BLASTOCYSTIS HOMINIS: ITS CHARACTERISTICS AND ITS PREVALENCE IN INTESTINAL CONTENT AND FECES IN SOUTH CAROLINA

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Alexeieff (1911) gave the name *Blastocystis enterocola* to a peculiar cell found in the intestines of certain vertebrates (man, guinea pig, rat, chicken and frog) and in the snail (*Haemopsis sanguisuga*), a structure which had previously drawn the attention of numerous observers. He classified with the Ascomycetes.

Ucke (1907), Bohne and Prowazek (1908), and Bensen (1910) had described this cell as an encystment of *Trichomonas intestinalis.*

Alexeieff's contention that it could not be an encysted trichomonas but was in reality a vegetable cell was based on the mucilaginous envelope similar to the capsule of certain Blastomycetes, the observed process of budding, the presence of germinating spores, and the occurrence of the same special structure in the seeds of a certain yeast (*Schizosaccharomyces actosporus*).

Brumpt (1912), who gave the name *Blastocystis hominis* to the species found in man, and Wenyon (1915) agree with Alexeieff as to its nature.

With the view that this cell cannot be a cyst of *Trichomonas intestinalis* I am in full accord. I have seen it often in human feces where no trichomonas could be found and also in the non-trichomonas-infected intestine of man and of the rat, from examination at autopsy of bodies which had not been dead long

enough to allow the trichomonas to disappear had it been present. Then too the true cyst of *Trichomonas intestinalis* which I have described (Lynch, 1916) bears no resemblance to *Blastocystis enterocola.*

Alexeieff has studied the organism in man, the rat, frog and a snail. Wenyon has found it to be very common in soldiers returning from Gallipoli to England.

As to its presence in the United States I have been unable to find any record. It is not mentioned in various books dealing with the examination of feces in this country. I am unable to find any reference to its occurrence in our various indices to medical literature. Siler and Nichols (1911) make no mention of it in their reports of examinations of the feces of one hundred and thirteen pellagrins and two hundred and sixty-nine patients ("practically all non-pellagrous") at Peoria, Kankakee, and Dunning, Illinois. Roberts (1913) in summarizing various reports of intestinal parasites found in pellagra in America, Italy and Egypt, does not mention it. Ridlon (1916) does not record any observation of it in his study of the feces of ninety-five pellagrins in Savannah. Stiles (1915) records no observation of it in an examination of twelve hundred and eighty-seven school children for animal intestinal parasites. Rosenberger (1911) makes no mention of it in his examination of twelve hundred and eighty patients for intestinal parasites in Philadelphia, although he very kindly aided me in my first recognition of the organism and assures me that he has seen it a number of times.

Of course reports of special studies of the prevalence of animal parasites may not be expected to record the occurrence of this organism which is regarded as a vegetable cell, but from my experience in South Carolina I feel sure that it is fairly common in this country, and that the general lack of any record of its occurrence is largely due to failure to recognize it.

In the examination of forty-five pellagrins in Charleston, I have encountered the organism in twenty-five cases, or in 55.5 per cent; in company with *Endamoeba coli* in thirteen of these, and with *Trichomonas intestinalis* in eleven, while all three of

these parasites were present in six of the cases. From the examination of the feces of one hundred and sixty-eight non-pellagrous patients in the same hospital, I found sixty-eight, or 40.4 per cent, to harbor the organism, in company with *Endamoeba coli* in thirty-two, with *Trichomonas intestinalis* in twenty, and associated with both of these protozoa in sixteen of the cases.

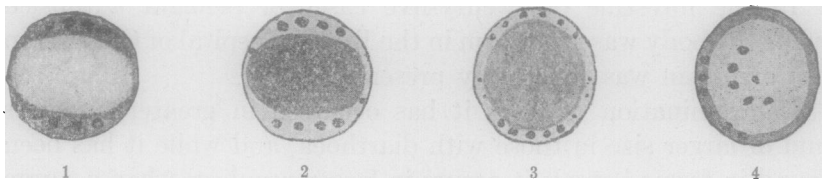
From a similar study of the actively pellagrous inmates of the South Carolina State Hospital for the Insane at Columbia, I found the organism present in seven of twenty patients, or 35 per cent, while in the old pellagrins without symptoms of the disease it occurred in three of twenty-seven cases, or in 11.1 per cent.

In the intestine of twenty-five cases of pellagra autopsied while the body was still warm in the Roper Hospital of Charleston the organism was constantly present.

In examination of feces it has occurred in greater numbers and of larger size in those with diarrhoea, and while it has been found in formed stools it occurs in larger numbers when a purge is given to those without diarrhoea. In the postmortem examinations it has been found to be limited to the large intestine and to the cecum where it is present in large numbers; when the pellagrous inflammation has extended into the lower end of the ileum the Blastocystis has accompanied it, but has gone no further. In the intestines the number of these organisms has appeared to vary directly with the grade of inflammation present. Control examinations of the intestine of the non-pellagrous have shown it to be present in about the same proportion as in feces, and also to be limited to the large intestine.

In feces the cell conforms very well to the characteristic appearance as described by Alexeieff and by Wenyon. It varies in size from about 5 to 15 microns and is generally rounded, though elongated forms are seen. It has a delicate capsule, which apparently allows some alteration in shape, enclosing a rim of cytoplasm which may be uniform in thickness in the rounded cells or thin in the midline and broad at each end in the elongated cells. A large central body or vacuole fills the major

part of the cell. Wenyon describes the rim of cytoplasm as being of greenish appearance and containing nuclei of the appearance of greenish refractive spots, and says that the great part of the content is a large vacuole. While this appearance is commonly observed, it is just as common to find the rim of cytoplasm clear or transparent, containing highly refractive nuclear bodies, and the major portion composed of a large central body of pale hyaline greenish yellow appearance. In other words the organism apparently reverses the materials of the content of its two internal parts (see figs. 1, 2, 3 and 4). This phenomenon has been observed to occur in the course of a few minutes. A cell with the hyaline greenish yellow rim and cen-



FIGS. 1, 2, 3, 4. FRESH UNSTAINED SPECIMENS OF BLASTOCYSTIS HOMINIS FROM HUMAN FECES. COMMON FORMS SHOWING REVERSAL OF APPEARANCE OF INTERIOR

tral transparent body changed slowly to one with a transparent rim and a central body of the same appearance as was the rim previously.

In addition to this change, which may be from either form to the other, the cell has been observed to change shape (see fig. 5), passing from a rounded to an elongate form and also becoming curved while being watched for a short while. The change in shape does not appear to alter the internal characteristics.

Large rounded forms have also been seen to extrudé through the capsule a large sac of transparent material, the wall and content of which was continuous with that of the central vacuole (see figs. 6, 7, 8 and 9). This sac was projected at the midline

on one side where the cytoplasmic rim was thin. It had a broad neck at first, but this gradually became constricted until the sac was turned loose and the cell became closed again. The extruded sac soon faded from view. The extrusion was as rapid as the throwing out of material from an encysting endamoeba, but the constriction and cutting loose of the sac was very gradual.

These phenomena, the reversal of internal appearances, the change in shape, and the extrusion of material from the central vacuole, have been observed only in the very fresh specimens which were kept at body temperature.

Binary division has been observed by keeping a cover glass preparation at body temperature for several days The cell divided equally until two and four were arranged in rectangular group, and then these disappeared. Stages of this division may be seen in fresh specimens from feces and intestine. Elongated forms, constricting forms and rectangular groups of two, four (see figs. 10, 11, 12 and 13) and sometimes eight cells are not uncommon.

These various phenomena have been observed chiefly in the stools of patients with diarrhoea or in specimens taken directly from the upper large intestine. In formed stools and in older specimens the small round type is all that is usually seen.

It has been interesting to observe the increase in size as well as in number from dysenteric patients, and particularly from the inflamed colon of pellagra. In formed stools from apparently normal intestines the number is small and the cells average about 8 or 9 microns in diameter. In dysenteric stools the number may be enormous and the size is larger, the cell diameter usually being around 15 microns, although many small forms may be present. In the inflamed cecum of pellagra the number is commonly large and the cells vary in size from 5 to 25 or more microns, many being very large. Especially is this true when they are present in ulcers. The exact meaning of this cannot, of course, be definitely stated until we know the properties of the organism. It appears that, while it does not propagate in the normal intestine and its contents to such an extent as to produce large numbers in feces, certain morbid processes of the large

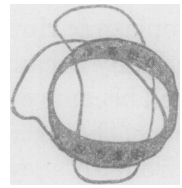
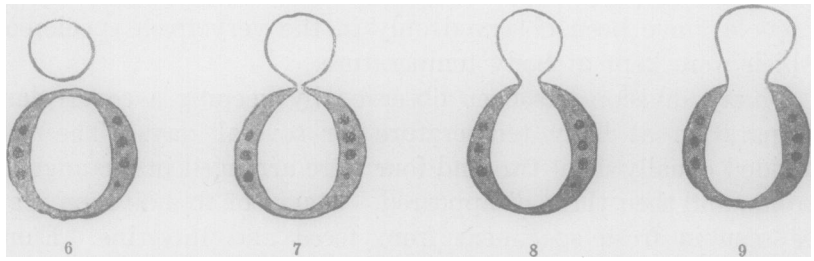
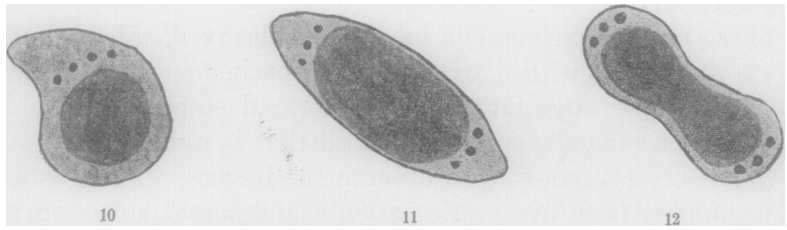


FIG. 5. CHANGE IN SHAPE OF BLASTOCYSTIS HOMINIS IN HUMAN FECES. FRESH SPECIMEN



FIGS. 6, 7, 8 AND 9. EXTRUSION OF MATERIAL FROM CENTRAL VACUOLE BY BLASTOCYSTIS HOMINIS IN HUMAN FECES



FIGS. 10, 11 AND 12. FRESH UNSTAINED SPECIMENS OF BLASTOCYSTIS HOMINIS FROM HUMAN FECES. ELONGATING FORMS

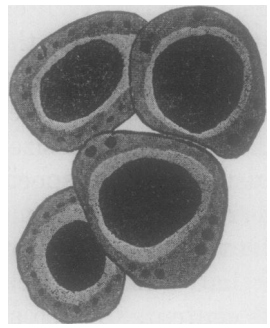


FIG. 13. GROUP OF BLASTOCYSTIS HOMINIS FROM CECUM IN CASE OF PELLAGRA AT AUTOPSY. HEIDENHAIN'S IRON-HAEMATOXYLIN AND EOSIN STAIN.

gut offer a better field, and it increases in number and also in size, while in case of diarrhoea large numbers and also many large vegetative forms may be thrown out. It appears that the pellagrous intestine is a splendid field for the growth of this cell, as it also appears to be for small yeasts, since they are usually abundant. The organism is not so common and is of smaller size in the feces of old pellagrins in whom the symptoms of the disease have disappeared.

It has also been interesting to note the differences in viability of the organism from different sources. In all specimens it has disappeared in the course of a few days, and in some exposure for a few hours leads to its elimination. It seems that in the formed stool, where the small rounded form is present, it lasts longest, while in the diarrhoeal stool or in the specimen from the inflamed cecum, where large cells showing the various active phenomena previously described are seen, it does not survive long. Apparently this small rounded type is the resistant stage of the organism, and the large active forms are vegetative non-resistant stages. While examples of binary division are commonly observed, I have not seen the process of budding described by Alexeieff.

As to the liability of the uninitiated to confuse *Blastocystis enterocola* with cysts of the endamoebae and trichomonas, I must agree with other writers, since at one time I looked upon it and described it as probably a cyst of *Trichomonas intestinalis*. However, there are distinct points of difference which if known cannot fail to clear up the difficulty. The typical pear shape, the nearly constant size (about 6 by 8 microns), the nucleus and the peculiar internal structures of the cyst of *Trichomonas intestinalis*, should make the recognition of this body not difficult. As between endamoeba and Blastocystis, the cysts of the former are also of fairly constant size, are round, have a thick capsule, the body being uniform and the nuclei, especially in stained specimens, characteristic; while the Blastocystis may vary from 5 to 20 or more microns in diameter in the same preparation, especially when diarrhoea is present or a purgative has been given, it may show rounded and elongated forms, and

may be single or in rectangular groups of two, four or eight. It also has a thin flimsy capsule, and a body composed of two parts, a cytoplasmic rim which may be transparent or of a pale hyaline greenish yellow, uniform in thickness in the rounded cells, but thin in the midline and thicker at the poles in the elongated cells, containing the highly refractive nuclear bodies commonly in groups in the broad portion at the poles, and a large central body which may be transparent or of pale hyaline greenish yellow.

In specimens stained with Leishman's modification of Wright's method the Blastocystis either has a bluish central body and pink cytoplasmic rim with reddish nuclear bodies or a pink central body and a bluish rim with red nuclear bodies, depending on the stage of the cell. It takes the Heidenhain iron-haematoxylin stain very well (see fig. 10), the rim staining pink, when counterstained with eosin, with black nuclear bodies and the central body appearing as a dark smoky or black body within a large clear vacuole. Apparently in the fixing process, this central body shrinks away from its wall leaving an empty space.

As to the exact nature of the cell, I feel that there is more to be learned. It is true that it bears strong resemblance to yeasts. I have, however, been unable to cultivate the organism in various media including those specially designed for the growth of yeasts, and, in so far as I have been able to learn, this has not been accomplished. Then too, the reversal of the appearance of the materials of the central body and cytoplasmic rim, and the extrusion of material from the central vacuole, are phenomena that I am unacquainted with in the yeasts; and for a yeast body it is singularly non-resistant, especially in the large active form.

As to the properties of *Blastocystis enterocola*, other than its morphology, we know nothing. Therefore, the full significance of its presence cannot be judged. I have seen it in the intestine of rats, and it has presented itself to me as a common intestinal parasite of man to which no attention has been paid in this country. Because of the liability of the observer to confuse it

with other encysted intestinal parasites, and since it has appeared to me to be possibly comparable to endamoeba, trichomonas, lamblia, etc., as an indicator of the contamination of the food or drink of an individual or a community with fecal matter of man or of certain lower animals, I consider it of sufficient importance to warrant a report of these observations.

As an intestinal parasite, of the importance of which we know little or nothing, it should receive our serious consideration.

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