of absorption is obtained and the cancer is produced sooner and with a smaller total dose. With pellets a total of five to ten milligrams is sufficient, whereas with injections in oil a total of 30 to 40 milligrams is used.

In a parallel group of experiments, an attempt has been made to induce mammary carcinoma of the rat with other estrogenic substances. The compounds used have been estradiol, estradiol dipropionate and diethylstilboestrol. The experiments are still incomplete but cancer has been obtained in one rat injected with 200 gamma of diethyl-stilboestrol daily for 100 days. This cancer induced with diethyl-stilboestrol is significant because the substance has the physiological action of estrone but is not a sterol. This suggests that the mammary cancers induced in the rats by the injection of estrogenic substances are due to the physiological changes produced rather than to the cancerogenic nature of the chemicals used.

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FUMARIC ACID FORMATION ASSOCIATED WITH SEXUALITY IN A STRAIN OF RHIZOPUS NIGRICANS

A DEFINITE relation has been known for some time to exist between the sexuality of fungi belonging to the *Mucorales* and certain biochemical reactions exhibited by them. Thus Satina and Blakeslee[1] demonstrated a high degree of correlation of the sexual nature of these fungi with such properties as reducing power of cell extracts toward $KMnO_4$ and tellurium salts, Manoilov's reaction, catalase content, etc. On the other hand, these authors could not establish any differentiation based on the carbohydrase systems of the various races. The differences in reactions obtained for the male and female races were in almost all cases quantitative rather than qualitative.

The present note concerns one strain of *Rhizopus nigricans* whose male and female races are distinct by virtue of the *possession or the complete lack of a certain specific physiological mechanism,* namely, the enzyme system by which the organism produces fumaric acid when grown on a glucose-mineral solution (Table I). So far as the authors are aware no similar case has yet been reported. The male race (−) was tested under a variety of experimental conditions and never was found to form fumaric acid, whereas the female race (+) produced this acid abundantly. Further, despite the fact that a large part of the glucose consumed was transformed by the plus race into fumaric acid, this organism was able to utilize the energy much more efficiently and synthesize much more cell substance than its male homologue, as measured by nitrogen consumption.

The ability to form fumaric acid is but one of the many specific reactions of which this group of fungi

TABLE I

FUMARIC ACID PRODUCTION BY MALE (−) AND FEMALE (+) RACES OF A STRAIN OF RHIZOPUS NIGRICANS*

	Female race (+)	Male race (−)
Glucose consumed, gm.	6.472	6.662
Fumaric acid produced, gm.	2.059	0
Conversion, per cent.	31.8	0
NH_3–N consumed in culture, mgm.	80.7	40.6
Calcium in solution due to organic acids, mgm.	722.1	49.6
Fumaric acid equivalent, calculated from Ca^{++}, gm.	2.094	.....
Per cent. of total acid as fumaric	98.3	.....

* Medium used: 200 cc portions of 5 per cent. glucose-mineral solution containing 82.0 mgm NH_3–N; incubation, 15 days at 28° C.

is capable, and it is not impossible that sexual differences within this group may eventually be correlated with other as yet unstudied physiological processes. It must not be inferred, however, that the above results are characteristic of all or even a significant number of sexual pairs of *Rhizopus;* another pair tested simultaneously yielded no such dissimilarity and even members of the same race differed in this respect. This would seem to indicate that fumaric acid formation is not at all a property specific to a race but may rather be attributed to some biological characteristic giving rise to strain specificity.

A detailed study of the process of fumaric acid production and its possible function in the mechanism of energy utilization by different species of *Rhizopus* will be published shortly.[2]

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GAS BUBBLES AS NUCLEI FOR "OOLITES"[1]

SPHERICAL bodies of calcium carbonate, with some of the characteristics of oolites, are now forming in a swimming pool supplied with water from one of the Pinkerton Hot Springs in southwestern Colorado. Five large springs and several smaller ones occur within an area of about a quarter of a square mile on the west side of the Animas River, about 12½ miles north of Durango. They appear to issue from fissures in the Ouray limestone, but the points of emergence are obscured by cones of travertine that have been deposited by the spring waters. The year-round tem-

[1] S. Satina and A. F. Blakeslee, *Proc. Nat. Acad. Sci.*, 12: 191–96, 197–202, 1926; 13: 115–22, 1927; 14: 308–16, 1928.

[2] The authors are indebted to Dr. A. F. Blakeslee for supplying cultures used in these investigations.

[1] Published by permission of the Director, Geological Survey, United States Department of the Interior.

perature of about 87° F.[2] and the uniformity of flow regardless of seasonal variations in precipitation indicate that the water rises from considerable depth.

The spring waters contain large amounts of calcium bicarbonate and salt (sodium chloride) and considerable quantities of other constitutents. The figures in Table 1 are an average of two very similar analyses of waters from two of the springs.

TABLE 1

COMPOSITION OF WATER FROM PINKERTON HOT SPRINGS*

Constituent	Milligrams per liter (Approximately parts per million)
Silica (SiO_2)	37
Ferric oxide + alumina ($Fe_2O_3 + Al_2O_3$)	Tr. – 14.1
Calcium (Ca)	513
Magnesium (Mg)	37
Sodium (Na)	665
Potassium (K)	100
Bicarbonate radicle (HCO_3)	1,255
Sulphate radicle (SO_4)	636
Chloride radicle (Cl)	945
Total dissolved solids	3,805
Excess carbon dioxide (CO_2)	453

* H. A. Curtis, in R. D. George, *op. cit.*, pp. 291–292.

The water from one of the springs is led through an iron pipe into a large concrete-lined swimming pool. Calcareous tufa, stained yellowish brown with iron oxide, is deposited rapidly and by the end of the summer tourist season, which lasts from June through September, the walls and floor of the pool are coated with 6 inches or more of the material. The pool is scraped clean once a year.

"Oolites" were found forming along the sloping floor of the pool in the early summer of 1935. They were most abundant where the water was less than 6 inches deep. They ranged from a fraction of a millimeter to about 2 millimeters in diameter and consists of film or skins of calcium carbonate that enclosed bubbles of gas, almost certainly carbon dioxide. The precipitate was very thin or absent on the tops of the mineral "balloons," but thick below. Many of the growths assumed the shape of tiny wine glasses, with slender stems 2 to 3 millimeters in height supporting the gas bubbles which were wholly or partly enclosed by calcareous material. The balloon-like bodies that were not attached to stems were easily detached from the floor of the pool, when they rose to the surface and almost invariably burst. The slight but almost constant agitation of the shallow water thus tended to prevent the formation of thick-walled or solid oolites.

Late in the summer, after the pool was drained, it was found that the "oolites" also formed in running water. At that time the spring water was allowed to run across the floor of the pool to a lower outlet. "Oolites" formed about gas bubbles in shallow pools and eddies along the sides of the stream, where agitation was at a minimum. The constant movement caused most of the structures to break soon after formation, however.

The gas bubbles were undoubtedly formed because of cooling and slight evaporation of the water which reduced the solubility of the carbon dioxide gas in the water. The bursting of the shells when they reached the surface may have been due to the sudden agitation, to the slight change in pressure, or to rapid partial drying on exposure to the air. No explanation is offered as to the mechanism that caused the formation of pedestals or the fact that most of the shells were thinner on top than on the bottom.

The occurrence has some bearing on the origin of oolites. Calcareous oolites are reported to form about gas bubble nuclei off the Florida coast.[3] The thin spherical coatings of calcium carbonate at Pinkerton also form about gas bubbles. It seems possible that under certain conditions these coatings could persist long enough to develop thick walls and thus become true oolites. The occurrence shows conclusively that some spherical bodies form without mechanical agitation, a conclusion at variance with that reached by some of the geologists who have studied oolites. At Pinkerton the "oolites" form both in quiet and in slowly moving water.

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THE RELATION OF MAXIMUM CRUSHING STRENGTH OF WOOD TO THE DEGREE OF SWELLING INDUCED BY VARIOUS CHEMICALS[1]

THE object of these experiments was to determine the effect of a number of chemicals upon the strength of wood and the relationship of the latter with the swelling caused by the chemicals. Sets of small blocks of Norway pine sapwood (*Pinus resinosa*) were oven dried, measured and placed in various organic liquids, mostly alcohols. Other sets of blocks were not oven dried, but the moisture content was raised above the fiber saturation point; the blocks were measured and then injected with various aqueous solutions. After the proper time the following results were obtained:

An inverse correlation of crushing strength with swelling was found for wood which was saturated by various organic liquids. The organic liquids did not weaken the wood to the same extent that water did for any given amount of swelling from the oven-dry condition. The intensity of swelling declined as the alcohol molecules became more nearly hydrocarbon in

[1] The experimental work was done at the Division of Forestry, University of Minnesota. The project was completed at the Division of Forestry, West Virginia University.

[2] R. D. George, *Colo. Geol. Survey Bull.*, 11: 291–292, 1920.

[3] T. W. Vaughan. Florida studies, Carnegie Inst. of Wash., Year Book 11, 157–158, 1913.