Here the facts actually known are duly set forth, and among other things it is shown that the rats were destroyed in great numbers, while it seems doubtful whether the 'ground-birds' were actually exterminated in any instance.

T. D. A. COCKERELL.

EAST LAS VEGAS, N. M.,
May 16, 1901.

AN EARTHWORK DISCOVERED IN MICHIGAN.

MR. G. N. HAUPTMAN, of Saginaw, Michigan, in a letter dated May, 1901, reports that 'there is on section 34, T. 21, N., R. 1 E., Ogemaw county, Mich., an earthwork [of horse-shoe shape]. The trench * * * is three feet' deep, and in it stand forest trees.

If any notice of this has ever been printed I should be glad to receive references to the same. I believe no note of this earthwork has previously been made, although four earthworks in the same county are well known and are recorded in the literature of archeology.

HARLAN I. SMITH.

PHYSIOLOGY IN THE SCHOOLS.

TO THE EDITOR OF SCIENCE: The writer has a 'horrible suspicion' that T. Hough imputes the physiological questions, to which he demurs, to him. He did not propound them. The high-school questions were taken from the text-book which the pupils had used, and if the text was legitimate, the questions were.

It is the writer's conviction that public school teachers are not generally qualified to teach physiology; that physiology proper is too abstruse for the grammar grades; and that the teacher in every grade should be expected to have a better knowledge of his subject than can be obtained from the elementary text placed in the hands of his pupils. Finally he may venture to express his fear that a little elementary knowledge of the reasons for the non-increase in stature of the human skeleton throughout life might not be amiss to his learned critic even.

S. W. WILLISTON.

SHORTER ARTICLES.

WHAT IS LIFE?

SOME thoughts, started by reading an article with the above title in *Nature*, Vol. 57, p. 138, 1898, by Horace Brown, and jotted down at that time, but laid aside, I have thought might perhaps interest the readers of SCIENCE, especially as the subject continues to be agitated.*

Heretofore in cases of dormant life, as in seeds kept for years, perhaps for centuries, or in dessicated infusoria, etc., in which under favorable conditions active life is revived, it has been supposed that very slow metabolic changes still go on during the state of dormancy—life is supposed to be feeble, but not extinct. The same was supposed to be the case in seeds or bacteria exposed to intense cold of — 180° to — 200° C. by Pictet or even — 250° by Dewar.

But it is now proved that at this temperature chemical affinity is destroyed and all chemical changes arrested, and therefore the chemical changes characteristic of life—metabolism—also must cease. But with the return of heat they revive. Therefore, in this case, life seems to spring spontaneously from dead matter. Must we then revive the old doctrine of spontaneous generation? If not we must change or greatly modify our conceptions of life.

From such experiments it is evident that, although life is, indeed, a distinct *form of energy*, yet its nearest alliance is with chemism. For as chemism is completely destroyed by extreme cold and again revived by heat, so life may be completely arrested by cold and again revived by heat—*if the molecular structure characteristic of living protoplasm* (whatever that may be) *remains unchanged.*

What then is the necessary condition of life—or, to put it clearly, what is the difference between *dead* protoplasm and *living* protoplasm, or rather protoplasm *capable of life?* Evidently it is not a difference in chemical composition, for no change in this regard takes place in the act of death. It is, I suppose, a difference in *molecular arrangement*—a difference in *allotropic condition.* As the necessary condition of chemical properties is a certain equivalent composition: so the necessary condition of vital properties is, in addition, a certain molecular constitution. But as equivalent composition may

**Nature*, Vol. 61, p. 67, 1899; Vol. 63, p. 420, 1901. *Revue Scientifique*, Vol. 15, p. 201, 1901, and SCIENCE, Vol. 12, p. 774, 1900.

remain, even though chemical activity be absent, so also the peculiar molecular constitution, characteristic of life may remain even though life—*i. e.*, active life—be absent. As chemism may be completely destroyed by cold and revived by heat, if the necessary condition, viz., a certain equivalent composition, remains: so life may be completely destroyed by cold, and again revived by heat if so be the necessary condition—a certain molecular constitution remains.

Again, Mr. Brown, in the article referred to, says that Spencer's definition of life, viz., 'a continuous adjustment of internal to external conditions' must be revised, since it applies only to *active* life and not to suspended life. I think not. Life in the true sense, *i. e.*, *actual* life must be active — the essential nature of life, as of all energy, is *activity*; but there is a necessary underlying condition, *i. e.*, a peculiar molecular constitution, which may be called *potential life*. As equivalent composition is potential chemism, which may under certain conditions become actual chemism, so a peculiar molecular constitution of protoplasm is potential life, which may under certain conditions become actual life. *Death* is not merely an *extinction* of life, *i. e.*, actual life, but also the *destruction* of the necessary condition of life, *i. e.*, the characteristic molecular structure of protoplasm. Extinction of life, therefore, is not necessarily *death*. There are therefore three conditions of protoplasm, viz.: (1) *living*, a condition in which life is actual; (2) *potentially living*, in which the necessary molecular constitution or vital constitution is present; and (3) *dead*, in which the vital constitution also is wanting.*

Joseph Le Conte.

Berkeley, Cal., May 24, 1901.

A 'SAND-BOW'—AN UNUSUAL OPTICAL PHENOMENON.

The following description, based on personal observation, is presented without discussion of the optical principles involved.

On the evening of May 16, the writer was crossing the main ridge of Antelope Island—the largest land body within the area of the Great Salt Lake. As he began the descent on the eastern slope, there appeared between the island and the mainland what seemed at first glance to be segment of a brilliant rainbow of unusual width. It was evident, however, that no rain was falling in that direction. Clouds were gathering in the south and west, but the sun was yet unobscured. A wind setting toward the mainland had lifted from the dry flats large quantities of the 'oolitic sand,' with which the lake bottom and the recently dried patches on this side of the island are covered to a depth varying from a few inches to several feet. This so-called 'sand' consists of calcareous spherules, fairly uniform in size between the limits of No. 8 and No. 10 shot. The oolitic bodies are polished and exhibit a pearly luster.

It would seem that the outer spherical surfaces reflected the light in such a manner as to produce the bow. The colored column appeared almost to touch the lake bed, and its ends subtended with the observer an angle of about 40°. The prismatic colors were distinct, the red being outside, *i. e.*, away from the sun. In apparent width the column was fully double that of the ordinary rainbow. A fainter secondary bow was plainly visible beyond the primary, with the colors in reverse order. The phenomenon was so brilliant as to attract the attention of all members of the party, and it remained visible for over five minutes, then, as the sun sank lower, it rapidly died away.

The production of a color bow by reflection from the outer surfaces of opaque spherules is a new phenomenon to the writer. It is inexplicable on the principle of refraction and total reflection from the interior of transparent spheroids, according to which the rainbow is generally explained.

If phenomena similar or analogous to the foregoing have been observed, reports of the same would doubtless be of instructive interest.

James E. Talmage.

University of Utah,
Salt Lake City, May 20, 1901.

* Similar views on the molecular constitution of living protoplasms were brought out by me, in January, 1892 in a lecture before the Philosophical Society of Washington. *Bulletin*, Vol. XII., p. 29, 1892.