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Growth adaptation to temperature in N. crassa wild-type strains

W. A. Matthews
Imperial College

B. C. Lamb
Imperial College

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Abstract

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Growth and adaptation were studied using linear growth in tubes based on those of Brown and Gillie (1963 Neurospora Newsl. 4: 19). Glucose minimal medium (Lamb 1966 Genet. Res. 7: 325) was used throughout. The six stocks were: Panama A (FGSC#1131); Panama a (FGSC#1130); Abbott 4A (FGSC#1757); Abbott 4a (derived from Abbott 4A x Lindegren 25a backcrossed to Abbott 4A six times); Lindegren 1A (probably the same as FGSC#853) and Lindegren r6a (from Lindegren 1A x Lindegren 25a, backcrossed to Lindegren 1A six times and intercrossed twice). The first three stocks were kindly provided by the FGSC, the others by L. C. Frost.

Table 1. Adaptation ratios.

	Earlier; 50mm/initial rate					Later; 500mm/50mm rate					Overall; final/initial rate				
Temp. °C	4	10	25	37	42	4	10	25	37	42	4	10	25	37	42
Abbott 4A	2.0	-	1.0	1.0	IG	IG	-	1.2*	1.3*	IG	2.0	-	1.6*	1.5*	IG
Abbott 4a	1.9	-	1.0	1.0	NG	IG	-	1.2*	1.1	NG	2.0	-	1.5*	1.5*	NG
Lindegren 1A	IG	2.0	1.0	1.3*	0.7	IG	6.1*	1.3*	1.2*	IG	0.8	6.1*	1.5*	1.8*	0.7
Lindegren r6a	1.4	1.0	1.0	1.2	1.3	IG	6.0*	1.4*	1.4*	IG	1.4	6.0*	2.3*	1.4*	1.3
Panama A	NG	1.5	1.0	1.0	1.0	NG	0.9	1.3*	1.0	1.3	NG	0.8	1.3*	0.2*	1.3
Panama a	NG	1.7	1.0	1.0	1.0	NG	1.7	1.2	1.2*	IG	NG	1.2	2.3*	1.4*	0.6*

* Significantly different at 5% level from 1.0. - Not done. NG = no growth. IG = insufficient growth.

Inocula were taken from stocks grown for two weeks at 25°C. Continuous growth was followed by using a series of tubes, transferring hyphae and conidia from one tube to the next just before the hyphae reached the end of the first tube. There was no noticeable lag in growth from this transfer. The results at some of the temperatures used are shown in Table 1.

Growth rates at intermediate temperatures and ability to grow at certain of the more extreme temperatures were not significantly different between the two Abbott strains, nor between the two Lindegren strains, but agreement was less good between the Panama strains. There were often significant (at the 5% level) differences between Abbot, Lindegren and Panama strains. Of the particular temperatures used, 25° was very clearly the optimum one for growth of Lindegren strains; 37° was best for Abbott strains; Panama A had a clear optimum at 37°, while Panama a, like the Abbott strains, grew best at 37° but with growth at 37° not greatly exceeding that at 25°. Having a high optimum temperature was not correlated with ability to grow at high extreme temperature because Abbott strains (optimum 37°) could not grow at 42°, while Lindegren strains (optimum 25°) could. Panama A and a both grew at 43°. Minimum temperatures for growth were: Abbott, 3°; Lindegren, 4°; Panama 5°. The Panama strains both grew significantly faster overall when grown at alternating temperatures of 10 and 42° (approximately 2 days at 42°, 4 days at 10°, per cycle) than at either 10° or 42° alone, showing faster growth with cyclic than with directional vegetative selection.

A simple numerical measure of adaptation is the ratio of growth rates (in a non-stalling culture) at two different times. Three such ratios were calculated; earlier adaptation (rate after 50mm/initial rate); later adaptation (rate after 500 mm/rate at 50mm); and overall adaptation (final/initial rate). Ryan, Beadle and Tatum (1943 Am. J. Botany 30: 784) reported a 24 hour lag after inoculation, so initial rates here were those recorded 2 or 3 days after inoculation, or later if the lag was longer. As expected from inocula grown at 25°, there was no early adaptation at 25°, but all strains later showed some adaptation (adaptation ratio greater than 1.0) at this temperature. The two Abbott strains were very similar in adaptability, with low ratios in the range 1.0–2.0. The Lindegren strains were similar to each other, with a wide range, 0.7–6.1. Within-strain variation was greatest for the

Panama strains. At 10° there was a very marked between-strain difference, both Lindegren strains showing high later adaptation, compared with much less or none in the Panama strains. Adaptability was generally greater at low temperatures than at high ones.

The Panama strains, with the greatest ability to grow at high temperatures and the poorest at low temperatures, probably came from a hotter environment than did the others. Because vegetative adaptation occurred both during continuous growth at 25° and on transfer from 25° to other temperatures, one cannot reliably deduce from these experiments the growth properties of the original wild-type isolates, as laboratory culture has probably altered them. The finding of differences in adaptation between wild-type strains is not unexpected after the many other differences found between wild types (McNelly-Ingle and Frost 1965 J. Gen. Microbiol. 39: 33, for example).

McDougall and Pittenger (1962 Neurospora Newsl. 2:10), using continuous hyphal propagation of an auxotroph at 30°, found progressive declines in growth after about 1800mm of growth, with eventual cycles of stopping and starting. In the present study, declines in growth rate often occurred at 42 or 43°, but at 10, 25 and 37°, growth rates did not diminish, and often were still slowly increasing after lengths of 2000-6000mm (except for Panama A, whose growth declined at 37° after 2200mm). The differences found here between the wild-type strains provide a basis for further studies on the physiology and genetics of growth and adaptation. The roles of such factors as spontaneous mutation and heterocaryosis are currently being investigated.

- - - Department of Botany, Imperial College, London S.W.7 2BB.