to a reed-pipe,' and suggests the resemblance between the vocal band action and the lip action in blowing a horn. Whether the lips in blowing a horn vibrate laterally as reeds or by compression as cushions, I am unable to say; they may quite possibly vibrate in a manner different from that assumed by Helmholtz.*

E. W. Scripture.

Yale University,
New Haven, Conn.

* Misunderstanding the point under discussion and supposing that Professor Le Conte was speaking of lateral vibrations of the lips and vocal cords, Professor Webster (Clark Univ.), replies to him in Science for May 24, N. S., Vol. XIII., p. 827, that the action of the lips and the vocal cords had already been explained by Helmholtz and that his description of 1862 'has never needed any improvement or correction.' Professor Webster asserts that he regards the simple *model* of a membranous reed pipe with a sheet of rubber in lateral vibration as 'a very convincing demonstration of the mode of action of the larynx.' He also classifies elastic cushions as 'reeds.'

PHYSIOLOGY IN THE SCHOOLS.

To the Editor of Science: Judging from the letter of S. W. Williston in your issue of May 24th, people must acquire their mental growth much more rapidly in Kansas than they do in the East. If I were confronted in an examination for the degree of doctor of philosophy with the question 'Why does the human body cease to grow about the twenty-fifth year?' I should think there were strong grounds for suspecting the examiner of endeavoring to show what I did not know, even at the price of asking questions whose answers I could not know. Yet we are told that this question has been asked of candidates for the State teacher's certificate. The theory of accelerated mental development is furthermore strongly supported by the apparent fact that children are expected, by the time they finish with the grammar school, to know about pleurisy, the respiratory center, residual air, appendicitis, *meatus auditorius* and the *motores oculi.*

If mental development is anywhere as rapid as these facts would suggest, there can, of course, be no criticism with regard to the consideration of these questions in physiology at the time indicated.

If, however, children generally show about the same rate of mental development as I have observed in the East, the writer would like to suggest that if less time were consumed in the contemplation of useless details of anatomy, relieved by worse than useless rambles into pathology, and more in the plain, common sense, practical study of the conditions of healthy living, teachers would no longer learn in examination papers that 'the body should be bathed frequently, should be bathed at least once a year.' There is, in fact, a horrible suspicion in the mind of the writer that something else than the text-book is at fault.

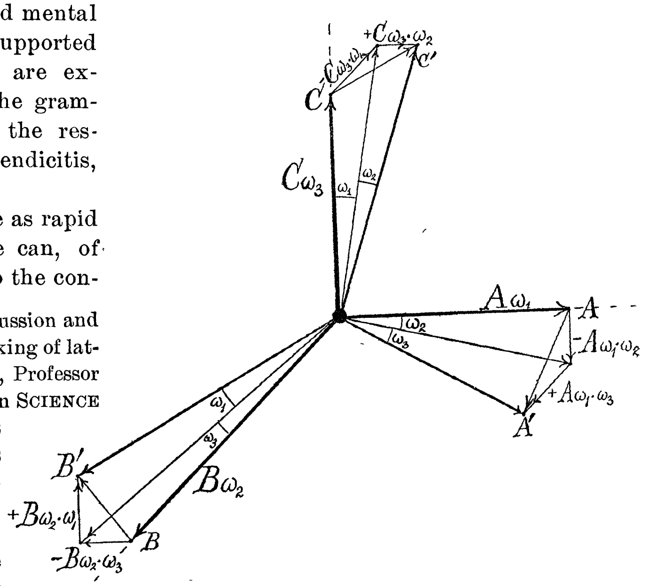
Theodore Hough.

Massachusetts Institute of Technology,
May 25, 1901.

SHORTER ARTICLES.

THE GENERAL EQUATIONS OF ROTATION OF A RIGID BODY.

After writing my brief note on the top,* it occurred to me that the same method might be



used to derive the Eulerian equations of rotation briefly and at once, in a way almost pic-

* This Journal, May 31, 1901.

torially lucid as to the meaning of the terms involved.

Let A, B, C, be the principal axes of inertia and ω_1, ω_2, ω_3, the angular velocities of the rigid body around them. All this is kinematic.

Let A', B', C', be the positions of these axes a unit of time later. Lay off the angular momenta, $A\omega_1$, $B\omega_2$, $C\omega_3$, along these axes in order, as shown. Then will AA', BB', CC', be the corresponding per second changes of angular momentum.

Resolve each of these into components parallel to the original axes, and bring those belonging to the same axis together, viz.,

$$\begin{array}{lll} -B\omega_2 \cdot \omega_3, & -C\omega_3 \cdot \omega_1, & -A\omega_1 \cdot \omega_2, \\ +C\omega_3 \cdot \omega_2, & +A\omega_1 \cdot \omega_3, & +B\omega_2 \cdot \omega_1, \end{array}$$

remembering that as each axis rotates about the other two, the component displacements per second will be

$$\omega_2,\ \omega_3;\ \omega_3,\ \omega_1;\ \omega_1,\ \omega_2.$$

Add to the component changes of momentum found, the direct per second changes of angular momentum around the respective axes, viz.,

$$+A\dot{\omega}_1, \qquad +B\dot{\omega}_2, \qquad +C\dot{\omega}_3.$$

Let L, M, N, be the torques around the three axes in order, and equate these to the *total* per second change of angular momentum corresponding to the same axes. In other words, after adding each of the three columns,

$$\begin{aligned} L &= A\dot{\omega}_1 - (B-C)\omega_2\omega_3, \\ M &= B\dot{\omega}_2 - (C-A)\omega_3\omega_1, \\ N &= C\dot{\omega}_3 - (A-B)\omega_1\omega_2. \end{aligned}$$

C. BARUS.

ON A CRINOIDAL HORIZON IN THE UPPER CARBONIFEROUS.

FOR more than half a century the Lower Carboniferous limestones of the Mississippi valley have been justly celebrated for their enormous wealth of crinoidal remains. On this account, they have become widely designated as Encrinital limestones, a title which has long since assumed a distinctive value.

The crinoidal element in the faunas of the Lower Carboniferous has been further emphasized by the apparent extreme paucity or entire absence of crinoid remains in all other parts of the Carboniferous section of the region. The few species described were few in number, from widely separated localities and from very fragmentary material.

Unusual interest was, therefore, aroused a few years ago by the discovery, in the Upper Carboniferous rocks of the Missouri river, of a formation so rich in fossil crinoids as to merit the title Encrinital as appropriately as any terrane of the Lower Carboniferous. Species were not only new and numerous, but individuals occurred in the utmost profusion, their stems and long, slender, beautifully pinnulated arms intertwining as intricately as the richest of flowing arabesques. Moreover, the state of preservation was wondrously perfect. From a morphological standpoint the discovery was one of the most important ever made.

The geological position of this rich crinoid fauna is a short distance above what is called the Lower Coal Measures. It is in the terrane now known as the Thayer shales, the base of which is a stratigraphic level not much over 600 feet above the Lower Carboniferous limestones. The Thayer shales are in the lower part of the Missourian series. They are dark blue in color, and lithologically are indistinguishable from the Crawfordsville Shales of Indiana, which have been so prolific in crinoids in fine state of preservation.

The biological peculiarities of the crinoids from the Thayer shales as compared with those of the nearest forms from the Lower Carboniferous are noteworthy features. For two faunas so closely connected in space the differences are so profound when apposed to the resemblances as to be almost inexplicable.

But a satisfactory solution of the remarkable problem has been lately supplied from a source other than the biotic. The recently worked-out stratigraphy of the region throws light upon it in an unsuspected manner. The actual position of the Thayer shales, instead of being removed only 600 feet from the Lower Carboniferous limestones, are, stratigraphically, thousands of feet away.

While the lower coal measures have long been known to rest unconformably upon the underlying rocks, the stratigraphic break has been regarded as merely local in nature. Of late, the real significance of this hiatus has been