Endamoeba coli. Excystation of *E. coli* was observed many times by the writer in material obtained by washing infected feces in water. This material either in water or in weak saline solution was sealed under a cover glass and placed on the stage of a microscope confined in a warm chamber. The protoplasm within the cyst is at first finely granular and the eight nuclei are usually clearly visible, but later the nuclei become invisible and a number of larger granules of various sizes appear. The first evidence of activity preceding excystation is the movement of the cytoplasm in the center of the cyst. No large free area exists between the cyst contents and the cyst wall such as described by Smith (1927) in *Iodamoeba williamsi*. Pseudopodia first appear through an opening in the cyst wall. This opening is small and the protoplasm streams through it rapidly in a thin strand. The amoeba does not leave the cyst wall at once, but usually, after from one half to three fourths of the protoplasm has escaped, movement begins in the opposite direction and most or all of the animal streams back again into the cyst. This egress and return of the protoplasm may occur as often as ten times before complete escape is effected and the liberated amoeba moves away from the deserted cyst wall.

After excystation the amoeba moves at first slowly but soon flows across the field by means of rapidly forming pseudopodia. These pseudopodia are somewhat similar to those of *E. histolytica*, being formed rapidly and more or less explosively and being at first free from granules although not so clear and hyaline as those of *E. histolytica*. In every case the entire contents of the cyst emerged as a single amoeba. Excysted amoebae were watched for more than six hours, but no division stages were observed.

Endolimax nana. Excystation could not be studied as easily in *Endolimax nana* as in *Endamoeba coli* because of its minute size. So far as could be observed, however, the process was similar in every respect. The first evidence of activity was movement in the cytoplasm; this was followed by a minute break in the cyst wall through which the cytoplasm protruded; then after flowing in and out several times the organism separated from the cyst wall as a single amoeba.

Chilomastix mesnili. Excystation of this flagellate was seen in only one case. The details were not clearly made out, but the essential features were observed. Movement of the protoplasm within the cyst was followed by a break in the wall at the anterior end and the rapid emergence of the organism, which soon took on approximately the shape of a typical trophozoite. One large cystostome was present. Whether the excysted specimen contained one or two nuclei was not determined. In this case the cyst was in a saline medium and excystation occurred after three hours and forty minutes at about 37° C.

Giardia lamblia. Complete excystation of *Giardia lamblia* in vitro has not been observed, but movement within the cyst can be brought about by the same method as that shown to be effective with other protozoa. Washed cysts from two to four days old were used. Material was sealed under a cover glass and kept in an incubator at 37° C. for two hours; it was then placed on the stage of a microscope in a warm chamber at approximately 39° C. Within from ten to fifteen minutes movement began in some of the cysts. The contents seemed to contract and expand, due probably to bending movements of the axostyle such as were observed in cysts recovered from the small intestine of the rat (Hegner, 1927). The protoplasm of the organism was seen to shrink away from the cyst wall and after from one to four hours became quiescent.

It seems safe to conclude from these observations that, as suggested above, moisture and a favorable temperature (about 37° C.) for a sufficient period (several hours) are the essential factors in excystation. It, therefore, follows that the digestive juices of the host that ingests the cysts of intestinal protozoa are unnecessary in bringing about excystation. They may be helpful, but on the other hand it is possible that they are harmful. If the latter is true, then the cyst wall probably protects the cysts from the secretions encountered in the stomach. In this connection it may be noted that no excystation nor protoplasmic movements were observed within the cysts of *Giardia lamblia* that were injected into the stomach of the rat, although cysts hatched in the small intestine of this animal (Hegner, 1927). Further details of excystation in these intestinal protozoa will be published in a later communication.

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ISOTOPES OF CALCIUM

THE writer has recently studied the selective reflection of several carbonates at about 6.5 microns. Polarized light was used so that bands due to vibrations along the different directions in the crystal would not be superimposed. In the case of calcite ($CaCO_3$) three small maxima were observed. The wave lengths were 6.36 μ, 6.54 μ, and 6.62 μ. When several bands overlap, it is difficult to calculate the true intensity of the separate bands as there is no zero line of reference. However, using the band at 6.54 μ as the standard, the band at 6.36 μ is about one twentieth as intense; also, the band at 6.62 μ is about one fifth as intense as the band at 6.54 μ. So it is likely that calcium is made up of isotopes with atomic weights of 39, 40 and 44 and of quantities in the ratio of one fifth, one, one twentieth, respectively. The atomic weights given would have the approximate separation as found for the bands and these atomic weights with the quantities named would give a mean atomic weight about 40.

It is interesting to note that calcium has been studied for isotopes by Dempster,[1] Aston[2] and G. P. Thomson.[3] Dempster found points which correspond to 40 and 44 and another set of points which correspond to atomic weight 39. However, he considered the 39 as due to potassium, which likely occurred as an impurity. Aston also studied calcium, but due to the fact that it did not produce anode rays easily, he did not find a line for calcium of atomic weight 44. Aston carefully excluded potassium from the mixture, but the line corresponding to atomic weight 39 was more intense than the 40 line. So the line at 39 was possibly a mixture of potassium and calcium. G. P. Thomson's work on calcium gives a broad line at 40 which was not resolved by his instrument. However, he states that there must be another line at 39 or 41 making calcium an isobar with potassium. So it is likely that calcium has an isotope of atomic weight 39. In addition to the above facts it appears that it would have been very difficult to detect the isotope of atomic weight 44 if the intensity were only one seventieth of that of atomic weight 40. It could not have been observed by the method of band spectra used by the writer. It seems probable, therefore, that the isotope Ca^{44} is present to a greater extent than one seventieth and that a mean atomic weight of 40.07 is made possible by the presence of Ca^{39}.

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[1] *Physical Rev.*, 18, 421, 1921.

[2] Aston, "Isotopes," p. 101.

[3] *Phil. Mag.*, 42, 857, 1921.

A PRE-CHATTANOOGA SINK HOLE[1]

THE Chattanooga shale is locally five to seven times the thickness generally observed in the region of the Gainesboro, Tennessee, quadrangle. This fifteen-minute quadrangle, ten miles south of the Tennessee-Kentucky line, was mapped by the Topographical Branch of the United States Geological Survey in 1925. Through it the Cumberland River swings in entrenched meanders four hundred feet below the level of the dissected Highland Rim Plateau.[2] The Fort Payne formation of lower Mississippian age is at the surface of the plateau throughout the area. Beneath the Fort Payne a green shale, varying in thickness from a few inches to one or two score feet, lies upon the Chattanooga shale. The Leipers, Catheys and Cannon strata of Ordovician age, together four hundred feet thick, are separated from the Chattanooga shale by a disconformity. The rocks of the region are gently arched in a northeastern extension of the Nashville Dome.

The writer spent three and a half months of the 1926 field season mapping the areal geology and structure of the Gainesboro quadrangle for the State Geological Survey of Tennessee. An interesting result of the summer's work was the discovery of an extraordinary local thickness of the Chattanooga shale. This body of shale is generally ten to fifty feet thick in the Nashville Basin and adjacent areas. According to general observation, the thickness does not vary more than five or ten feet in many miles.[3] The writer found the thickness to exceed 149 feet on Flynn Creek, five miles south of Gainesboro. The shale is exposed in several places in the vicinity with seventy-five or ninety feet of strata visible in a continuous outcrop. It lies in an irregular closed depression or series of depressions in a limestone conglomerate-breccia which is at the same altitude as Leipers, Catheys and Cannon strata. The actual contact of the breccia with formations other than the shale was not seen. Some of the blocks in the breccia contain fossils common to the Leipers and Catheys, but the fossils do not determine with certainty the formations from which the blocks were derived. Some of the blocks differ in lithology from the pre-Chattanooga strata heretofore observed in this general area. It is possible that a detailed and thorough study of all the blocks might yield information which would partially close the hiatus between the Leipers and Chattanooga deposits. The breccia is more than one hundred feet thick in some places.

[1] Printed with the permission of the state geologist of Tennessee.

[2] Purdue, A. H., "General Oil and Gas Conditions of the Highland Rim Area in Tennessee," Resources of Tenn., Vol. 7, No. 4, pp. 220–228. 1917.

[3] Butts, Chas., "Geology and Oil Possibilities of the Northern Part of Overton County, Tennessee, and of Adjoining Parts of Clay, Pickett and Fentress Counties," Tenn. State Geol. Survey Bull., 24, pt. 2-A. 1919. Hayes, C. Willard, and Ulrich, O., U. S. Geol. Survey Geol. Atlas, Columbia folio (No. 95). 1903. Mather, Kirtley F., "Oil and Gas Resources of the Northeastern Part of Sumner County, Tennessee," Tenn. State Geol. Surv. Bull. 24, pt. 2-B. 1920. Miser, Hugh D., "Mineral Resources of the Waynesboro Quadrangle, Tennessee," Tenn. State Geol. Survey Bull. 26. 1921.