

A RED MOULD. BY RALPH GILSON CURTISS.

The mould with which this paper has to deal was first found at Purdue University upon a plate culture which had been exposed to the air. It was at first supposed to be a mixture of a mould with a yeast, and this idea was a natural one in view of the behavior of the form when grown upon gelatine cultures. The characteristics exhibited during growth in this way seem to partake both of those ascribed to moulds and those which we are accustomed to associate with yeast forms. A mycelium is developed first, the early stages of which resemble in their growth those of the common moulds, but which soon disappear completely, its place being taken by a reddish film which covers the entire surface of the culture and which is thickly dotted with red specks. This dotted appearance is what gave rise to the supposition that a yeast was present in company with the mould, and it was only after a series of attenuated cultures had been made from the original plate that the true nature of the growth was ascertained.

It is evident that in a form whose growth shows such a remarkable and abrupt transition from the true mould stage to a yeast-like stage, we have a subject for research which should amply repay the most careful investigation. As soon as it was determined that both appearances were due to the growth of a single mould, cultures were made for the purpose of following its life history.

In fluid cultures the best results have been obtained with wort and Pasteur's solution. On wort kept at room temperature, a growth is apparent in twenty-four hours, and in forty-eight hours colonies are visible throughout the medium as well as covering the surface.

The peculiar red color is noticeable even in the thinnest portion of the growth, that on the surface showing as a pinkish film. This film, when broken by the platinum needle for purposes of examination, is found to possess a considerable toughness and is difficult to remove from the tube, except in large pieces.

A point which will receive more attention in later investigations is that when grown upon sugar solutions, all that portion of the growth which is exposed to the air turns black as it ages, while cultures made at the same time upon wort retain the characteristic red color.

The filaments of this mould vary considerably in size, according to age, the younger ones having the lesser diameter. They are divided at

frequent intervals by septa, especially in the older portions; the septa, however, seem in no way connected with the position of the branching hyphæ. The young filaments, which are usually filled with protoplasm that is transparent, sometimes contain a thread of protoplasm which is highly refractive and which shows no vacuoles. It is possible that it is this thread of refractive protoplasm which, in rounding off and becoming denser, produces the small spore-like bodies which are found in the mycelial cells.

The question of the reproductive methods of the red mould has been the chief source of difficulty in its study, and so far as the work has been carried these methods have not been fully determined.

As regards the formation of conidiophores this mould is markedly different from the commoner ones. In spite of the most favorable vegetative conditions having been given, both as to the kind of nutritive solution used in the moist chamber, and as to the temperature, no conidiophores have been discovered. A kind of division into cells, which is perhaps analogous to the formation of conidia in other moulds, takes place (Fig. 1), but observations as to the true significance of the division are not complete. The nearest approach to the formation of conidiophores is in the hypha shown in Fig. 2. Here a rounding takes place in the terminal cell and the hypha back of this rounding is divided by an extraordinary number of septa.

However inadequate the determination of vegetative reproduction, proofs of sexual reproduction have been more abundant. The red specks to which I have referred as being so thickly distributed over the surface of the gelatine cultures occur also in the tube cultures and in the moist chamber. When a culture is examined under the microscope, these specks are seen to be dense, irregularly shaped bodies of extremely varying sizes. (Fig. 3). Some are many times the size of others which have apparently reached the same stage of maturity. They are formed by the interlacing of the filaments and are found completely developed in so short a time that it has been impossible to secure the intermediate stages for photographing. As the interlacing of the filaments goes on, the massing becomes denser at some points than at others, and here these rough, compact, tuberous bodies are found. (Figs. 3, 4, and 5.) Unfortunately their thickness prevents their successful photographing (since it is impossible to focus with the microscope on more than one plane at a time). These bodies conform to a certain extent to the description of sclerotia but their function is evidently not that of a resting body formed under adverse conditions. On

the contrary they are formed almost immediately under the most favorable conditions and occur in all cultures. They rather resemble sporocarps in their function, but they do not contain asci, so far as has been determined.

When broken open soon after formation, these bodies are found to contain a large number of small yeast-like cells, which have a cell wall and are filled with protoplasm which is at first clear but soon shows a number (usually two) of denser, spore-like granules. The covering of the body is a rough yellowish wall.

If the yeast-like cells which these bodies contain were seen unaccompanied by any mycelial growth, it would be extremely difficult to distinguish them from the cells of a true yeast. This would appear to give considerable support to the theory that yeast and mould can be developed from the same growth interchangeably, but in reality it does not. Every attempt has been made to secure budding and fermentation from these cells but so far neither has been found. The growth of the cell is in every case by the sending out of a true mycelial filament.

What appears to be another method of producing a body similar to the one I have mentioned is shown in photographs 6 and 7. It may be that one of the filaments seen there fertilizes the other, though at any rate the resulting body is similar in color and appearance to the one formed by the interlacing of the filaments.

Three stages in a peculiar formation are shown in photographs 8, 9 and 10. The process consists in the coiling together in a peculiar manner of two hyphæ which may or may not arise from the same branch of the mycelium. Figures 8 and 9 show the coiling as it begins and figure 10 shows it in a more advanced stage. The body in figure 10 appears to have a definite structure, being formed by the coiling of two hyphæ—whose origin is visible—from the same mycelial branch.

In conclusion it may be stated that the investigations are by no means considered complete, but that it is to be hoped that additions can be made to our knowledge in the near future.

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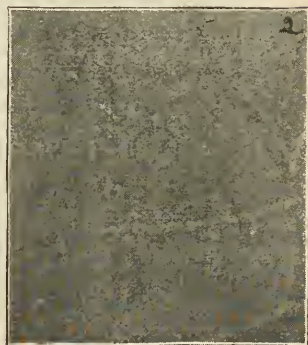
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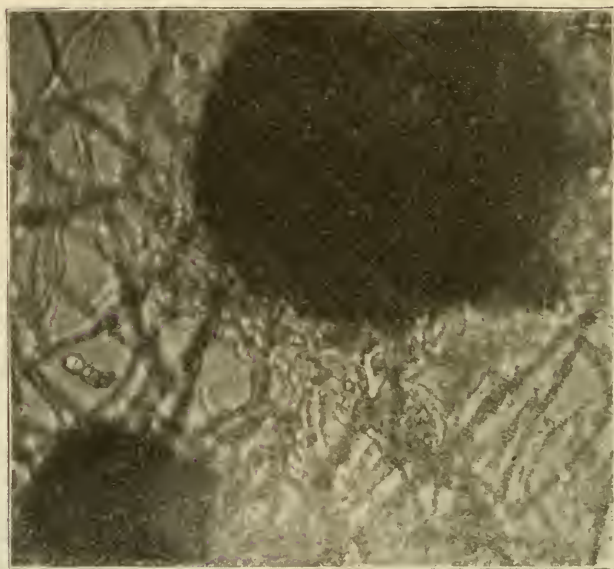
Bennett & Murray—"Cryptogamic Botany."

EXPLANATION OF PLATES.

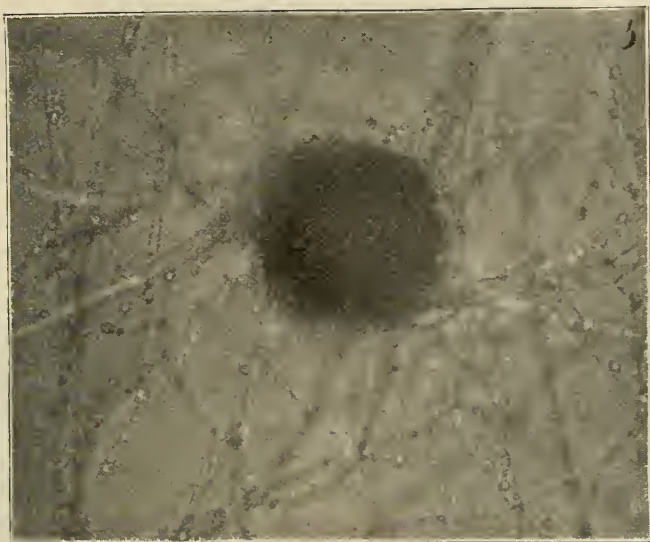
- No. 1. Culture on lactose five months old. $\times 495$.
- No. 2. Culture in moist chamber on wort three days. $\times 495$.
- No. 3. Culture on wort gelatine two days old. $\times 75$.
- No. 4. Culture in moist chamber on wort six days. $\times 495$.
- No. 5. Culture in moist chamber on wort six days. $\times 495$.
- No. 6. Culture in moist chamber on wort seven days. $\times 495$.
- No. 7. Culture in moist chamber on wort eight days. $\times 495$.
- No. 8. Culture in moist chamber on wort eight days. $\times 495$.
- No. 9. Culture in moist chamber on wort eight days. $\times 495$.
- No. 10. Culture in moist chamber on wort eight days. $\times 495$.



Curtiss on Red Mould.



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