under identical stimulus conditions, with brief foveal stimulation. The general form of the brightness scale for the dark-adapted observer and for stimulus conditions which preclude adaptation to the test stimulus approximates a power function, as had been predicted. The form of the function as well as its exponent remain essentially invariant with changes in the color of wide-band test stimuli.

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2. This research was supported by grant No. B-624 from the National Institute of Neurological Diseases and Blindness, U.S. Public Health Service. I express my gratitude to Dr. Robert M. Boynton, under whose sponsorship the research was initiated.
3. For a complete discussion of the binocular matching technique, see W. D. Wright, *Researches on Normal and Defective Colour Vision* (Kimpton, London, 1946).
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## Sexual Recombination in a Homothallic, Antibiotic Producing Fungus

*Abstract.* The presence of a perfect or sexual stage in the fungus *Emericellopsis salmosynnemata* has made possible an investigation of the effect of meiotic recombination on yields of antibiotic. While most of the fruiting bodies produced by this organism are the result of self-fertilization, conclusive evidence of cross-fertilization and recombination between two mutants was obtained. Cross-fertilization occurred rarely.

As pointed out by Raper (*1*), the application of the breeding techniques used by geneticists in producing better varieties in higher plants have frequently been looked upon with great interest by microbiologists engaged in improving strains of microbes of economic and industrial significance. This type of approach has been barred to them, however, by the absence of a sexual stage in the penicillia, aspergilli, and actinomycetes commonly employed in industrial fermentations.

*Emericellopsis salmosynnemata,* a fungus belonging to the order Eurotiales, has both a sexual or cleistothecial stage and an imperfect *(Cephalosporium)* stage (*2*). Since it is homothallic, the sexual fruiting bodies formed on corn-meal agar are normally the result of self-fertilization. However, since cross-karyogamy and recombination in homothallic fungi have previously been described (*3*), an investigation of the potential for sexual recombination in this organism was undertaken.

Table 1. Data on progeny from three hybrid cleistothecia resulting from the following cross: *al-4 lys⁻-1 ser⁺ f⁺* (75 unit/ml)* × *al⁺-4 lys⁺-1 ser⁻ f* (0 unit/ml)*

| Genotypes recovered | No. recovered | Radius of inhibition (mm) | Yield of synnematin (unit/ml) |
|---|---|---|---|
| *al-4 lys⁻-1 ser⁺ f⁺* | 15 | 3.5 | 75 |
| *al-4 lys⁻-1 ser⁺ f* | 3 | 0 | 0 |
| *al-4 lys⁺-1 ser⁻ f* | 1 | 0 | 0 |
| *al-4 lys⁻-1 ser⁻ f⁺* | 7 | 0 | 0 |
| *al-4 lys⁺-1 ser⁺ f* | 4 | 0 | 0 |
| *al-4 lys⁺-1 ser⁺ f⁺* | 1 | 6 | 400 |
| *al⁺-4 lys⁺-1 ser⁻ f* | 23 | 0 | 0 |
| *al⁺-4 lys⁺-1 ser⁻ f⁺* | 1 | 0 | 0 |
| *al⁺-4 lys⁻-1 ser⁺ f* | 3 | 0 | 0 |
| *al⁺-4 lys⁻-1 ser⁺ f⁺* | 3 | 0 | 0 |
| *al⁺-4 lys⁻-1 ser⁻ f* | 2 | 0 | 0 |
| *al⁺-4 lys⁻-1 ser⁻ f⁺* | 3 | 0 | 0 |
| *al⁺-4 lys⁺-1 ser⁺ f* | 4 | 0 | 0 |
| *al⁺-4 lys⁺-1 ser⁺ f⁺* | 3 | 7 | 600 |

* Yield of antibiotic of the parental auxotroph.

A factor of added interest in these studies is the production by *E. salmosynnemata* of the antibiotic substance synnematin B. The presence of this factor offered the opportunity for investigation of the effect of meiotic recombination on yields of the antibiotic.

After induction of a number of morphological and physiological mutants by ultraviolet irradiation of conidia, a series of sexual crosses were made for the purpose of demonstrating recombination of the selected markers and the effect of recombinant genes on yields of the antibiotic.

Crossing was accomplished by placing mycelial inocula about 1 in. apart on corn-meal agar. After a 2- to 3-week period of incubation at 28°C, single fruiting bodies were removed from the line of contact and single spores were isolated with a De Fonbrune micromanipulator. Colonies obtained from these single spores were analyzed for recombination by growth on suitable media.

Of a total of 98 cleistothecia of *E. salmosynnemata* in which single-spore analysis was performed, only nine showed conclusive recombinant types; in most instances all products of meiosis were not recovered. All recombinants from these crosses were then investigated for their antibiotic-producing ability, and yields were compared with those of the parental strains used in the cross, and with those of the original wild-type strain. Fermentations were run with the medium of Nara and Johnson (*4*), and filtrates were assayed by the agar-well technique against a sensitive strain of *Bacillus subtilis.*

Table 1 shows the results of one such cross between an albino, lysine-requiring mutant with fluffy mycelium (*al-4 lys⁻-1 ser⁺ f⁺*), and a serine-requiring mutant of wild-type color with flat mycelium (*al⁺-4 lys⁺-1 ser⁻ f*).

This cross proved interesting because almost all of the expected recombinant types were recovered. From the point of view of antibiotic production, a more critical evaluation of the effect of recombination on yields was not possible because of the low antibiotic activity of both parent strains. However, an examination of Table 1 suggests that genetic reconstitution to a prototrophic state by meiotic recombination is not sufficient to re-establish the original antibiotic-yielding capacity of the wild-type strain (average radius of inhibition, 7 mm). The results obtained from this particular cross indicate that possibly several factors active in the synthesis of the antibiotic may be linked to the chromosome carrying the gene for fluffy mycelium (*f⁺*); when other, unselected factors are brought together in a prototroph with *f⁺*, the proper gene combinations may be achieved, and the result may be production of the antibiotic. Mycelial color appears to have no effect on yields of the antibiotic.

These results indicate that a potential for hybridization and meiotic recombination exists in this homothallic fungus, and that an application of breeding techniques in studies of antibiotics may give promising leads in this field of research (*5*).

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