Short Communication

The Mating Reaction in Yeast

II. Spontaneous Occurrence of Omni-mating Types

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Summary. Meiosis in diploids of *Saccharomyces cerevisiae* either homozygous or heterozygous for the dmt gene result, in about 5% of the meiotic products, in spores which have undergone an interconversion at the mating-type locus. Some of these interconversions appear to result in the generation of spontaneous omni-mating strains. This phenomenon has now been quantitated and the distribution of mating-type loci in these “natural” omni-mating types determined.

It has been reported (Blamire and Melnick, 1975) that the dmt gene has some role in determining the mating-type directed sequence of events during sexual conjugation in α haploids. Haploids of the α mating-type carrying the dmt gene mate at low frequency with other α haploids giving rise to α/α diploids. This phenomenon is not observed when the dmt gene is put into an α haploid mating-type and α/α diploids heterozygous for the dmt gene (dmt/+ ) appear normal with regard to their growth and other physiological behavior. The mating-type locus still determines the ability of such diploids to sporulate (ie α/α’s will not sporulate whereas α/α’s will sporulate) regardless of the presence of the dmt gene in a heterozygous state, however, when the dmt gene is homozygous in an α/α diploid a new phenotype arises.

The new phenotype, termed omni-mating type (omt), is such that α/α diploids (dmt/dmt) instead of being sterile will mate with both α and α haploids giving rise to triploids. Such omni-mating type strains have been constructed by mating α and α haploids containing the dmt gene, and subsequently these strains have been used to isolate other classes of mating-deficient strains (Blamire and Melnick, 1975). The omni-mating type represents, therefore, an unusual deviation from the expected rules of yeast mating phenomenon.

It was noted that, during meiosis and spore formation in diploids carrying the dmt gene, a number of asci were not showing the expected 2:2 segregation of α and α mating types. It appeared that some form of interconversion (gene conversion ?) was taking place at the mating-type locus and that potential α haploids had been converted into α haploids. All other markers segregated normally including the dmt gene itself. Also in several asci, potential α spores had become “converted” into the omni-mating phenotype described earlier. It was decided therefore to quantitate these interconversions and also examine the distribution of the mating-type loci in these “natural” omni-mating types.

Crosses were carried out using haploids in which either the α strain alone carried the dmt gene or both haploid parents were dmt containing. A number of different
auxotrophic markers were included as controls including a gly-marker, and the diploids were either prototrophic, or, because of homozygosity of one of the auxotrophic markers, auxotrophic. These diploids were selected for in the usual way on selective media and recloned several times to eliminate contaminating haploids. These diploids were then transferred to potassium acetate media (MacKay and Manney, 1974) and allowed to sporulate. Tetrad analysis was then carried out on three such diploids heterozygous for the dmt gene, and one diploid homozygous for the dmt gene. Only complete asci were selected for further examination and each spore assayed for its auxotrophic markers and then tested for mating-type and the presence of dmt gene by methods described previously (Blamire and Melnick, 1975).

Table 1 shows the combined data for all the interconversions observed in these crosses and is expressed as a percentage of those interconversions per meiotic event. Several things can be noted. The frequency with which a haploids have been converted to \( \alpha \) haploids and visa-versa, is about the same (5%) which might be expected from normal gene conversion, however in all the asci so far examined no conversions of \( \alpha \rightarrow \alpha \) have been observed in heterozygous dmt diploids, and similarly no \( \alpha \rightarrow \alpha \) conversions have been seen in homozygous dmt diploids. Also, the frequency with which two spores in the same ascus are interconverted for mating-type is very high, far higher than expected from normal gene conversion. Natural omt strains always arise in pairs, in the same ascus, and from potential a spores. Assuming that the generation of these strains has involved an interconversion event at a potential a mating-type locus, then omt strains arise with a frequency of 66% of those conversions of \( \alpha \rightarrow \alpha \). If, for some reason, omt strains are not produced during this conversion then all four spores in that ascus become of the \( \alpha \) mating-type. This event has also been observed.

It is not known how or why the dmt gene should influence mating-type interconversions during meiosis, but it does not seem to be a general “enhancer” of gene conversion since other markers in these crosses did not appear to be influenced at all. It would seem that the dmt gene is more closely associated with the role of the mating-locus in both the mating reaction itself, and possibly during meiosis. The “faulty” dmt gene allows incorrect mating reactions to occur and also fails to maintain the integrity of the mating-locus during meiosis. The result of the latter “mistake” is to allow a spores to become \( \alpha \), and under extreme conditions (i.e. homozygous dmt, therefore no good dmt product ?) \( \alpha \) spores to become a. If this switch occurs at a time when two copies of chromosome III are present in the spore, then it may be possible for only one of the mating-loci to be switched giving rise to an \( a/\alpha \) state, and an omt strain.