Making Money Out of Moulds

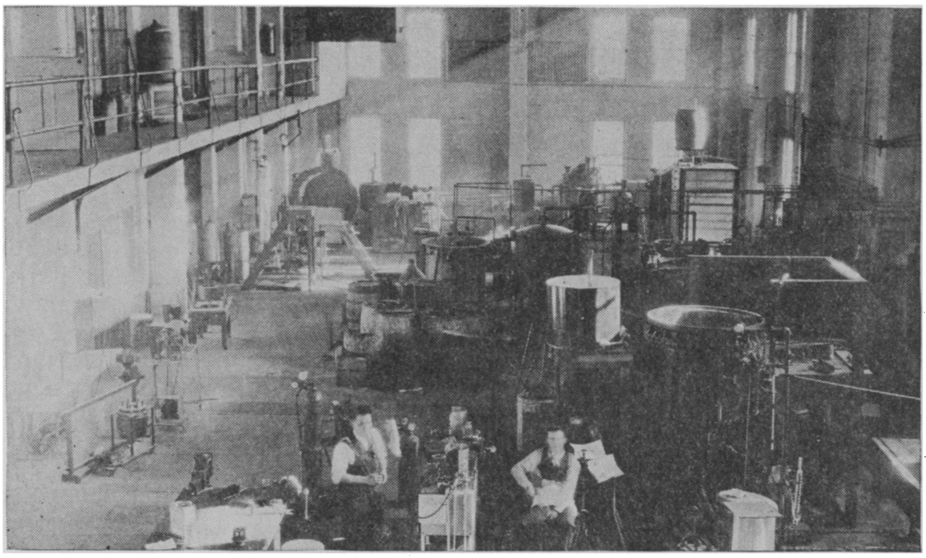
Botany

By Frank Thone

"Mould's doing very nicely this time, Dr. Herrick," says the serious, lean-faced young man. "Good thick growth; we'll get a very decent yield out of it."

"Fine, Dr. May, fine!" smiles his chief, peeping over the rims of a rack of wide, flat trays. "Don't think you've ever had better mould than this."

This colloquy is not between a pair of lunatics taking a mischievous delight in setting things out to spoil. It might take place any day in the cluttered interior of a business-like, chemical-factory-looking sort of building on the U. S. Department of Agriculture experimental farm at Arlington, Va., just across the Potomac from Washington. The speakers are Dr. Orville E. May and Dr. Horace T. Herrick, chemists of the Color and Farm Waste Laboratory, who have found out a new way by which money can be made from moulds, and are passing their secrets along for the benefit of industrial chemists and the public generally.



THE INTERIOR of the Color and Farm Wastes Laboratory of the U. S. Department of Agriculture at Arlington, Va.

Moulds have for ages been the sign of decay, of spoilage, of uselessness. When a piece of bread, a jar of preserves, an apple or orange, a neglected old shoe or glove has shown the telltale cottony white threads, variegated with patches of dusty black or blue-green, it has meant only that the mouldy object was ready for the garbage-can or trash-heap. Money in moulds? Only for the merchant who sells new things to replace the mouldy ones!

Yet here are a pair of serious, well-trained chemists getting their government pay-checks every month, who are day by day feeding good glucose by the hundredweight to one of these same pesky organisms, coddling and fostering its growth, giving it special apparatus for its accommodation, tenderly studying its wants as to temperature, water supply, mineral nutrients and so on—making a pet of a mould. And at the end milking that same pest turned into a pet for a valuable chemical. They feed their mould glucose that is worth, perhaps, five cents a pound wholesale. The chemical they get—gluconic acid—is worth 35 cents a pound, and before they started their work and showed how to get it out of mouldy glucose-water, it cost $100 a pound! That is what you can do if you treat moulds right.

But of course you must first have the right mould to treat right. That is the key to the whole business. It was not just a matter of going out and stopping the first mould they came to and asking it to make glucose acid out of five-cent glucose, and to do it at a reduction unheard of even at bargain-counter sales—$100 marked down to 35 cents. So far as now known, there are only two strains of moulds in the whole world that can do that. One is t e mould our American chemists are using, the other is being experimented with in Germany.

The history of the search for the mould that knows how to make glucose acid is condensed into its jaw-breaking botanical name—cryptically, but to the initiated no less intelligibly. The acid-maker is called *Penicilium luteum purpurogenum* var. *rubrisclerotium* Thom, No. 2670. That means, first, that it belongs to the genus *Penicilium.* Now the Latin word *penicilium* is the same as the English word "pencil"; only it means a brush—artists and sign-painters call their smaller brushes pencils sometimes. The Romans, you see, used sharpened reeds or small brushes when they wrote on parchment or papyrus, just as the Chinaman does now when he writes a washee-checkee.

But even so, why should a mould be called a brush? The nearest it comes to looking like a brush is its occasional resemblance to a wad of cotton. But put under a microscope a tiny pinch of this *Penicilium* that has begun to look a bit greenish and take a look at it. You will see hundreds of little things that look like somewhat frayed-out brushes, with tiny glistening beads strung on the bristles in long chains. These are the spores, which serve these microscopic plants as seeds serve the larger plants of our more familiar world.

Luteum is quickly explained. The word means "yellow", and this particular mould frequently assumes a yellowish cast of color.

The *purpurogenum* part of the name means "purple-maker". You may have noticed, sometimes, that mouldy growths often have a little ooze of purple fluid around them, even though the material they are making mouldy is colorless itself. This particular one of the many species of *Penicilium* has the power to make a purple dye, and that is why it got that name. Dr. Herrick says that some day the Color Laboratory may look into the matter of that purple dye, after they have got the acid-making possibilities of the mould well in hand. So some day Dad's birthday necktie or Sister's Easter hat may be bright with a Tyrian tint made from what was once a mere fruit-spoiler.

The next piece of the name, "var. *rubrisclerotium* Thom", means that one particular variety of this yellowish purple-making mould sometimes forms hard little lumps that are colored red, and that the man who first noticed this was Dr. Charles Thom, of the U. S. Department of Agriculture. Finally, the number 2670 means that Dr. Herrick (*Turn to next page*)

Money from Moulds—*Continued*

and Dr. May chose for their acid-making experiment a sample out of culture-bottle number 2670 of Dr. Thom's stock of his pet particular variety of this species. All this history is boiled down into that one tongue-twisting name.

Having finally got the name and address of the one acid-making mould that would do the job they wanted done, the two Arlington chemists then solicitously inquired what working conditions would suit it best. First, what temperature did it want? They put flasks of glucose solution with mould growing on it into incubators at various temperatures from 68 to 95 degrees Fahrenheit. The mould grew fastest and produced most acid at about 75 degrees. At the lower temperatures it did not grow very well; at the highest is looked weak and anaemic, and at last sank in the solution of its own weight and so drowned.

Then they asked the mould how much glucose it wanted to work on. They put in various flasks solutions of from ten to forty per cent., going up by five per cent. jumps. Here again the fungus chose the middle ground, growing best and giving the highest acid yield on the 25 per cent. solution. Finally, they tested out the half-dozen mineral elements every living plant has to have, and found out what concentrations of these would make the moulds do the best work.

In these researches a double object had to be kept in mind. For first you have to get your mould, and then you have to put it to work. When a mould is "planted" in a solution of glucose, you don't see any difference at all at first. A bit of the mould threads, so tiny as to be simply lost on the surface of fluid, is all that it starts with. From this the growth is so rapid that in a few days the whole surface of the solution is covered with a continuous sheet of mould, and only after it has reached its most vigorous growth does the production of acid go on at highest speed. Since the mould has to use up some of the glucose in building its own body and therefore can not use it in making acid, Dr. May tried using well-grown growths of it several times, draining off the acid-charged solution and then flowing in fresh sterile glucose-water underneath the mould sheet. The fungus would float up again and immediately begin making acid as fast as ever. The same sheet of mould can be used over again several times in this way.

Having got the moulds to answer all these questions under laboratory conditions, with their cultures living cloistered lives in large, bacteriologically pure glass flasks, Dr. Herrick and Dr. May proceeded to get the process on a more practical basis. You would think the Color Laboratory is a small chemical factory, anyway, if you should stop at Arlington for a look at it; the place is full of vats and pressure kettles and iron machinery generally, instead of the small, shining glass tubes and bottles we usually imagine in a chemist's laboratory. The workers there are not content merely to find the theoretical answer to a chemical problem. They get that first, and then tackle the first steps of magnifying their test-tube results by ten thousand, and getting them on a factory scale. This always presents difficulties, as any chemist can tell you.

It would not, in the present instance, be commercially profitable to raise moulds for acid in glass flasks. Too much costly human labor would be involved in filling and emptying them. The logical thing to do is to pour your glucose solution into wide, shallow pans and let your moulds spread themselves on the surface. Build racks so that the pans can be set one above the other, and enclose the racks in sheet-metal boxes to keep out as much dirt and contamination as possible. Arrange pipes to drain off the acid solution, and other pipes to run in fresh glucose-water. In short, set up a small factory unit.

So it was done. And here the experimenters hit their problems. Wide metal trays are cheap and easy to get. But gluconic acid attacks and corrodes all common metals, ruining both the pans and itself. A manufacturer of enamel ware undertook to build an acid-proof pan, and succeeded. But it cost as much as a bathtub, so that would not do. Also, it was found that in order to prevent the solution from sloshing and slopping around in the wide pans they had to be criss-crossed with low partitions. So a built-up pan was necessary. Dr. May tried first to build one out of sheet bakelite. He made a good pan, but again it was too expensive and also too heavy. The problem was solved when it was found that one of the new brushing lacquers made of cellulose, similar to the stuff used on automobile bodies, was highly resistant to the action of the acid. So it was possible to use economically made metal trays painted with this acid-proof lacquer.

Other problems rose, and in their turn were faced and solved as the question of the trays had been. One of them was left largely to the mould itself. That was the matter of weeds. For there are weeds among moulds as there are among larger crops—useless fungi that make no acid, whose spores fall into the culture pans and grow like tares among the wheat. These weed-moulds eventually betray their presence by off-color patches—usually black—amid the cottony cream white of the useful fungus. Under normal conditions the acid-making mould grows so fast as to smother out most of this weed growth, as a healthy crop of wheat will keep down most of the wild vegetation that tries to invade it. But if the weed moulds get the better of the culture, then there is nothing to do but throw it out, clean and sterilize the pan, and start all over again. It is to this end that the rack of pans is kept enclosed, to keep out the drifting wild spores.

But having got their acid, the chemists were confronted with a further problem. Hitherto, gluconic acid has been offered at so high a price, when it has been on the market at all, that nobody has troubled to rind any uses for it. So now that they have shown how it can be produced at a reasonable figure, they are turning to the question of finding uses for it. One dyestuff firm, Dr. Herrick says, states that they can use considerable quantities of it if a steady supply can be assured, but they make more or less of a trade secret of what this use is. The chemists at Arlington, however, have found another possible use which is not kept secret. Calcium, one of the two most important ingredients of our bones, naturally figures rather largely in medicine. Only, the compounds in which it is now on the market make it exceedingly nasty to take. Combined with gluconic acid, however, it can be put up as a pure white powder without any taste whatever. There is work in the drug business for a good many mould "farms", pending the discovery of other occupations for the fungus.

Gluconic acid manufacturing is the second modern business which moulds have invaded in this country. The first mould-acid venture is already a commercial success, at least one factory in New York being now on the tons-per-day basis with it. This factory makes citric acid, which is the acid of lemons and other citrus fruits, and competes with the original citric acid business of (*Turn to next page*)

Money from Moulds—*Continued*

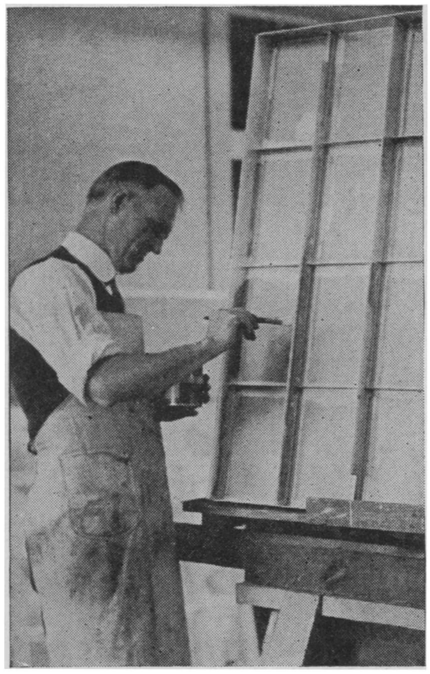
California, which extracts the product from fruits rejected as unfit for packing in the orchard regions. Paradoxically enough, the mould that makes citric acid belongs to the same group as the "green mould" that spoils many lemons in shipment and storage. Citric acid is widely used in industry and medicine. It forms the basis of lemon extract used in flavoring. And no big-league baseball game can be successfully run without it, for citric acid is indispensable in the manufacture of pop.

But the manufacture of gluconic and citric acids with the aid of fungi is only a modern manifestation of a very ancient craft, which, like many another handiwork of men that dates back to times older than history, has been carried on in total unconsciousness of the scientific secret underlying the process. Man has been a fungus-user from time immemorial, in many of his most widely practiced arts, but especially in those that have to do with the preparation of food. For, oddly enough, though he usually refuses to eat anything that is visibly mouldy, he has a perverse preference for some things that are the results of mould action on raw materials that are really good food materials when they are fresh.

There is cheese, for instance. Cheese is nothing but milk curds that have been allowed to stand and get all mouldy. The older and mouldier the cheese the better it is. Watch a seasoned gourmet selecting some choice Parmesan some time. He picks the cheese with green whiskers every shot!

If, during the recent celebrations at the coronation of the Emperor of Japan, you had suggested to a loyal subject of that monarch that he was drinking health and long life to his sovereign in mouldy rice-water, you would probably have found yourself involved immediately in something resembling a war. But *sake*, that potent rice wine that is Japan's national drink, is produced from an infusion of rice by the action of a mould. Similarly, *sho-you* sauce, which you find in hair-tonic bottles in the chop-suey restaurants, is prepared from soy beans by fermentation with moulds. The same sauce, plus a lot of pepper and some other cryptic ingredients, becomes Worcestershire sauce.

Not only moulds but their relatives, the bacteria and yeasts, are old-time though until recently unknown allies of man in his food-preparing. Mankind has been making the two big



RETOUCHING one of the wide metal culture trays with acid-proof lacquer

B's, Bread and Beer, a great deal longer than he has been making written history; both are yeast products. Noah's disastrous adventure with some wild yeasts is well known; and the elaborate "purging of the old leaven" practised by the Jews at Pesach is simply a precaution needed to keep the household culture of yeast pure and uncontaminated, backed by the force of religious authority.

Bacteria are not so closely related to the moulds as are the yeasts, but they are still regarded as members of the fungal cousinship. Bacteria have to act on cream before it can be made into butter, and bacteria-treated milk, under a variety of trade names, is now a widely used health food. Some cheeses are made by the action of bacteria on milk solids. Sauerkraut, another ancient food now coming to be regarded as "good for you", is simply shredded cabbage that has undergone bacterial fermentation.

The industries depending on moulds, yeasts, bacteria and other forms of minute plant and animal life are now just on the threshold of passing from the old rule-of-thumb, empirical methods of the ages to the new, exactly controlled, scientific methods of the future. Making citric and gluconic acids with the help of moulds, controlling the fungus flora of food factories and dairies, manipulating the growth of yeast in bakeries, are only pioneering steps. The time is coming when these microscopic fungi will be grown not for their by-product but for themselves, when yeast by the ton will be cattle food or perhaps even human food, and when the cellulosic bodies of now despised moulds will perhaps be moulded into "art ivory", or dissolved and spun into rayon, or made into glistening lacquers for motor cars. The possibilities of micro-agriculture are only beginning to be opened up.

Science News-Letter, March 9, 1929

In the 15 years between 1851 and 1866, the floods which altered the course of the Yellow River of China took the lives of more than 30,000,000 people through drowning or malnutrition.

New Ideas on Personality

Psychiatry

The keynote of the present tendency in psychiatry and psychology is the appearance of the idea that personality is not just the physical constitution and psychological and mental traits, but the integration of all of them, declared Dr. Karl A. Menninger, director of the Menninger Clinic of Topeka, Kans., at the opening session of the American Orthopsychiatric Association's sixth annual meeting in New York.

Psychiatrists must break out of the vicious circle, known to medical men, into which they are now falling, advised Dr. James S. Plant of the Essex County Juvenile Clinic of Newark, N. J. He said that psychiatrists and social workers, seeking a cause for the child's behavior problems, were going back in a procession to an earlier and earlier period in the child's life, to the prenatal period, to the parents and finally to the parents' childhood. Thre was no telling where this might lead to, he said. The surgeon, confronted by the vicious circle in medicine, does not seek the original cause but tries to cut out the immediate cause of trouble. Psychiatrists should try more to relieve actual conditions without looking too far for their ultimate cause, he advised.

Science News-Letter, March 9, 1929

California leads this country in power farming, Wisconsin running a close second.