the summer school the young instructor may earn sufficient for his maintenance.

In nearly all of our colleges the salary paid to the teacher below the grade of professor is so small as to render it all but necessary for him to devote at least a portion of the summer vacation to primary teaching. This evil chiefly affects the teacher who is neither old nor young, but who in the fullest possession of his newly developed abilities rejoices still in the full energy of youth, and yet is upon the threshold of that fuller knowledge which years alone can bring. Now if ever is he fitted for giving new thought to the world, and now of all times are his free moments precious.

In my official connection with a laboratory whose purpose it is to afford unrivaled facilities for research to those best fitted to avail themselves of the opportunity, I find that fully one third of our ablest investigators feel obliged to decline invitations to pursue research work free of all expense; and answer that in order to provide adequate support for wife and family they must forego the attractive prospect, and teach in the summer schools. And thus they must decline facilities for the solution of problems which years of training have best fitted them to solve, and to the solution of which their thoughts must turn with hope and longing.

Granted that research must generally be performed at a sacrifice to him who loves it, and that the genius of advancing thought flourishes best in adversity, is this an argument for rendering research well-nigh impossible, and for substituting the low achievement of expounding well-worn facts for the glory of discovery?

Our colossal universities are weak in research when compared with those of Germany, and when we look upon the great names of those who were among us we see that productive scholarship has not advanced with our material progress.

We must have more of the spirit of Agassiz who knew of the hidden wealth by Lake Superior's shore, but had not time to make money; of Henry who knew of the practical value of his electro-magnet but swerved not from his path and ever studied science simply for his love of it, never asking of it the rewards of wealth.

Not the least of this evil of which we speak is the fact that our colleges are putting into the high place the ideal of mere money getting. The most inadequate measure of success is thus lauded as the highest, and it is a lamentable fact that a large number of our leading college professors have deserted research to enter upon commercial careers.

Measure our universities by standards truly high. What character do they develop in their graduates, what love for research do they inspire, how thorough is their scholarship. Even small colleges may excel the great universities in these things. This matter has been most ably discussed by Professor Münsterberg in his book upon 'American Traits,' giving as he does the deferential but nevertheless just opinion of one who as a visitor among us contrasts our achievements in higher education with those of his native land.

It is to be hoped that one among our graduate schools may develop as an autonomous institution, with its own special faculty devoted exclusively to the advancement of its aims, and substituting the standard of original work for that of mere erudition, and of quality for that of quantity. If one among them thus should raise its head, all others soon would follow.

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ON THE ORIGIN OF THE SMALL MOUNDS OF THE LOWER MISSISSIPPI VALLEY AND TEXAS.

To the Editor of Science: Apropos of a communication under the above title by P. J. Farnsworth in your issue of April 13, 1906, I beg the privilege of a few remarks.

From time to time a number of notes have been written upon this subject in Science by Messrs. Veatch, Branner, Bushnell and perhaps others, but unfortunately none of these papers are available to me except those of Messrs. Farnsworth and Bushnell.

The mounds to which I allude are low,

circular eminences, averaging, say, twenty feet in diameter, seldom exceeding two feet in height, occurring thickly studded over extensive areas of both forest and prairie lands.

For nearly twenty years I have been observing these mounds in the second bottoms of the rivers of the southern coastal plain, the coast prairies of Louisiana and Texas, in southern Arkansas, Indian Territory and in the extension of the old valleys of the rivers toward the great plains.

I do not believe that they owe their origin to the uprooting of trees, the handiwork of man, to glacial agencies, or the pressure of underground gases, as some of your correspondents and others have alleged.

As to Mr. Farnsworth's theory that they are the result of uprooting trees: while I have seen many mounds in the forests which have thus been made, this hypothesis can not apply as a general explanation, owing to the fact that millions of the mounds occur on the newly made coast prairie of the Texas region which is not and has never been inhabited by forest growth. Two weeks ago I drove through thousands of these mounds on the mainland of Texas opposite Galveston Island, and any one familiar with the conditions of that portion of the coast prairie will immediately abandon the uprooting tree theory.

Mr. Bushnell's theory that these mounds were made by man is also totally inadequate. I am well aware of the fact that in poorly drained flat areas of the old flood plains and second bottoms of the Mississippi Valley and its tributary laterals, mounds do exist which were constructed by aboriginal hands, but the mounds under discussion are not of this class. I have seen hundreds of these dissected by roadways and other cuttings and they show no trace of human work. Furthermore, they are so numerous and extensive that their construction by men would have required a larger population than has ever yet inhabited these regions, or than it could possibly support.

The glacial theory can also be dismissed with the statement that in most instances these mounds inhabit non-glacial formations.

Another theory, which has probably been mentioned by some of your correspondents, is that the mounds are produced by the ascending gas above oil pools, has wide local adherence and should be discountenanced because of its economic misapplication. In fact, the name 'gas mound' now being used locally by the people for this class of phenomena in Texas is the only specific one which I have heard applied. Many charlatans and even misguided honorable men are holding to the 'gas-mound' theory and express astonishment when any one disputes it, notwithstanding the fact that the identical mounds are found to occur in many districts where not the least sign of oil or gas has been discovered. This theory has cost useless expenditure of many thousands of dollars in drilling for oil pools.

While frequently feeling, like Professor Forshey, as quoted in Mr. Farnsworth's article, that the more familiarity I have with these mounds, the less explicable they seem to me, I am of the decided opinion that they are natural products of certain topographic, climatic and geologic conditions.

It has been my observation that the mounds always occur upon areas of poorly drained sublevel surfaces in regions of abundant, periodic rainfall. They are also always underlain by formations of alluvial materials of relatively uncompact sands and clays.

The rainfall upon these places, owing to absence of well-defined runways, stands until it is evaporated or absorbed. The materials have different capacities for absorption and transmission, retention and loss of water, resulting in the unequal settling of the ground and the formation of the mounds and their interspaces. In the dry season these mounds are frequently augmented in size by drifting sands.

While writing upon this subject, I might add that last year I observed mounds exactly similar to those of the southern coastal plain region upon the Bavicora plain near the top of the Western Sierra Madre of Mexico at an altitude of nearly 7,000 feet. This plain, like the coast prairie, is an extensive flat upon which the rainfall stands for a considerable time after falling.

ROBT. T. HILL.

111 BROADWAY, NEW YORK,
April 20, 1906.

SPECIAL ARTICLES.

THE AVAILABILITY OF CELLULOID IN ILLUSTRATING CHROMATIC POLARIZATION.

1. It is not unusual to find that celluloid shows brilliant colors between crossed nicols on the cut edges. This observation suggested the use of the material to illustrate the properties of plates cut parallel to the optic axis, when seen in polarized light in the usual way. In fact, if a strip of celluloid is evenly stretched, fields of color vying in brilliancy with those of the natural crystal, may be obtained quite uniformly over an area an inch or more square, and variable at will through two or more well-defined orders; or the color of any given crystal may be similarly increased or decreased continuously in order. The well-known complicated figures seen in compressed or annealed glass are thus simplified, in a way that is at once interpretable in terms of elementary optical theory.

2. In the following experiment I used strips of clear celluloid, about 20 cm. long, 1 cm. or less broad (to avoid the need of excessive traction) and but .025 cm. thick (for flexibility). They were mounted between rollers, very much in the manner used in film cameras, except that one roller was rigidly fastened while the other could be rotated by the aid of a lever and clamped. If many strips are to be simultaneously stretched, it is advisable to secure one end of the strip under a plate of brass, bringing the ends around the remote edge and holding them down under a second smaller plate, in order that the maximum of friction may be encountered. The roller in this case is preferably a strong hollow brass cylinder (say 2 cm. in diameter) with a central longitudinal slot. Through this the ends are passed and wedged in place with a conical rod forced into the inside of the tube. About one complete turn should be taken to insure friction. For special purposes instanced below, a similar adjustment for stretching at right angles to the preceding should be added. Screw apparatus or uniform loads are also useful in particular cases.

3. As the two directions of vibration are parallel to the strain and at right angles to it, respectively, the nicols may be adjusted at 45 degrees to the vertical and the pulls be either horizontal or vertical. The phase difference ϕ for a thickness of strip, d, being

$$\phi = 2\pi d(n - n')\lambda,$$

where n and n' are the two indices of refraction for light of normal wave-length, λ. The plan of experiment consists in varying $n - n'$ continuously from 0 by increasing stress as far as the breaking point of the strip, and to increase d successively from the thickness of 1 to that of four strips ($d = .025$ to .1 cm.). The following results may be recorded:

One strip, $d = .025$ cm. Colors whitish to middle of the first order. When the strip breaks, the efficiency does not much exceed a quarter wave-length plate. Such a plate of mica, where mean and minimum elasticities are involved, is but $d = .0032$ cm. thick; a similar plate of selenite, where maximum and minimum elasticities occur, is .0027 cm. thick for mean wave-lengths. Hence the efficiency of a strip of celluloid stretched nearly to the breaking point is for like thicknesses, about 13 per cent. of that of mica and 10 per cent. of that of selenite.

Two strips, $d = .050$ cm. The earlier whitish colors now become more and more saturated and the strips break about at the end of the order.

Three strips carry the phenomenon (when stress is gradually increased) from colorless to the middle of the second order, extremely vivid colors overlying the whole visible area of the strip; four strips complete the first two series. If more strips are to be used the machine must be strong and quite perfect in its clutch, otherwise there is slipping and abrasion, by which the strength of the strips is decreased. Apart from this the experiments may be carried into higher orders of color at pleasure.

4. *Special Experiments.*—If three or four strips of successively decreasing width overlie each other symmetrically, so as to form a