CONCERNING THE REACTION OF CERTAIN FUNGI TO VARIOUS WAVE LENGTHS OF LIGHT.

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Since fungi lack chlorophyll, their needs with regard to light are quite different from those of green plants. While light is not needed for photosynthesis, yet it forms an element of the environment of the great majority of the Eumycetes. It has long been considered true that light, especially sunlight, is detrimental to the complete development of a fungus. Hence, one who hopes to avoid mildews and musty odors opens the house to the sun and air. On the other hand many fungi apparently will not complete the cycle of their development in complete darkness. Thus, many Coprophilous fungi remain sterile in darkness, producing their fruiting bodies only when exposed to direct sunlight. Many of this group of fungi exhibit positive phototropic responses. The sharpshooting of Pilobolus is especially famous. Apparently with most fungi vegetative development proceeds as rapidly in the dark as in the light. Many produce their sporangia or conidia regardless of the presence or absence of light. The higher Basidiomycetes, however, prefer illumination for sporophore production. Many of this group produce sporophores only upon light exposure, although such exposure needs to be brief in many cases.

An attempt to catalogue and analyze light effects is not an easy task. White light as it comes to us from the sun is a composite of many wave lengths. Furthermore, we now know that there are light waves and other vibrations of the ether which though not immediately evident to our physical senses nevertheless exert a most profound influence upon living processes.

The effect of light upon the growth of fungi in cultures was given as a problem to an advanced class in the "Physiology of the Fungi" at Purdue University. This class developed a technique, made preliminary observations, and achieved some interesting results. Their results are herewith summarized.

The problem had two phases: A. Growth of fungus in continuous light, continuous darkness, alternate light and darkness. B. Growth of cultures under continuous illumination through spectrally pure glass filters. Cambosco filters were used.

Observations were made concerning rate of growth, spore production, hyphal modifications, changes in color, zoning, etc.

This work demonstrated that fungi may be made to vary in spore production and vegetative development with changes in the quality and the intensity of the light source. These results have since been elaborated by Cooper and Porter[1] in a recent paper.

[1] Cooper, D. C. and C. L. Porter. Phytopathology. *18*:881-899. 1928.

Since these preliminary investigations have indicated that fungi vary considerably in their reactions to light, the authors have begun an elaborate series of investigations in an effort to classify and interpret these phenomena. The results which follow are in the nature of a report of progress.

Our present research involves but two phases of this very large and intricate problem. (a) The effect of various wave lengths of light confined to the visible spectrum. (b) The effect of the extremely short and non-visible radiations of the ultra violet.

The use of colored glass filters spectrally pure enabled us to investigate the reaction of fungi under different portions of the visible spectrum. Filters used were those sold by the Cambridge Botanical Supply Co., under the name of Cambosco spectro-radioscopic glass filters. In the experiment here recorded the following filters were used: No. I transmitting full spectrum except yellow. No. II transmitting primary blue. No. III transmitting only infra red. No. IV transmitting red and yellow only. No. V transmitting blue-green.

The filters were placed in the bottoms of light proof boxes, in which was suspended a tungsten filament electric globe of appropriate candle power.

The experiment was carried on in an especially constructed dark room in the basement of the greenhouse. Each set of exposed plates was separated from the others by screens of heavy dark building paper so that it was impossible for any cross lighting to take place. The plates were exposed with the lids of the petri plates in place. Removal of the lids caused rapid drying of the media and such practice was considered unnecessary.

It was found that the filters not only varied in the quality of the light they transmitted but also in the quantity. The amount of light transmitted by the several filters was carefully measured and equality in quantity of illumination was secured by varying the candlepowers of the lights and the distance of the lighting apparatus from the exposed plates.

It was realized that temperature as well as light affects fungous cultures. Temperature records of the various exposures were kept and in no case did the temperature vary to an appreciable degree.

The fungi used were: *Colletotrichum lindemuthianum, Cephalothecium roseum, Sclerotium rolfsii, Sclerotinia* sp.

It is evident from our experiments that in the wave lengths of light to which the four cultures were subjected little marked difference is to be noted in any of the points upon which particular observation was made. There is a tendency for the cultures to grow less rapidly in any of the lights than in darkness. This inhibition was especially marked when filter No. V was used. The most sensitive portion of a culture to light is apparently the aerial hyphae and differences, often quite marked, are to be noted. Such variations in development of aerial hyphae often change the entire macroscopic aspect of the colony. Only two of the fungi used, *C. lindemuthianum* and *C. roseum*, produce spores in culture. Of these, the latter was quite constant in sporulation no matter what the light, but the former shows a range of sensitivity in this particular

in varying wave lengths of light. Malformations of hyphal filaments were produced under certain filters. Such malformations are very interesting and will be the subject of further intensive study. They either indicate some physiological change within the fungus or a possible tendency to mutate.

The second portion of our research dealt with the effect of ultra violet radiations on fungus cultures. The same fungi used in the previous experiment were used here. Ultra violet radiations were secured from a Cooper Hewitt quartz mercury arc.

The half-plate method of exposure was used. The lid of the plate was removed and half of the fungus colony was covered with the black paper in which photographic plates are wrapped. The distance of exposure was 60 cm. Length of exposure varied from five seconds to 60 minutes. A certain number of cultures were exposed after a filter which permitted only wave lengths between 363-365 was inserted into the machine. The remaining cultures were exposed to the full range of the ultra violet radiations.

Two marked changes are produced by the ultra violet, viz., inhibition of growth and collapse and probably death of the aerial hyphae. Relatively short exposures will produce these effects, which are quite visible to the naked eye. In addition to these effects spore formation is inhibited sharply in *Cephalothecium* but on the other hand slightly accelerated in the case of *Colletotrichum*. Stevens[2] has recently demonstrated these same effects and in addition claims that ultra violet affects quite materially the production of sexual fruiting bodies in the fungus used. The fact that the filter prevented any of the visible effects noted in its absence would indicate that only wave lengths between 395 and 410 are harmful to fungus growth.

In order to discover whether the fungi exposed to ultra violet radiations had been killed or merely inhibited, transfers were taken from the exposed and unexposed portions immediately after radiation.

With the exception of *Sclerotinia* sp. cultures exposed to the radiations of ultra violet for as long as an hour are not killed, as their transfers grow in a normal fashion. Sclerotinia is not killed in a half an hour of radiation. This fact is quite remarkable as the collapsed condition of the aerial hyphae would indicate that this portion of the fungus had been killed. It is evidently clear from our work that the hyphae lying on the surface of the medium or imbedded in it are not so quickly or easily affected by the ultra violet radiations.

While we must regard this investigation as too fragmentary to draw any very definite conclusions, yet we feel quite sure that from our observations to date the following statements are justified: 1. Fungi are extremely sensitive to light changes. 2. The quality as well as the quantity of light affects the growth and development of fungi. 3. It is apparent that ultra violet wave lengths cause greater material changes than do those of the visible spectrum. 4. While the ultra violet affects the aspect of colonial development, yet the actual killing effect is not marked.

[2] Stevens, F. L. Science N. S. *68*:514-515. 1928.