with this view, the glacial map of Asia which precedes the chapter is covered with extensive glaciated areas over the regions which I have specifically visited. All of which shows the confusion of mind which has widely prevailed up to the present time concerning the glacial conditions of Southern Siberia and Central Asia, and goes to justify the editor in naming my article.

4. I am not aware that Kropotkin had any personal knowledge of the southeastern border of West Turkestan. But it is significant that Geikie, on his authority, speaks of 'immense sheets and terraces of loess' fringing the base of its mountainous border. The writer in SCIENCE assumes, as I believe unwarrantably, that the only indication of a former sea-level is the occurrence of sea shells. On the contrary, in the broader studies of physical geography that are now current, sea-levels may be determined in many places by terraces where shells are not present.

5. With reference to the occurrence of the bones of land animals and of terrestrial mollusks in the loess, I need only to say, that the great uncertainty concerning the situation of these remains with reference to the original deposit largely, if it does not entirely, breaks the force of the argument which is drawn from it. No one will deny that the wind has in many instances redeposited vast amounts of loess, nor that subsequent streams have done the same. But to go no farther than our own country, it is difficult for any one who is familiar with the situation of the loess over Northern Missouri, for instance, or in the center of the Mississippi Valley at Vicksburg, to believe that it has been deposited either by the wind or by flowing streams of water when the land stood at its present level.

In due time I hope to bring the facts in fuller detail before the public. But this much I may confidently say, that the whole problem of the loess has not yet been fully comprehended, much less has it been solved. If the renewed discussion elicited by my report shall contribute to an understanding of the subject, a great point will be gained. But I am sure that the as yet little understood facts of Central Asia will contribute much toward a solution of what has been one of the most perplexing of all the geological problems.

G. FREDERICK WRIGHT.

'THE LARYNX AS AN INSTRUMENT OF MUSIC.'

TO THE EDITOR OF SCIENCE: Noting in your issue of May 24, a communication from Arthur Gordon Webster quoting Professor Le Conte's reference to the larnyx, comparing it in its function to a horn and citing a passage from Helmholtz containing the same comparison, I am tempted to refer your readers to a much earlier example of the same conception. I quote the following from some notes of mine: "In 1700 Dodart ('Memoire sur les causes de la voix de l'homme,' par M. Dodart, *Memoire de l'Academie des Sciences*, 1700, p. 238) insisted that the trachea only furnishes the material of the voice, *i. e.*, the expired air. The glottis is the only organ of the voice. All the effects of the glottis for tones depend on the tension of its lips, and of its various internal structures. The concavity of the mouth has no part in the production of the voice, but it is a modifier of it, and still more is this true of the nose. He showed that Galen's comparison to a flute could not be accepted if one were to go into details. He spoke of the vibration of the ligaments, of the dilatations and contractions of the glottis. He asserted that the trachea is elongated in high notes and shortened in low ones. He likened the vocal organ rather *to a horn or trumpet. According to him the glottis is the place which corresponds to the lips of the musician; the body of the instrument extends from the glottis to the external orifice of the vocal canal, that is to say the mouth.*"

JONATHAN WRIGHT.

SHORTER ARTICLES.

PREDETERMINED ROOT-HAIR CELLS IN AZOLLA AND OTHER PLANTS.

ORDINARY root-hairs arise in acropetal succession in the zone where the surface tissue is becoming fixed; that is to say, in a region at some distance from the root apex, where the cells have ceased to divide and have reached, or are reaching, full elongation. They come from any or all of the superficial cells indif-

ferently. "Only in Lycopodium," says De Bary (*Comparative Anatomy*, p. 60), "can special hair-cells be distinguished from the other epidermal cells of the root."

Special hair-cells are, however, to be found in a considerable range of plants, in which they form a rather striking anatomical character of the epiblema. In all the cases which I have studied, root-hairs arise from cells differentiated for the purpose at a very early stage of the epiblema, and *from no other cells*. The hair-cells are short, often very short, sometimes wedge-shaped, possess peculiarly dense and deep-staining cell contents, and are distributed in a manner determined by the mode of origin. They originate from the division of cells near the root apex. Of each cell pair formed, one becomes a hair-cell and very shortly shows distinctive characters; while the other either becomes a single ordinary, much elongated surface cell, or divides to form several such (hairless) cells. In most cases the cutting off of hair-cells seems to be a matter of stimulus. At times the roots are wholly devoid of hairs and hair mother-cells; at other times the growing conditions —as it would seem—call out these structures.

I find such special hair-cells in *Azolla*, *Isoetes*, *Selaginella*, *Equisetum*, certain Alismales and certain Nymphæaceæ.

In *Azolla pinnata* (the only species examined by me) the root shows several points of interest. The root-cap (as we may call the structure derived from the original segment cut from the outer face of the apical cell) consists of two cell layers, except at the apex, where the inner layer finally undergoes an extra periclinal division. The inner layer for a time coheres closely to the root-trunk, which is thus clothed with a true epidermis. At the same time the outer layer is separated from the inner except at the apex, and forms a distinct root-cap proper. The inner layer is finally pushed away from the root-trunk by the growth of hairs arising from the outer layer of the cortex, so that at maturity, and even before, the main body of the root is quite destitute of an epidermal covering.

The hairs arise in close proximity to the apex. Exterior cortical cells divide by a wall oblique to the external surface. The lower of the two cells so formed in each case almost immediately gives rise to a hair, while the other divides transversely to form two, four or eight hairless cells. At first the hairs stand in regular zones, but ultimately these zones often become more or less broken by the unequal multiplication of the intervening cells in the different vertical rows.

In several species of *Nymphæa* examined the hair mother-cells or the hairs themselves were found as apparently constant characters of the epiblema, alternating very regularly with ordinary cells. In *Nymphæa*, it will be recalled, the root is without epidermis (except root-cap), the epiblema being merely the outermost layer of cortex, the Nymphæaceæ in this respect agreeing with Monocotyledons and certain Pteridophytes. The hair-cells may develop in such a way as to give root-hairs, or they may be—under most conditions they commonly are—suppressed by the closing together, above them, of the ordinary elongated cells. Whenever hairs are found they proceed from short, specialized cells, early distinguishable not far from the growing point. An essentially similar condition is found in *Brasenia*, *Cabomba*, and *Nuphar*.

In some Alismales—*Sagittaria*, *Limnocharis*, *Aponogeton*—essentially the same phenomenon, the production of root-hairs solely from predetermined hair-cells, obtains. This is interesting in view of the recent discovery of the monocotyledonous character of one of the Nymphæaceæ.

I purpose in the near future to describe at length these and other like cases of root-hair formation.

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QUOTATIONS.

SCIENCE AT A WESLEYAN UNIVERSITY.

THE dismissal of Professor Frank D. Tubbs from the chair of natural sciences in Wesleyan University, at Salina, Kansas, throws an interesting light upon the standards of orthodoxy in that State. Professor Tubbs is laboring under the grave charge of believing in evolu-