundings, and to take advantage of circumstances with which they certainly could not have been previously familiar. In order to preserve the nest with a view to study the life-history of its occupant, the sod containing the tube had been carefully dug up, and the upper and lower openings plugged with cotton. Upon the arrival of the nest in Philadelphia, the plug guarding the entrance had been removed; but the other had been forgotten, and allowed to remain. The spider, which still inhabited the tube, immediately began removing the cotton at the lower portion, and cast some of it out. Guided, however, apparently by its sense of touch, to the knowledge that the soft fibres of the cotton would be an excellent material with which to line the tube, she speedily began putting it to that use, and had soon spread a soft smooth layer over the inner surface and around the opening. The nest in this condition was exhibited, and showed the interior to be padded for about four inches from the summit of the tower. The very manifest inference was drawn, that the spider must for the first time have come in contact with such a material as cotton, and had immediately utilized its new experience by substituting the soft fibre for the ordinary silken lining, or by adding it thereto.

LETTERS TO THE EDITOR.

Equations of third degree.

THE second or third terms of any equation may be made to disappear, and we may therefore assume

$$x^3 + Ax^2 + B = 0; \qquad (1)$$

and the solution of this equation must involve the general solution of cubics. Assume

$$x = y^{\frac{2}{3}} - y^{\frac{1}{3}}z^{\frac{1}{3}} + z^{\frac{2}{3}}. \qquad (2)$$

Hence

$$y^{\frac{1}{3}} = \sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{1}{2}z^{\frac{1}{3}}.$$

$$y = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{2}xz^{\frac{1}{3}} - z + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$y + z - \tfrac{3}{2}xz^{\frac{1}{3}} = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$z^{\frac{2}{3}} - \frac{y + z}{x}z^{\frac{1}{3}} = \frac{x^3 - (y + z)^2}{3x^2}.$$

$$z^{\frac{1}{3}} = \sqrt{\frac{4x^3 - (y + z)^2}{12x^2}} + \frac{y + z}{2x}.$$

$$z = \sqrt[\frac{3}{2}]{\frac{4x^3 - (y+z)^2}{12x^2}} + \frac{y+z}{2} + \frac{3(y+z)^2}{4x^2}\sqrt{\frac{4x^3 - (y+z)^2}{12x^2}}.$$

$$432x^6(z - y)^2 =$$
$$64x^9 + 240x^6(y + z)^2 + 192x^3(y + z)^4 - 64(y + z)^6.$$
$$x^9 - 3x^6(y + z)^2 + 3x^3(y + z)^4 - (y + z)^6 = -27zyx^6.$$
$$x^3 + 3\sqrt[3]{zy}\,x^2 - (y + z)^2 = 0. \qquad (3)$$

In (1) and (3), equating coefficients,

$$3\sqrt[3]{zy} = A, \quad zy = \frac{A^3}{27}. \qquad (4)$$

$$-(y + z)^2 = B, \quad y^2 + 2yz + z^2 = -B. \qquad (5)$$

Whence, from (4) and (5),

$$y = \sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$
$$z = \sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

Substituting these values of y and z in (2),

$$x = \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}} - \frac{A}{3} + \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}}, \qquad \text{formula } (a)$$

or

$$x = -\sqrt[3]{\frac{B}{2} + \frac{A^3}{27} - \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}} - \frac{A}{3} - \sqrt[3]{\frac{B}{2} + \frac{A^3}{27} + \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}}. \qquad \text{formula } (b)$$

In the case of the irreducible case of formula (b), which is similar to Cardan's formula, formula (a) may be used. In such case, only one part, as $\sqrt{-\frac{B}{4}}$, of formula (a) is imaginary, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is real; and if the signs of the roots of equation (1) be changed, which is done by changing simultaneously the signs of A and B in equation (1), the converse is true, that is, $\sqrt{-\frac{B}{4}}$ is real, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is imaginary. Which shall be the imaginary term is, then, arbitrarily chosen. Hence, factoring preparatory to expansion by the binomial theorem, the coefficient of $\sqrt{-1}$ may be made less than unity when the real term is unity.

A. M. SAWIN.

Evansville, Wis.

Solar constant.

It is feared that the letter of Mr. Hazen (SCIENCE, i. 542) in relation to above topic may not entirely remove the confusion of which he justly complains. It should be premised that there are two units of heat in common use among physicists: the smaller being the quantity of heat required to raise the temperature of one gram of water 1° C.; the larger, the quantity of heat required to raise the temperature of one kilogram of water 1° C. The larger of these units is a thousand times as great as the smaller; and, in ordinary applications, no confusion is liable to arise. In either case, the number of units of heat received by the unit-mass of water is (sensibly) proportional to the number of degrees of rise of temperature.

With regard to the 'solar constant,' two additional units are required, — a unit of surface, and a unit of time. This constant may be defined in general terms