Effectiveness of selection based on variability uncomplicated by heterotic effects

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Abstract
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whether the event(s) responsible for the change had occurred between the proximal and distal ends. Consequently besides adding a new section of growth tube to the distal end, we also added another section to the proximal end of the tube. Since then two sets of growth tubes have been maintained.

Starting with section XXIII and in succeeding sections, a cycle of stopping and starting of the culture was observed. For example, in section XXIII growth ceased for 8 days and then resumed, again at a sub-maximal rate, averaging slightly less than 1 mm./hr. The culture again stopped in section XXIV for 10 days; in section XXV, for 15 days and again in the distal end of XXV for 22 days. In section XXVI it stopped for 5 days, grew an additional 105 mm. and then stopped again for 45 days, resumed growing for 240 mm. and again stopped for 32 days. At this writing (October 2, 1962), the culture has again resumed growth at 1.5 mm./hr.

On the other hand, the growth of the culture started from the proximal end of section XVI has been somewhat more consistent and has averaged approximately 2 mm./hr. compared with less than 1 mm./hr. for the culture in the original portion of the growth tube. The culture growing at 2 mm./hr. has stopped twice, once for 11 days and shortly after resuming growth again, for 27 days. It has grown at a fairly constant rate since then, although some periodic changes in growth rate have been observed.

Certain degenerative changes have been periodically observed in the morphology of both cultures. The ability to conidiate has been greatly impaired if not entirely lost, as has the ability to function normally as a perithecial parent in sexual crosses. Evidence suggests that the changes in growth rate are, at least in part, extranuclear. For example, growth in section XX averaged .82 mm./hr. Conidia from this section were removed and made into a heterokaryon with a compatible strain of the genotype pan-l; al-1 A, ad-4; al-2 A and pan-l; al-1 A homokaryons were then isolated from this heterokaryon and their growth rates determined. Such determinations showed that although some of the pan-l al-1 A isolates maintained a growth rate comparable to the normal control culture from which the heterokaryon was prepared, it was also possible to isolate pan-l; al-1 A homokaryons whose growth rate was less than half that of the normal control. In a like manner certain of the ad-4; al-2 A homokaryons persisted at the much reduced growth rate; however, it was possible to obtain a significant number of ad-4; al-2 A isolates whose growth rates averaged 2.95 mm./hr. This is a significant increase in the rate of growth compared with the .82 mm./hr. of the adenine-requiring culture used to prepare the heterokaryon. It thus appears that a portion of the reduced growth rate of the ad-4; al-2 A culture can be overcome by what we colloquially refer to as rejuvenation by normal cytoplasm. In similar rejuvenation experiments, homokaryotic ad-4; al-2 A strains that produced abundant conidia were recovered; whereas, the culture in the growth tube from which they were derived had very few, if any, macroscopically visible conidia. Further investigation will determine, if possible, the nature of the observable changes found in the continuously growing culture. ---Department of Agronomy, Kansas State University, Manhattan, Kansas.

Papa, K.E., A.M. Srb and W.T. Federer.
Effectiveness of selection based on variability uncomplicated by heterotic effects.

Selection for rapid growth is being practiced in progenies of inter- and intra-strain crosses of Neurospora to determine the rate of progress based on variability achieved through recombination uncomplicated by heterotic effects. Additional information, including environmental effects, should make it possible to develop and test mathematical genetic models for quantitative traits in haploid organisms.

Progenies of inter- and intra-strain crosses, including reciprocal crosses between Neurospora strains from Honduras and the Philippine Islands and the standard St. Lawrence strains of N. crassa, 74A and 77a, are under various stages of selection. Selection is carried out at each of three temperatures (18°C, 25°C, and 35°C) and each cross at each temperature replicated. Twenty progeny (10 of each mating type) from each cross at each temperature are grown in duplicate growth tubes every generation. The fastest growing progeny of opposite mating type are then crossed to obtain the population for the next generation.

Most of the inter-strain crosses have been carried through ten or more cycles of selection. Fewer cycles have been completed in the intra-strain crosses. Intra-strain crosses of Honduras and the controls (74A and 77a), in most cases, have exhibited a marked reduction in fertility with increased selection. This is primarily manifest in fewer perithecia being formed, ascospores failing to mature and an increased
Figure 1. Mean growth rate for two intra-strain crosses of Neurospora at three temperatures. Each mean is based on twenty progeny with two observations/progeny.
Figure 2. Mean growth rate for two inter-strain crosses of Neurospora at three temperatures. Each mean is based on twenty progeny with two observations/progeny.
frequency of mature ascospores failing to germinate.

The data obtained thus far indicate that selection has been effective in increasing growth rate. Figures 1 and 2 show the progress attained through selection in two intra- and two inter-strain crosses. As can be seen from figure 1 (two inter-strain crosses), considerably more progress was made in the cross Hon. la/Hon. 3A than in 77a/74A. This is not surprising, since 74A and 77a are highly inbred and improvement in growth rate in these lines in contrast to the other cross would seem more dependent on favorable mutation and less dependent on favorable recombination.

Slightly more progress was attained in the inter-strain crosses as shown in Fig. 2. In most of the inter-strain crosses studied thus far, the unselected progeny means of the original crosses are greater than those of the inter-strain crosses. This is not entirely true, however, in the four crosses included in figure 1 and 2 at 18°C. In addition, lower progeny means for the unselected original crosses were obtained at 35°C, in each case where 74A was used as either parent due to one or more temperature-sensitive genes evidently present in this strain. These genes appear to be eliminated following one cycle of selection at 35°C.

Statistical analyses of the data indicate a lower genetic component of variance among the progeny as the number of cycles of selection increases. The rate at which the variance is reduced appears to be directly correlated with the type of cross involved (inter- or intra-) as well as with the strains used in the original crosses. A reduced variation among progeny accompanied by no significant increase in mean growth rate for several consecutive cycles should offer some indication of the extent to which selection, in the manner outlined, can be continued. Although all of the data have not yet been statistically analyzed, there appear to be no real differences between reciprocal crosses. Therefore, extra-chromosomal effects on growth rate in this study are either absent or too minor to detect. ---Department of Plant Breeding, Cornell University, Ithaca, New York.

Perkins, D. D. Ascii of bis X bis crosses for chromosome cytology. In perithecia of crosses homozygous for the group-V morphological mutant bis: biscuit (B6), developing ascii become greatly swollen, and early in growth assume the shape of pears or balloons. In squashes of bis X bis material, ascii at pachytene and later stages are easily ruptured, and nuclei from the ruptured ascii are greatly flattened merely by the pressure of a coverglass, so as to give workable figures and well spread chromosomes far more frequently than are ordinarily obtained using the same procedures with standard materials. (Paraphysoid cells are also swollen in crosses homozygous for bis.)

Chromosome behavior appears to be normal in Prophase I of B6 X B6 crosses, and pairing was normal at the most fully extended pachytene stage in one nucleus where all seven bivalents could be traced. Ascospores are not linearly arranged in maturing ascii, however, and spore formation is frequently irregular and abnormal. Eight-spored ascii are most frequent, but ascii are found with four spores, with odd numbers less than eight, and occasionally with more than eight spores. Ascospore size varies. Giants and dwarfs are found. In some asci, nuclear material remains outside the spore walls.

These observations were made with two B6 strains of 74A background, Fungal Genetics Stock Center numbers 277 and 278. Observations are now being extended to homozygous crosses and intercrosses involving all available presumed bis alleles, including B6, B12, D12, B30, D312, C-1670 and C-1810-1, and to B6 X wild. (In crosses heterozygous for B6, ascii are presumably normal. B6 has been widely used as a marker for investigating linkage and crossing over, with no evidence of aberrant behavior.)

J. C. Murray (1960. Cornell Ph.D. thesis) and Murray and Srb (1962. Canad. J. Bot.) have reported that mature ascii are non-linear in crosses that are homozygous for the group V mutants C-1810-1 or C-1670, called pk-1: peak-1 and pk-2. Intercrosses between C-1810-1 and bis (B6) indicate that the two are allelic (no wild-type recombinants were observed among 8181 segregants by W. N. Strickland, unpublished). Murray and Srb do not mention any irregularities other than the absence of linearity.

In homothallic fungi, a homozygous effect on ascus morphology would immediately be apparent in every selfed perithecium. Mutants have been reported in the homothallic Sordaria macrospora that resemble bis in their effect on ascus development. (Heslot 1958. Rev. Cytol. et Biol. Veg.; Esser and Straub 1958. Zeits. Vererb.) Possibly these, like bis, may prove favorable for chromosome cytology. In heterothallic