

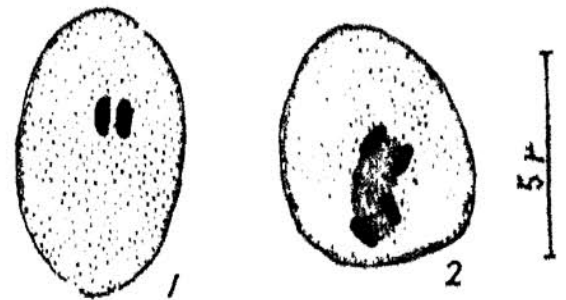
MITOSIS DURING BUDDING IN *SACCHAROMYCES CEREVISIAE*

THERE is little agreement as to whether during budding the nucleus of *S. cerevisiae* divides by mitosis (Kater,¹ Beane,² et al.,³ Richards,⁴ Henri⁵) or Guillermond⁶ classifies yeasts as haplo- and diplobiontic depending on whether meiosis takes place after or before zygote formation. This is based solely on the assumption that since nuclear reduction occurs in higher Ascomycetes, in yeasts also "meiosis must occur within the ascus." Any advance in our knowledge of the cytogenetics of the yeasts depends on a demonstration first of mitotic division during budding. Bahan⁷ observed during budding two chromosomes which split longitudinally to give rise to two daughter-nuclei but Guillermond is disinclined to accept his conclusions. Darlington⁸ states that "the effective test of a nucleus is not so much in its chemical and physical properties, but in its behaviour: a nucleus is a cell-body which arises or reproduces by mitosis". Strict application of the above test to yeasts renders doubtful even the identification of a particular structure in the yeast-cell as the nucleus.

Every text-book on Cytology warns the reader of the caution to be exercised in interpreting certain appearances as amitosis. Re-investigations in many cases with improved technique have resulted in demonstration of mitosis in cells which have previously been thought to divide by amitosis and Darlington mentions "that the apparent contradiction to genetic principles in the occurrence of amitosis need no longer be taken seriously."

It was thought therefore, that a careful investigation of the behaviour of the nucleus during budding was an essential introduction to a study of the cytogenesis of the yeasts.

The strain of *S. cerevisiae* (N.C.T.C. 3007) employed by us was SC 9 in the National Collection of Type Cultures, India. Wort cultures were made from wort-agar slants and conditions were standardized so that in a smear



almost all cells were practically at the same stage of development. Systematic examination demonstrated that vital changes take place in the nucleus at definite intervals and that the whole process of division of the nucleus takes only about 20 minutes. Indeed, the anaphase stage is passed through so quickly that unless one is very careful it may be missed completely.

Among the various fixatives and stains tried, smears fixed in Carnoy and stained with

Heidenhain's hæmatoxylin were found to give excellent pictures. No particular treatment was found necessary to remove the metachromatic granules from the cells. In smears fixed for 60 minutes in Carnoy's fluid, mordanted overnight in iron-alum and kept in hæmatoxylin for 24 to 36 hours, careful differentiation gives only pictures of the chromosome stages. We have smears where large number of cells are at particular phases of the mitotic cycle.

There are only two chromosomes, both identical in appearance (Fig. 1). The measurements of the two chromosomes in four cells at the same stage of the cycle are as follows:—

(1) $1.33 \mu/0.33 \mu$, $1.33 \mu/0.4 \mu$; (2) $1.33 \mu/0.4 \mu$, $1.33 \mu/0.27 \mu$; (3) $1.33 \mu/0.33 \mu$, $1.00 \mu/0.33 \mu$; (4) $1.00 \mu/0.33 \mu$, $1.00 \mu/0.33 \mu$. At anaphase shown in Fig. 2 they measure $1.00 \mu/0.33 \mu$.

Badian's paper has evoked contradictory opinions. While Guilliermond rejects Badian's interpretations, Henrici considers that "the two chromosomes described by him are more definite than the vague accumulations of minute chromatin granules described by Guillermond". It appears as if Badian saw structures missed by the other workers. *S. cerevisiæ* does not form an exception to the general rule, for, nuclear division during budding is by mitosis.

Our thanks to Mr. M. Sreenivasaya for his active interest and encouragement. One of us (M.K.S.) wishes to thank Messrs. The K.C.P., Ltd., Uyyuru, for the generous grant of a studentship.

Fermentation Technology Section,
Indian Institute of Science,
Bangalore, M. K. SUBRAMANIAM;
February 1, 1945. B. RANGANATHAN.

-
1. Kater, J. McA., *Biol. Bull.*, 1927, 52. (6); 436-448.
2.* Beams, H. W., L. W. Zell and N. M. Sulkin, *Cytologia*, II (1): 1940 30-36. 3. Richards, O. W., *J. Bact.* 1938, 36, (2): 187-195. 4. Henrici, A. T., *Bact. Rev.*, 1941, 5, 97. 5. Guilliermond, A., *Bot. Rev.* 1940, 6, (1) 1-24. 6.* Badian, J., *Bull. Acad. Polonaise. Sci. et Lett. B. Sci. Nat.*, 1937, 1/5, 61-87. 7. Darlington, C. D., "Recent Advances in Cytology," Second Edn. (Churchill, London, 1937).

* Papers not consulted in original.