Genetic Inhibition of Ascus Formation in Cochliobolus carbonum

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Contribution No. 874, Department of Plant Pathology, The Pennsylvania Agricultural Experiment Station. Journal Series Paper No. 5000.

Accepted for publication 1 June 1976.

ABSTRACT

DALMACIO, S. C., and R. R. NELSON. 1976. Genetic inhibition of ascus formation in Cochliobolus carbonum. Phytopathology 66:1354-1355.

An analysis of 51 complete ascus tetrads from four different crosses of *Cochliobolus carbonum* isolates indicates that inhibition of ascus formation is controlled by a single locus, designated *S-s* in allelic form, and inherited independently of the *A-a* mating type alleles.

The recent detection of race 3 of *Cochliobolus carbonum* Nelson (*Helminthosporium carbonum* Ullstrup) (4) prompted studies on the genetics of pathogenicity and virulence of the new race. During the course of the studies, certain crosses were observed to produce morphologically normal yet sterile perithecia. This brief report summarizes our genetic evidence for ascus inhibition in *C. carbonum*.

MATERIALS AND METHODS

Seven ascospore isolates were used in four different crosses to study the genetic inhibition of ascus formation. Crossing procedures described previously by Nelson (2) were followed. Complete tetrads of eight ascospores each were isolated from the crosses 20 days after pairing. Seven days after isolation and growth on potato-dextrose agar, each ascospore isolate was mated back to parental isolates or, in the case of one cross, outcrossed to an isolate of a desired genotype. The presence or absence of asci was determined 20 days later by microscopic examination of 10 randomly selected, morphologically normal perithecia.

RESULTS AND DISCUSSION

Ascus inhibition was observed initially in a cross between an isolate of race 1 and an isolate of race 3 of *C. carbonum* in which ascospores of several tetrad asci segregated for mating reactions in a manner displayed in Table 1. Results such as these suggested that the mechanism preventing ascus formation was genetically controlled and, in the case of Table 1, that isolates CC-1, CC-2, CC-7, and CC-8 all carried some factor(s) for ascus inhibition. Tetrad analysis of progeny from crosses CC-1 × CC-3 and CC-2 × CC-4 were performed by backcrossing each of the progeny to their parental isolates. The results of analyzing 16 complete tetrads from each cross are presented in Table 2. It is concluded that ascus inhibition is controlled by a single gene designated herein in allelic form as *S-s*. Inhibition occurs when both isolates of opposite mating type carry the *s* allele. The presence of the *S* allele in either or both parental isolates results in normal ascus development.

Data obtained from two additional crosses further substantiate these conclusions. An ascospore isolate, obtained from the cross CC-1 × CC-3, with the presumed genotype *A s* was crossed with CC-4 (*a S*). Eleven of 14 tetrads segregated as tetratypes, one as a parental ditype, and two as nonparental ditypes. A second ascospore isolate, obtained from the same cross (CC-1 × CC-3), with the presumed genotype *A S* was crossed with CC-3 (*a S*). All progeny from five complete tetrads were fertile when crossed with CC-1 (*A s*) or CC-7 (*a s*), depending on their mating type.

Chi-square analysis of the tetrad types from the three crosses showed a statistically good fit for 1:1:4 ratio for the parental and nonparental ditypes and tetratype tetrads, respectively. This tetrad distribution is referred to as N-distribution which suggests no linkage (1). This could be explained by either one of two interpretations, namely: (i) the *A-a* and *S-s* loci are on the same chromosome and recombine freely with one another, or (ii) the two loci are on different chromosomes and either

TABLE 1. Mating reactions obtained in a tetrad analysis of eight monoascosporic isolates of *Cochliobolus carbonum*

Compatibility group	Isolate	Mating reaction[a] in crosses of indicated isolates (a)			
		CC-3	CC-4	CC-7	CC-8
A	CC-1	F	F	SP	SP
A	CC-2	F	F	SP	SP
A	CC-5	F	F	F	F
A	CC-6	F	F	F	F

[a]Legend: F = fertile perithecia with ascospores; SP = morphologically normal perithecia without asci.

TABLE 2. Mating reactions and proposed genotypes for parental isolates and tetrad progeny obtained from crosses CC-1 × CC-3 and CC-2 × CC-4

Cross and parental genotypes	Tetrad genotypes	Tetrad type[a]	No. of tetrads
CC-1 (*As*) × CC-3 (*aS*)	2*As*:2*AS*:2*as*:2*aS*	T	13
	4*As*:4*aS*	PD	2
	4*AS*:4*as*	NPD	1
CC-2 (*As*) × CC-4 (*aS*)	2*As*:2*AS*:2*as*:2*aS*	T	11
	4*As*:4*aS*	PD	2
	4*AS*:4*as*	NPD	3

[a]Legend: T = tetratype; PD = parental ditype; and NPD = nonparental ditype.

or both recombine freely with their respective centromeres. The former can only occur if the two loci are far apart; i.e., when the frequency of crossing over between them is high. The helicoid arrangement of ascospores within asci precludes the estimation of distance between the loci and their respective centromeres.

The genetic control of ascus inhibition in *C. carbonum* appears to be similar to that reported for *Cochliobolus spiciferus* Nelson (5). Such a similarity provides further evidence for what appears to be a true biological relationship among species of *Cochliobolus*. Although the presence of the *S-s* alleles and the previously reported *I-i* alleles for perithecial inhibition (3) in *C. carbonum* may reduce the frequency of intraspecific fertility within the species, they also may aid in preserving the biological distinctiveness of *C. carbonum* by minimizing interspecific hybridization with biologically related species.

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