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### Our rivals : The molds, yeasts and bacteria.

H. B. Knighton  
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"OUR RIVALS, THE MOLDS, YEASTS AND BACTERIA"

A THESIS  
SUBMITTED TO THE FACULTY  
of the  
COLLEGE OF ARTS AND SCIENCES  
of the  
UNIVERSITY OF LOUISVILLE  
IN CANDIDACY FOR THE DEGREE OF  
"MASTER OF SCIENCE"

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by

H. B. KNIGHTON

1910

H. B. Knighton

2093

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## Our Rivals:

### The Molds, Yeasts and Bacteria.

A plea for cleanliness and carefulness from an economic point of view.

In this day when the erstwhile plebian hog has taken to scaling the social ladder and has climbed beyond the ken of many an honest workman, it behooves the housewife to wage, with double zeal the warfare on our rivals, the molds, yeasts and bacteria who come as unbidden guests eating the very food that we must have, raising enormous families at our expense, frequently making themselves obnoxious as long as the food lasts, then quietly withdrawing into themselves and either waiting for a fresh supply of food or allowing the housewife to start them by the dust-brush route to a new lair.

Not all these rivals are enemies; to be sure, some are of inestimable value but all need control and localization; the hog aforementioned is valuable, too, but who wants him skirmishing for himself in the kitchen? And who wishes molds, yeasts and bacteria contending for the supremacy of the dish-cloth? Yet the dish-cloth of the ordinary house-keeper is one of the most fruitful breeding grounds.

The following data obtained from a square inch of dishcloth which had been wrung from the dish water and hung on the kitchen range in a quiet atmosphere for fifteen minutes, will show that the moisture, darkness and warmth provided an ideal lodging place for what are commonly called "germs."

It should be understood that the kitchen from which these experiments are developed is large, well-lighted, having a northern

and an eastern window, and a door opening into a well-lighted pantry besides a door leading directly into the yard; the walls are painted; the floor is an uncarpeted oak; there is little furniture; The house-keeper is the intelligent mother of a family.

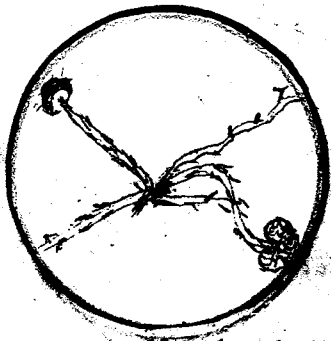
To obtain the data, the square inch of cloth was soaked a few moments in distilled water; the water added to a tube of melted and cooled nutrient gelatin, thoroughly shaken and poured into a Petrie dish; kept at room temperature. At the end of twenty four hours, ten to fifteen pin-point colonies could be discerned; at the end of forty eight hours, a cottony mass, which proved to be yeast, had partially covered the surface of the gelatin. Black mold grew up at the edge of the dish and hundreds of tiny rod-shaped forms announced the presence of bacteria. An aversion to inoculation rendered it impossible to determine whether or not these bacterial forms were pathogenic, but they probably were not as they developed at room temperature. Why then should any one devote a second thought to them?

Merely from an economic point of view. As long as the cloth is moist they are of little interest but as soon as it dries the first shake will set some of them free and these may fall on any starchy food and infect it, thus rendering it a direct loss; for many a house-wife fears to use anything that has molded, be it ever so slightly. When fermentation sets in food is almost universally thrown away; when putrefactive changes, due to bacterial growth take place, food is really unfit for use.

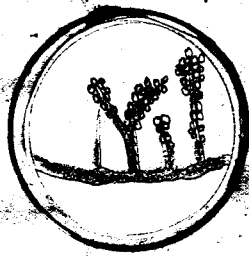
The illustrations show the cloth used and various fields from the culture.

For the housewife is thereby furnishing unwittingly, a most excellent medium for the growth of the spores of mold yeast and bacteria, always more or less numerous in the water, in the air, and on the very cloth used.

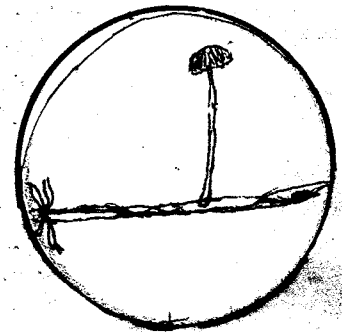
Hygienically and economically considered bread should be thoroughly baked, quickly cooled and kept dry.



Rhizopus Nigricans.

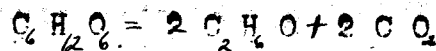


Stysanus.



Single strand, raised on a glass-slide.

In the yeast family we the least troublesome of our rivals, for man has learned to subject its necessity to his will and control to a great extent, and it is due to its growth in a suitable food and temperature environment that we have the chemical reaction



making possible our raised bread, our wine and our beer.

Sometimes the wild or uncontrolled yeast spore, carried by the air from its home on the ground or fruit may fall into unprotected syrup or jelly and cause fermentation, but little harm is done if the condition is noticed soon enough, for boiling will kill all spores and stop the reaction. The only household case that the writer has found recorded in which the yeast seems to have outwitted man's

But the dish-cloth is not the only habitat of our rivals. Let us take a peep into the bread-tin. It stands on the pantry shelf. The bread has been put in before it was thoroughly cool and has "sweated," thus forming an excellent culture medium for molds. Even before they are visible, a musty odor warns one of their presence. They are beautiful and intensely interesting in their different stages of growth but only the person equipped with a microscope and a fund of patience and interest can enjoy that phase and even then the bread-tin should not be expected to yield the specimens. And it is not only the immediate contents that are a loss for, unless the box is thoroughly washed, scalded and sunned until the musty odor is gone there is danger of the next batch of bread being lost also.

Another possibility of bread-loss is inadequate baking..... it must be thoroughly baked, for the interior of the loaf, owing to the large amount of moisture will not be raised above 212 F. and thus will lack sufficient heat to kill the spores of bacteria and mold that may be present and of yeast that we know are present. These yeast cells in the moist inner regions will not be broken down but will grow on the moist starchy medium and the bread will ferment.

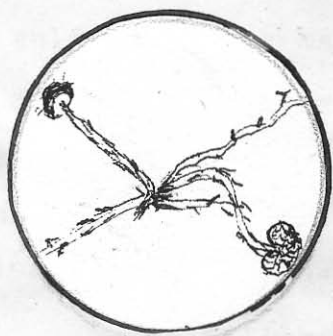
To prove that yeast cells are still alive in slack-baked bread, I baked a loaf in too quick an oven. Its smooth brown crust gave it a wholesome and appetizing appearance but the doughy interior spread upon a freshly sliced potato and covered with a tumbler gave rise two days later to several masses of yeast cells and to a weakly and sparsely fruiting black mold:

The almost universal custom of wrapping the warm bread in a damp cloth to soften the crust should be most earnestly discountenanced

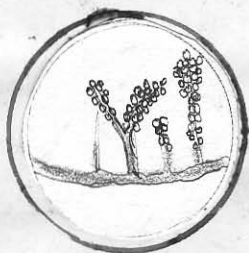


for the housewife is thereby furnishing unwittingly, a most excellent medium for the growth of the spores of mold yeast and bacteria, always more or less numerous in the water, in the air, and on the very cloth used.

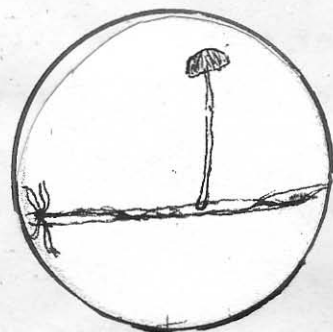
Hygienically and economically considered bread should be thoroughly baked, quickly cooled and kept dry.



Rhizopus Nigricans.

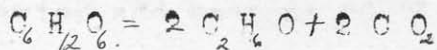


Styvensus.



Single strand, raised on a glass-slide.

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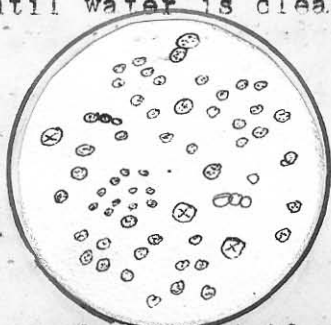
Sometimes the wild or uncontrolled yeast spore, carried by the air from its home on the ground or fruit may fall into unprotected syrup or jelly and cause fermentation, but little harm is done if the condition is noticed soon enough, for boiling will kill all spores and stop the reaction. The only household case that the writer has found recorded in which the yeast seems to have outwitted man's

ingenuity completely is where it gets into milk and butter and produces a bitter taste.

If the yeasts occasionally spoil our butter, the bacteria really make butter possible, since butter is made from soured cream and bacteria cause the souring. As several kinds of bacteria are capable of causing fermentation in cream, the flavor of the butter produced may vary. Conn succeeded in isolating the bacillus that gives the most agreeable flavor...the June flavor...and that bacillus is now sold to butter manufacturers, thereby insuring dependable results not only as to flavor but also as to freedom from other and perhaps questionable bacteria. The efficiency of the Conn Bacillus No. 41 was demonstrated in the laboratory and the feasibility of using it in the ordinary home proved.

The following formula gave a delicious butter:

- (a) Skim milk.....2% of the cream to be soured.
- (b) Pasturize skim milk at 150° F. for half hour.
- (c). Chill quickly.
- (d). Sprinkle with lactic acid bacillus; keep at 60° F. for 24 hours  
d = acid generator or starter.
- (e). Treat given amount of cream as in (b) and (c).
- (f). Add 2% of starter and keep at 60° F. for 24 hours.
- (g). Churn 20...30 minutes to produce butter.
- (h). Remove; wash until water is clear; salt; work; mold.



Field from lactone tablet.

Another bacillus of value to the house-keeper is the acetic acid bacillus. This bacillus occasionally causes trouble by souring wines and stewed fruit. But by its growth the sweet apple juice is converted from cider into vinegar. These bacteria, for there are several species of them, have the power of bringing together the oxygen of the air and the alcohol developed during the fermentation of the apple juice and thus producing vinegar. It is for the purpose of supplying a sufficiency of air that the bung-hole of the cider barrel is carefully left open when the farmer wishes his cider to become vinegar. The "mother" of vinegar is a mass of acetic acid bacilli.

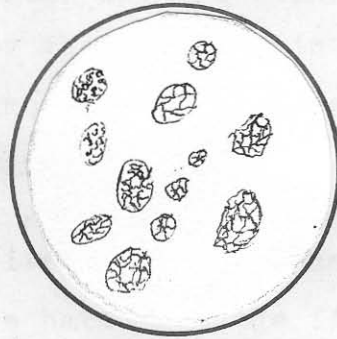
A recognized brand of acetic acid bacillus is on the market. The use of this bacillus was demonstrated in the laboratory experiment of kraut-making.

The crock, plate, cloth and weight to be used were sterilized. The cabbage shredded and a suspension of acetic acid bacilli in sterilized water prepared. A layer of cabbage was put into the crock, a layer of salt and a sprinkling of the suspension, this was repeated until the crock was almost filled. Then the cloth was laid over the cabbage, the loosely fitting plate slipped in and the weight placed upon it. The crock was then placed in the incubator. The salt and water of course form a solution, this solution on account of its great density extracts the water from any germ cell that may find an entrance and hence prevents the growth of such chance organisms during the time required by the acetic acid bacillus to grow. This scientifically made kraut is free from foreign bacteria which often injure the flavor and sometimes spoil the less carefully prepared article.

To return to the home experiments, under the shelf in the pantry is the vegetable basket. When the supply gets low the market man who knows from long experience where the basket is, just empti-



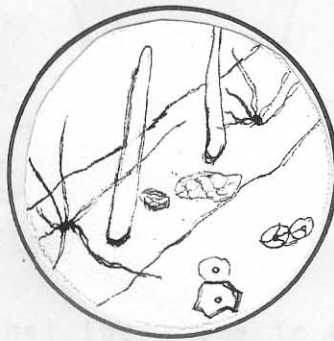
Field from  
Cider vinegar.



Field from  
wine vinegar.

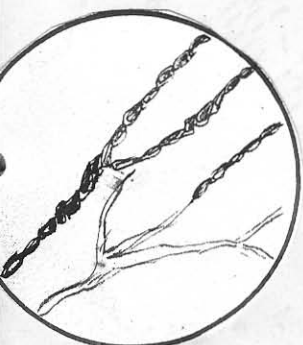


Wine vinegar.



Wine vinegar.

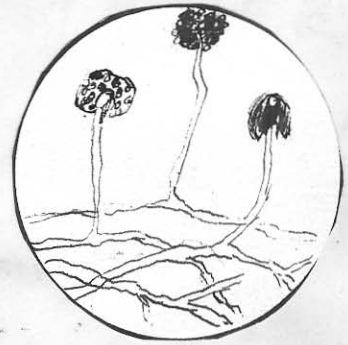
es fresh vegetables on top of the old ones, thus the older are left for a still longer exposure to the ravages of the ubiquitous molds, yeasts and bacteria who enter through any crack in the skin and settling in the moisture furnished by the juice begin to multiply in geometrical progression and continue this rate of growth as long as the food supply lasts. The apple in the dark corner yields a blue mold. The potato squeezed in beside it gives a white and a black mold. The apple and the potato are both shriveled and softened but so long as they are not shaken they do little harm but the first breath is going to send some of the spores into the air to settle where they may and some are sure to find a broken place in the skin of another vegetable and thus history repeats itself.



Blue



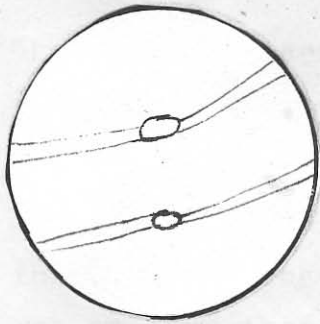
White



Black

Any animal or plant that increases in any such astounding rate as the above is proclaiming to the world that many of its members are to perish through untoward surroundings and many to lie dormant in uncongenial environment. And a refrigerator may be classed as uncongenial; yet the waste pipe furnished, when the sediment caught on a sterilized needle was planted and allowed to grow, eight mold colonies, four blue, one white, three black, and a liquifying bacterium of offensive odor.

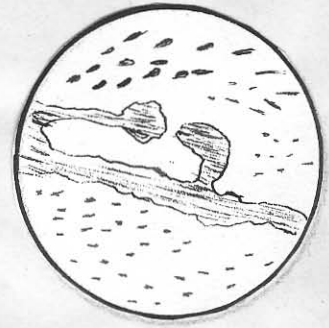
In one of these colonies was found a mold at the conjugating stage.



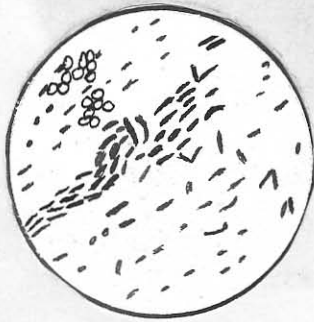
Brown Mold.



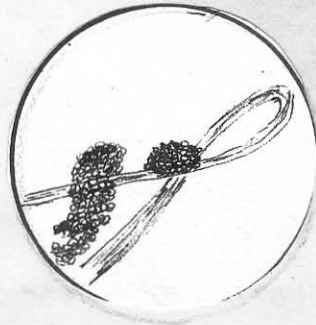
Blue Mold.



Conjugation of Mold.



Bacteria,  
offensive odor.



Mass of Spores  
on thread.

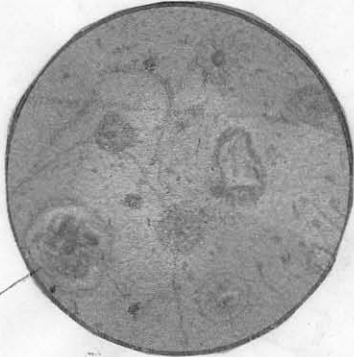


Styxanus.

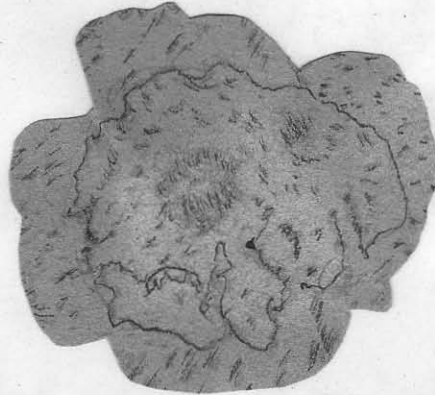
Among the uncongenial resting places we might put a spider web. But one from a ceiling corner, placed across a Petrie dish of nutrient gelatin showed to the naked eye at the close of 24 hours, 33 colonies: three in saucer shaped depressions; a yeast and a mold patch

The spider web strands, roughened by the clinging dust particles, form an excellent lodging place where spores may lie quiescent until noticed by the housewife and all too frequently swept by a careless stroke of the broom into more congenial quarters, it may be into the air passages of the sweeper, there to find the warmth, moisture and nutriment needed for their proliferation. In nine cases out of ten the body is in good condition and no harm is done by inhaling these spores but .....the tenth case is worth thinking about. These spores are not necessarily the product of ones own premises.

They may be disease germs coughed or sneezed into the air by a chance visitor, they may be freed from the coat of the dog when he shakes himself, they may be brought in by the draught that cools the kitchen for these almost weightless particles travel far. The heated air of the room, rising, carries the spores or "germs" upward and the elusive web catches them.



Spider-web Culture.

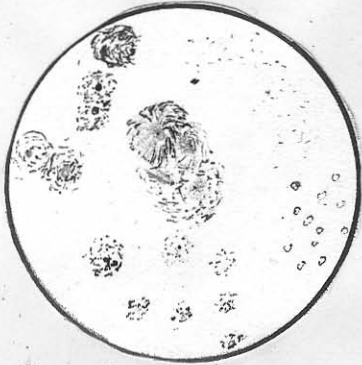


a much magnified.

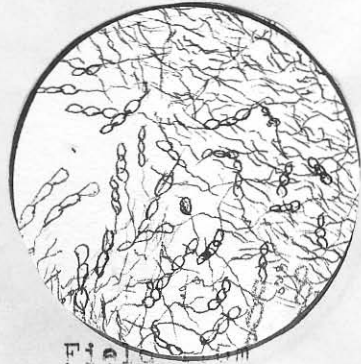
Probably one of the most prolific carriers of spores is the fly. His contaminating power is scarcely dreamed of by the laity. As an annoyance he is screened from the house but it is neither his tickling nor his buzzing that is his real offense. Look at the results of a few seconds imprisonment of a green fly in a Petrie dish of nutrient gelatin. After incubating for 24 hours at room temperature 220 small colonies were estimated, 1 very dark brown globular colony, 2 with blue green centers, 1 with a red bloody looking central streak, 9 with grey centers. The red-centered one was a liquifying organism. On examination the larger colonies proved to be molds. From a small bacterial colony two pure cultures were made. In order to discover whether this organism was pathogenic or not, one was left at room temperature, the other place in the incubator. The later did not grow while the former developed a fine new colony, showing that this bacterium at least was not dangerous.

The following fields are selected from this one culture:

Culture from fly track.



Petrie dish  
fly track.



Field  
fly track.



Fly track.



Yellow fluid.

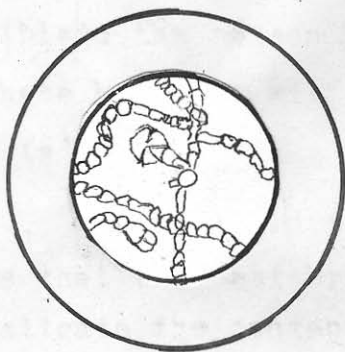


glazed white colony.



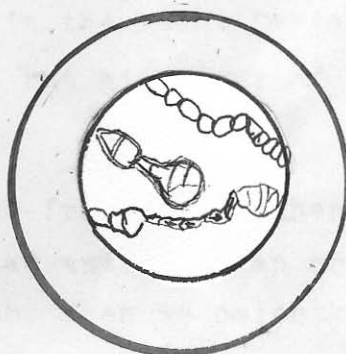
pale yellow colony.





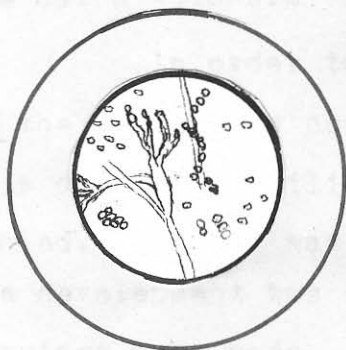
Field from red streak

Anteraria



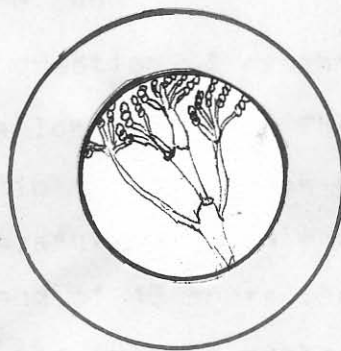
Field from red streak

Anteraria



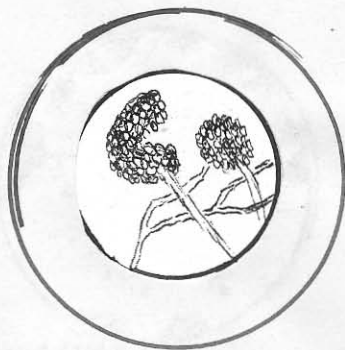
Field from tough white colony

Monilia



Tough white colony

Monilia



White colony

Aspergillus.

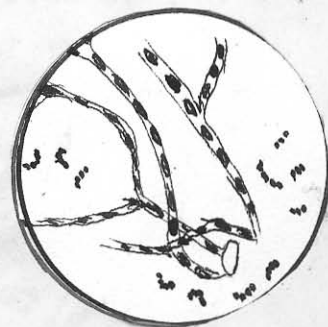
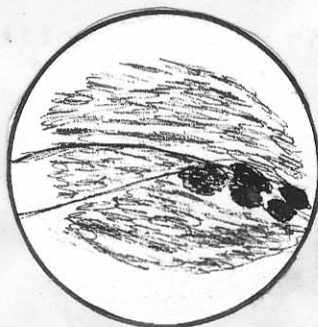


Foot of the green fly used

This is from one fly only. If it were food alone that is ruined by the fly it would be bad enough but look at the chances of inoculation possible to the person with an abrasion in the skin. Certainly very few of these bacteria will prove pathogenic but his power of contaminating food is untold.

Why should the cat be banished from the kitchen? Every one knows that the best bred cat will take advantage of an opportunity to investigate the contents of an open dish. When we catch kitty at this we are provoked, it is an impertinence in the cat, but is it anything more, is it dangerous? That the bite or scratch of a cat may develop seriously is well known but how many have given a thought as to what the cat's whiskers may be leaving in the food?

In order to answer the first question, I caught our cat while in the pantry and cut off a short and a long whisker. These I placed in a dish of sterilized, nutrient gelatin that had been melted and cooled. The dish was kept at room temperature. At the end of 24 hours the development was slight but at the end of 48 hours the following drawings were made. As will be noticed the greater number of colonies are molds, again emphasizing the prevalence of the various species of molds and showing another means of transference.



a..liquifying

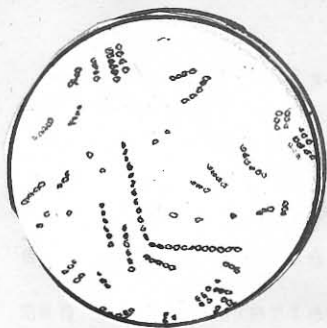
Mold

Orange

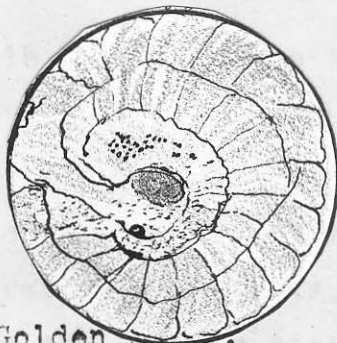
b..green

c..white

d..orange



White



Golden

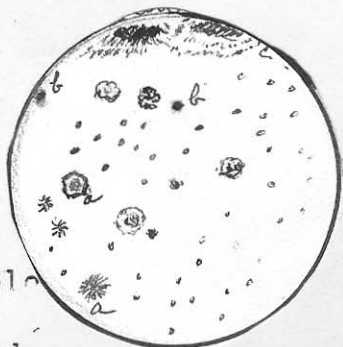


Green.



White

Having found the spores of our three rivals in such diverse positions and conditions we should naturally suspect that the dust settling on the floor would be a fertile field for investigation. In pursuance of this idea, I swept and immediately exposed a Petrie dish of gelatin for ten minutes. The result was not as astounding as I had expected it to be. The growths were not so varied, consisting almost entirely of molds. As stated in the beginning of this paper the floor is of oak and possibly the kind of wood in connection with the relatively large amount of light and the circulation of air prevented any great accumulation of these plants of the air.



a..lemon color  
b..orange  
c..black mold

Petrie dish



Monilia

In this struggle for existence that we are all waging, from the largest to the most minute, it will be noticed that the most universal of our rivals are also the least dangerous and become our enemies only when we lack control of them. Many have been captured by man and converted into valuable servants, many more are yet to be captured, but the wage is and will be eternal vigilance.

Plant

Cryptogam

Thallophyta

Fungi

Zygomycota

Phycomycetes

Mucorini

Stygnanus.

Stelionifer

Mucedo

Carpophyta

Ascomycetes

Tubiferaeae

Penicillium (Blue-mold).

Protozoa

Schizomycetes

Bacterials

Saccharomycetes

Common yeasts.

Myxob

Found on piled vegetables makes a slimy matrix.

3 forms

Bacillus

Coccus

Spirillum

Micrococcus

Staphylococcus

Streptococcus

Cryptogram (Hidden Marriage) disseminated by spores.

Thallophyte: plants having no differentiation into roots, stem, leaf.

Fungi: plant made up alway of threads; never of tissue and the threads have no green coloring matter; they have no seeds but are propagated by spores.

A spore is not differentiated into parts as is a seed. It is a little part of the plant cut off. It may be carried by the wind and under favorable circumstances will germinate.

Fungi are divided into families according to the structure and method of producing spores.

Phycomycetes: (Algal-like fungi) Threads not woven together; spores borne in sporangia.

Ascomycetes: (Sac-fungi) Spores borne in sacs.

Schizomycetes: (Splitting-fungi) Spores are simple cells with thickened wall.