O'Brien, S.J. and R.J. MacIntyre. Cornell University, Ithaca, New York. A biochemical genetic map of D. melanogaster.

Presented on the following two pages is a genetic map of the D. melanogaster genome including only those loci whose alleles affect known molecular species, directly or indirectly. At each locus is a locus or gene designation followed by a reference number listed in the bibliography. Under the locus designation is listed the enzyme(s) or other molecular species which is affected by the gene. There is no intended implication that any locus is or is not the structural gene for the molecular species listed. We have also included a list of proteins which have not been mapped, but which have been characterized somewhat in D. melanogaster, and could be mapped by similar techniques to those utilized with previous mappings.

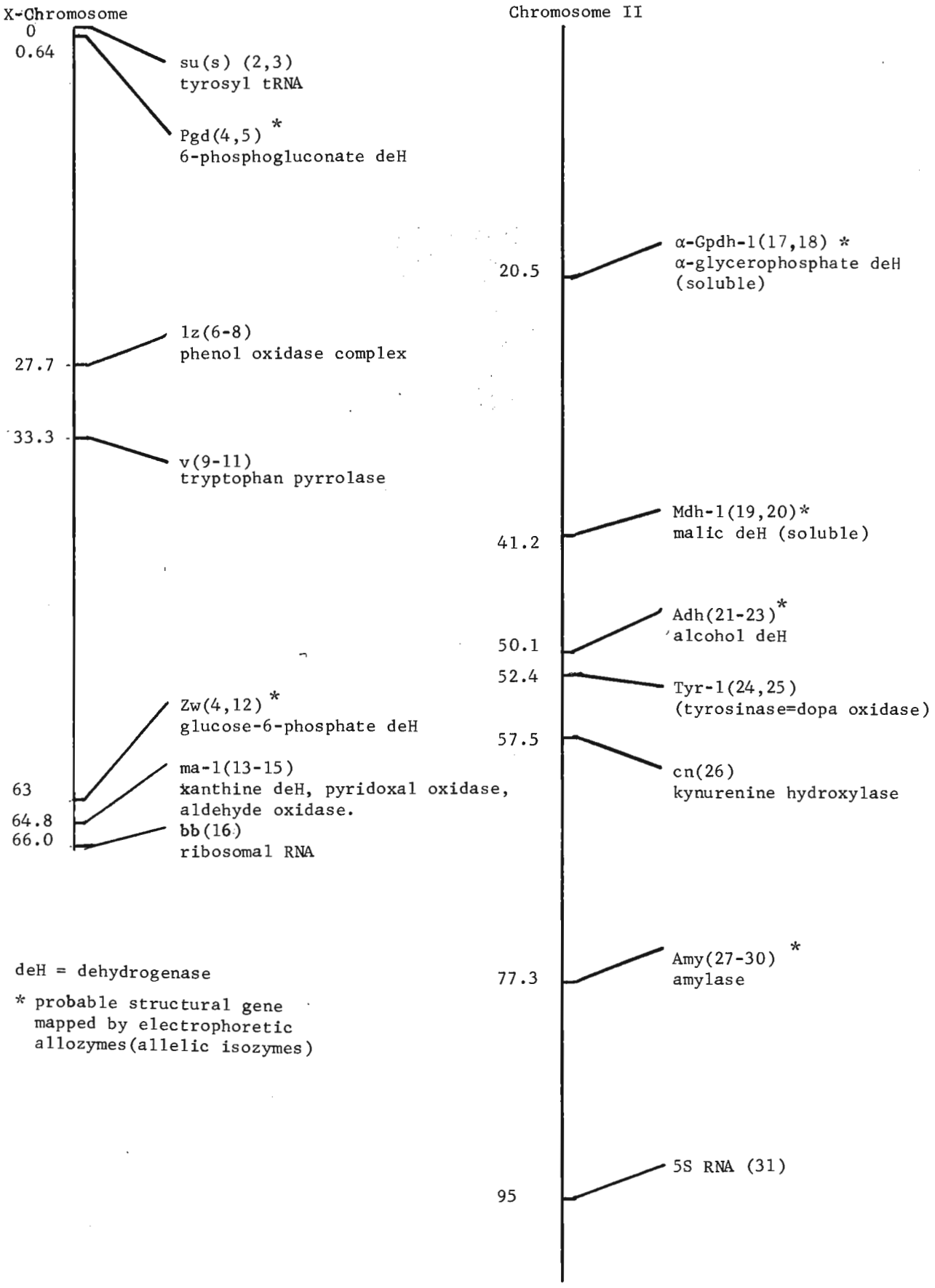
Unmapped systems more or less biochemically characterized in D.m.

Protein-1(49)
Protein-4(50
Protein-5(50)
Protein-8(51)
Protein-9(51)
Protein-13(51)
several enzymes(52)
protease(53)
adenylate kinase(54)
acetyl cholinesterase(55)
choline acetyltraferase(55)
aldolase(56,57)
β-galactosidase(58)
glutamate aspartate transaminase(59)
hexokinase(60)
kynurenine ormamidase(61)
lactate deH(62)

References Cited

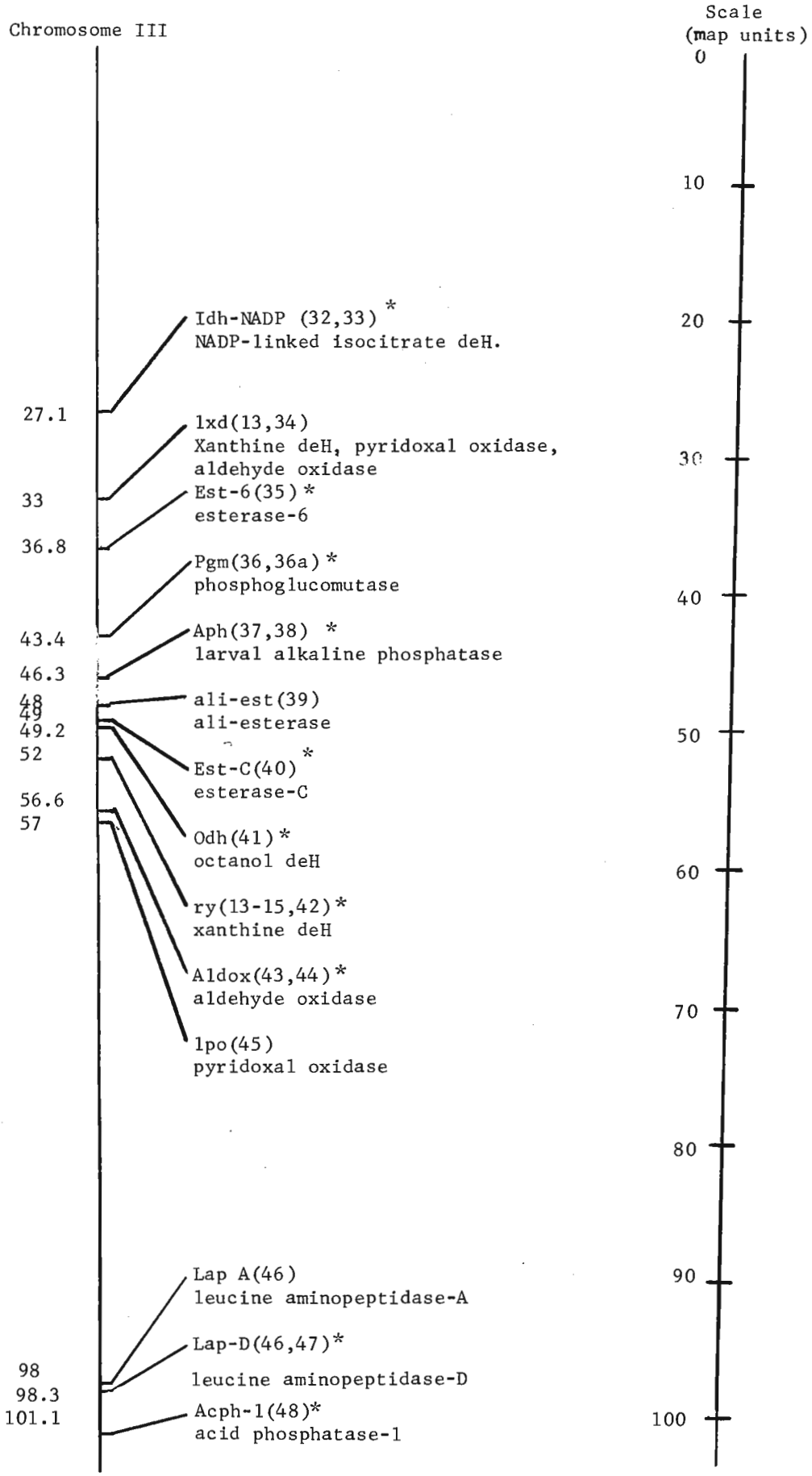
D. = Drosophila D.m. = Drosophila melanogaster

1. Lindsley, D. and E.H. Grell 1968. Genetic Variations in D.m. Inst. Wash. Publ. No. 627. (General reference).
2. Twardzik, D.R., E.H. Grell and K.B. Jacobsen 1969. Genetic control of iso-accepting forms of tyrosyl-tRNA in a suppressor of D.m. Genetics 61: s59.
3. Tartof, K.D. 1969. Interacting gene systems: I. The regulation of tryptophan pyrrolase by the vermilion suppressor system in D. Genetics 62: 781-795.
4. Young, W.J. 1966. X-linked electrophoretic variation in 6-phosphogluconate dehydrogenase. J. Hered. 57: 58-60.
5. Gvozdev, V.A., V.J. Birstein and L.D. Faizullin 1970. Gene dependent regulation of 6-phosphogluconate dehydrogenase activity in D.m. DIS 45: 163.
6. Peeples, E.E., D.R. Barnett and C.P. Oliver 1968. Phenol oxidases of a lozenge mutant of D. Science 159: 551-552.
7. Peeples, E.E., A. Geisler, C.J. Whitcraft and C.P. Oliver 1969. Comparative studies of phenol oxidase activity during pupal development of three lozenge mutants (lz^8, lz, lz^k) of D.m. Genetics 62: 161-170.
8. ____ 1969. Activity of phenol oxidases at the puparium formation stage in development of nineteen lozenge mutants of D.m. Biochem. Genet. 3: 563-569.
9. Baglioni, C. 1959. Genetic control of tryptophan peroxidase-oxidase in D.m. Nature 184: 1084-1085.
10. ____ 1960. Genetic control of tryptophan pyrrolase in D.m. and D. virilis. Heredity 15: 87-96.
11. Kaufman, S. 1962. Studies on tryptophan pyrrolase in D.m. Genetics 47: 807-817.
12. Young, W.J., I. Porter and B. Childs 1964. Glucose-6-phosphate dehydrogenase in D.: X-linked electrophoretic variants. Science 143: 140.
13. Glassman, E. 1965. Genetic regulation of xanthine dehydrogenase in D.m. Fed. Proc. 24: 1243-1251.
14. Glassman, E. and H.K. Mitchell 1959. Mutants of D.m. deficient in xanthine dehydrogenase. Genetics 44: 153-167.
15. Grell, E.H. 1962. The dose effect of $ma\text{-}1^+$ and ry^+ on xanthine dehydrogenase in D.m. Z. Verben. 93: 371-377.
16. Ritossa, F.M., K.C. Atwood and S. Spiegelman 1966. A molecular explanation of the bobbed mutants of D. as partial deficiencies of ribosomal DNA. Genetics 54: 819-834.
17. Grell, E.H. 1967. Electrophoretic variants of alpha-glycerophosphate dehydrogenase in D.m. Science 158: 1319-1320.



deH = dehydrogenase

* probable structural gene mapped by electrophoretic allozymes(allelic isozymes)


Chromosome III
Scale
(map units)
0
10
20
30
40
50
60
70
80
90
100
Idh-NADP (32,33) *
NADP-linked isocitrate deH.
27.1
lxd(13,34)
Xanthine deH, pyridoxal oxidase,
aldehyde oxidase
33
Est-6(35) *
esterase-6
36.8
Pgm(36,36a) *
phosphoglucomutase
43.4
Aph(37,38) *
larval alkaline phosphatase
46.3
48
49
ali-est(39)
ali-esterase
49.2
52
Est-C(40) *
esterase-C
56.6
57
Odh(41) *
octanol deH
ry(13-15,42) *
xanthine deH
Aldox(43,44) *
aldehyde oxidase
lpo(45)
pyridoxal oxidase
Lap A(46)
leucine aminopeptidase-A
Lap-D(46,47) *
leucine aminopeptidase-D
98
98.3
101.1
Acph-1(48) *
acid phosphatase-1

18. O'Brien, S.J. and R.J. MacIntyre 1968. New Mutants DIS 43: 61.
19. O'Brien, S.J. 1969. Genetics of malic dehydrogenase-1 in D.m. DIS 44: 113.
20. Grell, E.H. 1969. New Mutants DIS 44: 47.
21. Johnson, F.M. and C. Denniston 1964. Genetic variation of alcohol dehydrogenase in D.m. Nature 204: 906-907.
22. Grell, E.H., K.B. Jacobsen and J.B. Murphy 1965. Alcohol dehydrogenase in D.m. Science 149: 80-82.
23. Ursprung, H. and J. Leone 1965. Alcohol dehydrogenase: A polymorphism in D.m. J. Exper. Zool. 160: 147-154.
24. Lewis, H.W. and H.S. Lewis 1961. Genetic control of dopa oxidase activity in D.m., II. Regulating mechanisms and inter- and intra-strain heterogeneity. Proc. Nat. Acad. Sci. U.S. 47: 78-84.
25. ____1963. Genetic regulation of dopa oxidase activity in D. Ann. N.Y. Acad. Sci. 100: 827-839.
26. Ghosh, D. and H.S. Forrest 1967. Enzymatic studies on the hydroxylation of kynurenine in D.m. Genetics 55: 423-431.
27. Kikkawa, H. and K. Abe 1960. Genetic control of amylase in D.m. Ann. Zool. Japan 33: 14-23
28. ____1964. An electrophoretic study on amylase in D.m. Jap. J. Genet. 39: 401-411.
29. Doane, W.W. 1967. Cytogenetic and biochemical studies of amylase in D.m. Amer. Zool. 7: 780.
30. Bahn, E. 1967. Crossing over in the chromosomal region determining anylase isozymes in D. m. Hereditas 58: 1-12.
31. Wimber, D.E. and D.M. Steffensen 1970. Localization of the 5S RNA genes on D. chromosomes by RNA-DNA hybridization. Science 170: 639-640.
32. Fox, D.J. 1970. New Mutants DIS 45: 35.
33. Young, W.J. personal communication
34. Keller, E.C.Jr. and E. Glassman 1964. A third locus (lxd) affecting xanthine dehydrogenase in D.m. Genetics 49: 663-668.
35. Wright, T.R.F. 1963. The genetics of an esterase in D.m. Genetics 48: 787-801.
36. Hjorth, J.P. 1970. A phosphoglucomutase locus in D.m. Hereditas 64: 146-148.
36a ____1970. New Mutants DIS 45: 39.
37. Beckman, L. and F.M. Johnson 1964. Variation in larval alkaline phosphatase controlled by Aph alleles in D.m. Genetics 49: 829-835.
38. MacIntyre, R.J. 1966. Locus of the structural gene for the third instar larval alkaline phosphatase (Aph). DIS 41: 62.
39. Ogita, Z. 1961. Genetical relationship between ali-esterase activity and insecticide resistance in D.m. Genetical and biochemical studies on negatively correlated cross resistance in D.m. IV Botyu-Kagaku (Scientific Insect Control) 26: 93-97.
40. Beckman, L. and F.M. Johnson 1964. Esterase variations in D.m. Hereditas 51: 212-220.
41. Courtright, J.B., R.B. Imberski and H. Ursprung 1966. The genetic control of alcohol dehydrogenase and octonol dehydrogenase in D. Genetics 54: 1251-1260.
42. Yen, T.T.T. and E. Glassman 1965. Electrophoretic variants of xanthine dehydrogenase in D.m. Genetics 52: 977-981.
43. Courtright, J.B. 1967. Polygenic control of aldehyde oxidase in D. Genetics 57: 25-39.
44. Dickinson, W.J. 1969. New Mutants DIS 44: 48-49.
45. Collins, J.F. and E. Glassman 1969. A third locus (lpo) affecting pyridoxal oxidase in D. m. Genetics 61: 833-839.
46. Beckman, L. and F.M. Johnson 1964. Genetic control of aminopeptidases in D.m. Hereditas 51: 221-230.
47. Falke, E. and R.J. MacIntyre 1966. The genetic localization of a non-specific leucine aminopeptidase in D.m. DIS 41: 165-166.
48. MacIntyre, R.J. 1966. The genetics of an acid phosphatase in D.m. and D. simulans. Genetics 53: 461-474.
49. Hubby, J.L. 1963. Protein differences in Drosophila. I.D.m. Genetics 48: 871-879.
50. Pantelouris, E.M. and E.J. Duke 1963. The inheritance of lymph proteins in D. Genet. Res. Camb. 4: 441-445.
51. Duke, E.J. 1966. Further studies on the inheritance of lymph proteins in D.m. Genet. Res. Camb. 7: 287-294.
52. Sims, M. 1965. Methods for detection of enzymatic activities after electrophoresis on polyacrylamide gels in D. species. Nature 207: 757-758.
53. Kikkawa, H. 1968. Biochemical genetics of proteolytic enzymes in D.m. I. General consider-

ations. Jap. J. Genet. 43: 137-140.
54. Brewer, G.J. 1970. An introduction to isozyme techniques. Acad. Press, N.Y.
55. Dewhurst, S.A., R.E. McCaman and W.D. Kaplan 1970. The time course of development of acetylcholinesterase and choline acetyltransferase in D.m. Biochem. Genet. 4: 499-508.
56. Marzluf, G. and E. Mayer 1968. Aldolase in D.m. DIS 43: 151.
57. Brenner, H. and O. Leulhard 1969. Aldolases from D.m. Helv. Chim. Acta. 50(5): 1366-1372.
58. Bakula, M. 1970. Beta-galactosidase in axenic and non-axenic cultures of D.m. DIS 45: 67.
59. Burr, M.J. and A.S. Hunter 1969. Glutamate aspartate transaminase of D.m. DIS 44: 53.
60. Murray, R.F. and J.A. Ball 1967. Testis-specific and sex associated hexokinases in D.m. Science 156: 81-82.
61. Glassman, E. 1956. Kynurenine formamidase in mutants of D. Genetics 41: 566-574.
62. Rechsteiner, M.C. 1968. Lactate dehydrogenase and alpha-glycerophosphate dehydrogenase in D.m. Ph.D. thesis, The Johns Hopkins University, Baltimore.

Patty, R.A. University of Nebraska, Lincoln, Nebraska. Durations of copulation in some recent "eastern" and "western" strains of D. athabasca.

As reported by Miller (1958, Evolution 12: 72-81) and Miller and Westphal (1967, Evolution 21: 471-492), "western" D. athabasca has relatively long durations of copulation, "eastern" athabasca relatively short copulation times, with little overlapping (some long copulation times only in a derivative of the Carbon County, Pennsylvania, strain of "eastern" athabasca -Miller and Westphal, 1967). Strains from several new western and eastern localities have recently been acquired (the latter from collections by Drs. George Hooper and Max Levitan, via Dr. R.A. Voelker); these have been identified as "western" or "eastern" athabasca on the basis of geographical source, Y chromosome type, salivary gland chromosome patterns (by Drs. Miller and Voelker). As part of an attempt to reinvestigate the genetic basis of copulation time variation in athabasca, observations of copulations have recently been made, employing approximately 1-week old flies aged in isolation and observed at 70-80°F. The following table gives observed values (it also includes recent observations with the old Carbon County and Duluth strains used by Miller and Westphal, 1967):

"Western" athabasca:
Minesota (Bass Lake): 6'21", 7'15", 10'18", 12'46", 15'32", 17'56" ($\bar{x}$ = 11'41").
Minnesota (Duluth): 6'37", 7'37", 7'58", 8'00", 8'55", 9'15", 10'50" ($\bar{x}$ = 8'28").
Wyoming (Medicine Bow Natl. Forest): 6'33", 6'52", 8'28", 9'10", 9'46", 9'50", 10'20", 10'55", 11'15", 16'26", ($\bar{x}$ = 9'58").
"Eastern" athabasca:
Massachusetts (South Williamstown): 0'55", 1'07", 1'08", 1'11", 1'22", 1'24", 1'30", 1'34", 1'45", 1'53", 2'09", 2'25", 2'28" ($\bar{x}$ = 1'36").
New Jersey (Englewood): 1'12", 1'20", 1'21", 1'27", 1'36", 1'39", 1'47", 2'22" ($\bar{x}$ = 1'54").
New York (Poughkeepsie): 0'34", 0'45", 0'53", 1'02", 1'03" (2), 1'05", 1'07", 1'09", 1'10" (2), 1'11", 1'14", 1'18", 1'19", 1'33", 1'46", 1'56", 1'57" ($\bar{x}$ = 1'13").
Pennsylvania (Allentown): 1'58", 2'05", 5'54" ($\bar{x}$ = 3'19").
Pennsylvania (Carbon County, Jim Thorpe): 0'41", 0'56", 1'20", 1'21", 1'34", 1'43", 1'46", 1'55", 2'03", 2'07", 2'19", 2'30", 2'37" (2), 2'44", 2'55", 3'40", 3'48", 4'57" ($\bar{x}$ = 2'17").
Pennsylvania (Philadelphia): 1'16", 1'24", 1'25", 1'35", 1'55", 2'03", 2'25", 2'35", 2'39", 2'54", 2'57", 3'19", 6'47" ($\bar{x}$ = 2'33").

The range of copulation times for "eastern" D. athabasca from Allentown, Philadelphia, and Carbon County, Pennsylvania, exceeded the upper limit of 2'29" found by Miller and Westphal (1967) in most of their "eastern" strains. The lower limit for copulation time in "western" strains was observed to be 6'21" (Bass Lake, Minnesota) and the upper limit for the "eastern" strains 6'47" (Philadelphia). Thus, an overlapping of copulation times of "western" and "eastern" athabasca is confirmed, though most strains continue to conform to the earlier impression of nonoverlapping long and short copulation times for "western" and "eastern" athabasca respectively.