Letter to the Editor

Mating-Type Switching in Filamentous Ascomycetes

Little is known concerning the mating-type genes of filamentous ascomycetes, compared to those of the yeasts Saccharomyces cerevisiae (reviewed by Herskowitz and Oshima 1981; Klär, Strathern and Hicks 1984) and Schizosaccharomyces pombe (see Beach 1983, Egel 1984). The two mating-type alleles that are typically present in genetically well-studied filamentous species, such as Neurospora crassa, Sordaria brevicollis and Aspergillus immersus, appear to be extremely stable. Mutations to loss of mating-type function have been obtained in Neurospora (Griffiths and Delange 1978; Griffiths 1982). Some of these mutations are revertible, but no changes or reversals of mating specificity have been found. In N. crassa, the mating-type genes specify functions not only in the sexual phase of the life cycle but also in the vegetative phase, where strains of opposite mating type show vegetative (heterokaryon) incompatibility with one another. Efforts to separate these different functions of the Neurospora mating-type gene by recombination have failed (Pittenger 1957; Newmeyer, Howe and Galeazzi 1973), but the two have been resolved by mutation. Griffiths and Delange (1978) obtained a single, unique mutant in which the vegetative incompatibility function was inactivated while the mating function was retained. In all other mating-type mutations which they obtained, both the vegetative and sexual functions were inactivated.

Recent developments with Neurospora may have opened the way for a better understanding. The mating-type locus has been cloned molecularly (Vollmer and Yanofsky 1986). A biological assay has been developed for the pheromone involved in attracting trichogynes to cells of opposite mating type, and the pheromone is being characterized (Bistis 1981, 1983). Complementing self-sterile mutants have been obtained and have been used for genetic manipulations in the homothallic (normally self-fertile) species Neurospora africana (Sands 1982; Arnold 1983). Complementing self-sterile mutants have been obtained and have been used for genetic manipulations in the homothallic (normally self-fertile) species Neurospora africana (Sands 1982; Arnold 1983).

In contrast to the stability of mating type in species such as N. crassa, what appears to be a regularly occurring unidirectional reversal of mating type has been described in the filamentous ascomycetes Chromocrea spinulosa (Matheson 1952), Sclerotinia trifoliorum (Uhm and Fuji 1983a,b) and Glomerella cingulata (Wheeler 1950).1

In C. spinulosa and S. trifoliorum, ascospore-size dimorphism is associated with mating type. Each ascus contains four small and four large ascospores. (One postmeiotic nuclear division occurs before ascospores are delimited in these organisms. Ascospores become two-celled in G. spinulosa.) The small ascospores invariably produce cultures that are self-sterile. The large ascospores give rise to self-fertile cultures, and these produce ascii that again contain four large (self-fertile) and four small (self-sterile) ascospores. The self-sterile cultures produce hybrid perithecia when they are fertilized by microconidia of cultures from large ascospores, or when mycelia of the two types form a zone of contact. As with the selfed cultures, hybrids between the self-sterile and self-fertile forms exhibit simple Mendelian segregation of the two traits.

The simplest hypothesis for this behavior is that Chromocrea and Sclerotinia have two mating types. One mating type is stable and always yields self-sterile mycelium, while the other can be switched at some frequency to the first type, yielding a mixed, and therefore self-fertile, mycelium. It is important to note that, in order to satisfy the observations, the switching in the self-fertile (homothallic) form must be unidirectional and irreversible. Otherwise all progeny from a selfed, and therefore homozygous, culture would be self-fertile.

A similar pattern of self-sterile and self-fertile segregation occurs in G. cingulata, although ascospores are all the same size. The unstable mating-type allele B mutates readily to b. This mutation is 13 times more frequent when an unlinked mutator gene M is present (Wheeler 1950). M is thus analogous to HO inSaccharomyces. Reverse mutations of b to B can occur, but they are rare (Chilton and Wheeler 1949).

Unidirectional switching of mating type is not the only way in which ascii containing four self-fertile and four self-sterile spores might originate. Ascii of this constitution might also be encountered if a self-sterility mutation unrelated to mating type were segregating in a truly homothallic species. But in such a situation, the progeny of self-fertile cultures would all be expected to be self-fertile; no self-sterile progeny should be produced. This alternative has been excluded for the examples cited above, where self-fertile cultures originating from single ascospores regularly produce ascii that contain four self-fertile and four self-sterile progeny.

These observations indicate that mating type switching is not limited to yeasts, but can occur also in filamentous ascomycetes.

1 Stocks of Chromocrea spinulosa, Sclerotinia trifoliorum and Glomerella cingulata are available from the American Type Culture Collection. Chromocrea can also be obtained from the Fungal Genetics Stock Center, Department of Microbiology, University of Kansas Medical Center, Kansas City, Kansas 66103.

Many questions remain unanswered. The underlying basis of the reversals has not been studied in any depth. It remains unknown whether the mechanism of reversal in filamentous species involves transposition and activation of information from silent cassettes, as in yeast, or perhaps occurs by another type of rearrangement such as inversion, or even involves some other type of mechanism such as DNA modification (Holliday and Pugh 1975).

The mating type behavior described in Chromocrea, Sclerotinia and Glomerella is simulated by S. cerevisiae strains that have only one type of storage cassette. For example, a strain of genotype MATa/ MATa HO/HO HMLa/HMLa HMRa/HMRa produces haploid segregants of two types: self-sterile with stable mating type (genotype MATa HO HMLa HMRa), and self-fertile (genotype originally MATa HO HMLa HMRa; these switch to MATa and then mate to form a diploid of genotype MATa/MATa HO/HO HMLa/ HMLa HMRa/HMRa like the original parent).

No doubt other filamentous ascomycetes will be found to conform to the Chromocrea-Sclerotinia pattern of mating type reversal. Perhaps eight-spored ascospores of Neurospora crassa. VII. Mutation and segregation in plus cultures. Am. J. Bot. 56: 717–721.


LITERATURE CITED


