Table 3. The frequencies of detrimentals and estimated elimination rates of lethal genes through allelism in the Anyang wild population of *D. melanogaster* for the period of 1967–1982

Year	detrimentals (le + sle)	allelism (i)	iq^2	pq	q^2	$hpq + 2hq^2$	h
1967	0.254	0.0179	0.0005	0.143	0.030	0.203	0.012
1976	0.264	0.0314	0.0008	0.136	0.027	0.190	0.012
1981	0.225	0.0210	0.0004	0.119	0.019	0.157	0.017
1982	0.193	0.0133	0.0003	0.126	0.022	0.170	0.016
average	0.234	0.0209	0.0005	0.131	0.025	0.180	0.014

Table 4. The estimated effective size[18] of the Korean populations of *D. melanogaster*

Year	q	I_c	I_g	*Ne* ($u = 10^{-5}$)
1967	0.1727	0.0179	0.0139	3,600
1976	0.1625	0.0314	0.0264	2,000
1981	0.1380	0.0210	0.0181	3,100
1982	0.1480	0.0133	0.0112	5,300

q, frequency of lethals; I_c, allelic rates; $I_g = \frac{-\ln(1 - I_c q^2)}{[\ln(1-q)]^2}$.

allelic elimination equals total genotypic elimination (see Wallace[16]). hpq stands for the fraction of elimination contributed by individuals carrying one lethal chromosome. 2 hq^2 for the fraction of those carrying two, non-allelic lethal chromosomes. The calculated value for lethal-elimination is 0.0003 for the present sample. Overall average dominance was calculated to be 1.6% in the 1982 population. All the other values for these elimination rates are smaller than the assumed lethal mutation rate, indicating a slight dominance effect of the deleterious genes. Crow and Temin[13] found an average of 3%. All our h-data are much smaller. Hoenigsberg et al.[17] hypothesized that the effects of dominance are of cyclical nature exerted by modifiers in larger and more relaxed populations. Our data could be interpreted along with this explanation.

The estimated sizes for effective population number of *D. melanogaster* are presented in table 4. The sample of 1982 turned out to give a value of 5300 individuals (= *Ne*). This indicates an expansion of the local population (*Ne* 1976 $\approx$ 2000, *Ne* 1981 $\approx$ 3000). It should be noted that Powell[19] has shown for *D. pseudoobscura* populations that in periods of population flush a relaxed selection occurs. Our allelism rate of 1.33% could be in accord with this hypothesis.

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2 Dobzhansky, Th., and Spassky, B., Genetics *48* (1963) 1467.
3 Sperlich, D., Feuerbach-Mravlag, H., Lange, P., Michaelidis, A., and Pentzos-Daponte, A., Genetics *86* (1977) 835.
4 Pfriem, P., and Sperich, D., Genetica *60* (1982) 49.
5 Krimbas, C., Genetics *44* (1959) 1359.
6 Band, H.T., and Ives, P.T., Evolution *22* (1968) 633.
7 Mukai, T., and Yamaguchi, O., Genetics *76* (1974) 339.
8 Sperlich, D., and Karlik, A., Verh. dt. zool. Ges., München (1963) 73.
9 Watanabe, T.K., Watanabe, T., and Oshima, C., Evolution *30* (1976) 109.
10 Paik, Y.K., and Sung, K.C., Jap. J. Genet. *44* (1969) 180.
11 Choi, Y., Theor. appl. Genet. *53* (1978) 65.
12 Choi, Y., and Paik, Y.K., Korean J. Genet. *5* (1983) 35.
13 Crow, J.F., and Temin, R.G., Am. Nat. *98* (1964) 21.
14 Dobzhansky, Th., Columbia University Press, 1971.
15 Sperlich, D., Gustav Fischer Verlag, Stuttgart 1973.
16 Wallace, B., Columbia University Press 1981.
17 Hoenigsberg, H.F., De Polano, M.M.E., Ordones, M., Castaneda, H.C., and Monje, C.A., Genetica *59* (1982) 43.
18 Nei, M., Proc. natn. Acad. Sci. USA *60* (1968) 517.
19 Powell, J.R., Evolution *32* (1978) 465.

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The evolutionary history of *Drosophila buzzatii*. V. Differential survivorship on *Opuntia* between *D. buzzatii* and *D. serido*[1]

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Summary. Survival time of *Drosophila buzzatii* adults on an *Opuntia* (prickly pear) medium was significantly longer than that of its nearest relative *D. serido*. A significant difference was also found between *D. buzzatii* adults from two experimental populations, one of them fed on *Opuntia* rots for more than two years and another one kept on standard *Drosophila* medium for the same period of time. These results suggest that adult selection may be taking place in cactiphilic *Drosophila* in their natural habitats and could be responsible for the niche differentiation between *D. buzzatii* and *D. serido*.
Key words. Drosophila buzzatii; Drosophila serido; Opuntia; survivorship, differential; feeding behavior; niche differentiation; *Drosophila,* cactiphilic.

The nutritional requirements of *Drosophila* adults are very simple; only sugar is necessary to keep the flies alive. In addition, a mixture of essential amino acids, salts and vitamins is required for normal egg production[2,3]. Accordingly, feeding sites for most *Drosophila* species seem to be unspecific, that is to say, adult flies are attracted and feed upon a wide variety of fermenting substrates[4]. Cactiphilic *Drosophila* species, however, might have a particular, rather different, feeding behavior. Fellows and Heed[5] reported that a large mortality took place when flies of different *repleta* group species from the Sonoran Desert (Arizona) were placed in population cages with rotting cacti as the only food source. Similarly, we observed that almost all *D. buzzatii* and *D. serido* adults placed in population cages with *Opuntia ficus-indica* (prickly pear) rots as food, died in a few days. There was, however, a big difference between these two species. The *D. serido* population became extinct after the first generation, while the two populations (P1 and P2) founded with *D. buzzatii* flies survived, and could be maintained on the same food for more than two years[6]. These observations make sense because although the two species are closely related, there is evidence that, at least in Argentina where the ancestors of the population founders were

collected, each species has its own trophic niche, *D. buzzatii* being associated with several species of *Opuntia* while *D. serido* utilizes mainly columnar cacti[7]. The experiments described below were devised to test 1) whether or not there is a differential survivorship on *Opuntia* between the two species and 2) whether or not the observed mortality in the *D. buzzatii* populations was selective, showing that intrapopulation variability exists for the character. The answer to both questions was found to be affirmative.

We compared first the survival time of adults from three different original populations: 1) Two laboratory stocks of *D. serido* derived from two wild females collected in Vipos (Tucumán). 2) Two laboratory stocks of *D. buzzatii* derived from two wild females collected in San Luis. 3) Two experimental populations of *D. buzzatii* (P1 and P2) started with a sample of flies from Arroyo Escobar and fed on *O. ficus-indica* rots for more than 20 generations. All the localities cited are in Argentina; their geographical positions are shown elsewhere[7]. Survival time was measured using three different media (treatments). In each case, two replicated vials per stock (or population cage) were established (four vials per population). All tested adults were reared under near optimal conditions in culture bottles with David's killed-yeast *Drosophila* medium[8] to avoid any difference in survival due to the nutrition of larvae. 10 males and 10 females, 3–6 days old, were place in each vial and the number of survivors scored every 12 h. The test was carried out at 25 °C.

Glass vials of 3.2 × 11 cm were used. Treatments were as follows. a) No food (control). Adults were placed on a small disk of foam rubber under which a piece of water-soaked cotton was introduced to avoid desiccation. b) *Opuntia* medium (without replacement). Several small pieces (about 10 g) of *O. ficus-indica* cladodes were put into each vial, 10 cm^3 of 1% agar was then added to make the medium consistent. Green and rotting pieces were combined in order to provide a suitable medium for the flies. Rotting pieces of *Opuntia* pads were produced by keeping them in a tightly closed jar at 25 °C for five days. Adults were left in the original vials until they died. c) *Opuntia* medium (with replacement). Vials with the same medium as in b. Adults were transferred to new vials with fresh substrate every 48 h.

The results of this test are summarized in figure 1. A three-way analysis of variance showed no significant differences between replicates of stocks from the same population ($F = 1.47$; $= 0.10 < p < 0.25$). The mean number of survivors over the four vials is therefore shown on the graph. In contrast, differences between populations as well as between treatments are highly significant ($F = 294.34$, $p < 0.001$, and $F = 497.05$, $p < 0.001$, respectively). *D. serido* adults lived for about the same time on the three media. In other words, *Opuntia* medium did not extend their lifespan in relation to the control. On the other hand, *D. buzzatii* adults showed a significantly longer survival time on *Opuntia* medium than in control vials. There are also significant differences between the *D. buzzatii* flies taken from laboratory stocks and those from population cages with *Opuntia,* on both kinds of *Opuntia* medium (with and without replacement). In addition, the survival curves of *D. buzzatii* with these two last treatments are different, the slopes corresponding to the *Opuntia* medium with replacement being significantly smaller than those without replacement.

The observed difference between the *D. buzzatii* adults from laboratory stocks and those coming from population cages with *Opuntia* suggests that the initial mortality in these cages was effectively selective. However, this test is not completely reliable because laboratory stocks cannot really be considered to be a control for experimental populations. There are two reasons for this. First, inbreeding has probably made laboratory stocks much more homozygous than experimental populations. Second, the original flies came from different localities (San Luis and Arroyo Escobar, respectively) and there may be interpopulation variability for the character.

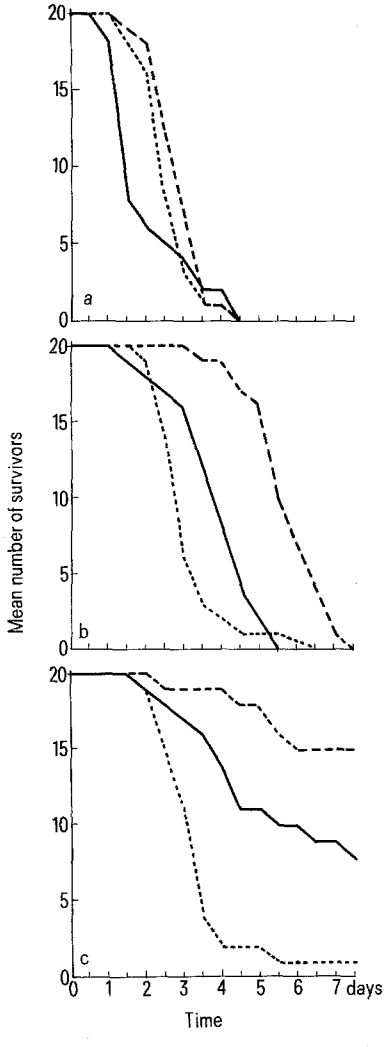

Figure 1. Survival curves (means of four replicates) of adults from two laboratory stocks of *D. buzzatii* (——), two experimental populations of *D. buzzatii* fed on *Opuntia* rots for more than 20 generations (– – – –) and two laboratory stocks of *D. serido* (· · · · · ·), kept at 25 °C on three different media. *a* No food (control); *b Opuntia* medium (without replacement); *c Opuntia* medium (with replacement). See the text for further explanation.

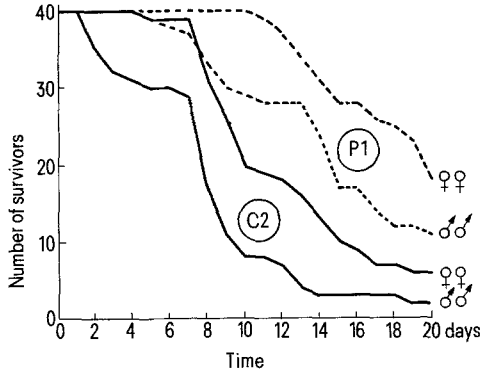

Figure 2. Survival curves (total number of survivors from four replicates) on *Opuntia* medium of *D. buzzatii* adults from two experimental populations of identical origin, one of them (P1) fed on *O. ficus-indica* rots for more than 20 generations and the other (C2) kept on standard *Drosophila* medium for the same period of time.

In order to confirm the previous result, a second test was performed. Survival on *Opuntia* medium of adults from population P1 was compared to that of adults from an experimental population (C2) with an identical origin but kept on standard *Drosophila* medium instead of on *Opuntia* rots (see Ruiz[6] for details). Four vials (with 10 individuals each) per sex and population were established. As in the previous case, adults to be tested had been reared under near optimal conditions on standard *Drosophila* medium. Adults were transferred to a new vial with fresh substrate every five days. The number of survivors was registered daily.

Figure 2 shows the results of this test: Adults from population P1 lived longer than those from population C2. On the other hand, in both cases females lived longer than males. A two-way analysis of variance performed with the number of survivors at day 10 yielded the following result: F(populations) = 32.53, $p < 0.001$, and F(sexes) = 10.24, $p < 0.01$. Analogously, for the data of day 20: F(populations) = 84.76, $p < 0.001$, and F(sexes) = 9.42, $p < 0.01$. Approximate times of 50% survival are 7.8 days (C2 males), 10.7 (C2 females), 14.6 (P1 males) and 19.6 (P1 females).

Three main conclusions can be drawn from the results reported here.

1) *D. buzzatii* adults are able to utilize *Opuntia* rots as feeding substrate while *D. serido* adults are not. The physiological basis of this difference is at present unknown but several possibilities exist. The simplest one, although not the most probable, is that *D. serido* adults cannot metabolize the monosaccharides present in the cladodes of *O. ficus-indica*, i.e. glucose, fructose and galactose[9]. An alternative hypothesis is the presence in the *Opuntia* medium of toxic compounds, such as alkaloids which have been detected in small amounts in *Opuntia* cladodes[9]. Toxic compounds can be also produced by microorganisms associated with the rotting process. Several volatile compounds, such as ethanol, methanol, ethyl acetate, isobutanol and isoamyl alcohol have been identified as cactophilic yeast metabolites[10]. In addition, 2-propanol, n-propanol and acetone have been found by us in significant amounts in natural rots of *O. ficus-indica* from southern Spain. All these chemicals can occur in our *Opuntia* vials and may be potentially toxic to *D. serido* adults. Preliminary studies (F. Peris, personal communication) show that the egg to adult viability of *D. serido* in *Opuntia* rots is comparable to that of *D. buzzatii*. Moreover, *D. serido* adults reared from this substrate in the laboratory are fertile and reproduce normally when transferred to culture bottles with standard *Drosophila* medium. However, if placed on *Opuntia* medium, they die before maturity and this explains the extinction of the *D. serido* population referred to above. All these observations lead to the idea that adult selection could be the crucial step in the niche differentiation between *D. buzzatii* and *D. serido*.

2) The mortality observed in populations P1 and P2 was selective and resulted in an improved adult survival on the *Opuntia* medium. This means that intrapopulation variability does exist for the character and that adaptation to feed on this substrate may arise through natural selection. Whether this kind of selection is actually taking place in cactiphilic *Drosophila* species in their natural habitats in unknown.

3) *D. buzzatii* adults lived longer on the *Opuntia* medium when transferred periodically to new tubes with fresh substrate. This suggests that the rotting process makes *Opuntia* tissues unsuitable for adult feeding. Fellows and Heed[5], trying to explain the observation cited above, suggested that the presence of *Drosophila* larvae was probably the cause of the inability of cactus tissues to support adult life. Our results, however, show that even in the absence of larvae, *D. buzzatii* adults do not readily survive on *Opuntia* medium. Depletion of sugar or the accumulation of toxic compounds produced by the microorganisms growing on the medium might be the cause.

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2 Van Herrewege, J., C.r. Acad. Sci. Paris (D) *276* (1973) 2565.
3 Sang, J.H., in: The Genetics and Biology of Drosophila, vol. 2a. Eds M. Ashburner and T.R.F. Wright. Academic Press, London 1978.
4 Carson, H.L., Harold L. Lyon Arboretum Lecture *2* (1971).
5 Fellows, D.P., and Heed, W.B., Ecology *53* (1972) 850.
6 Ruiz, A., Ph. D. thesis, University of Santiago, Spain, 1982.
7 Ruiz, A., Fontdevila, A., and Wasserman, M., Genetics *101* (1982) 503.
8 David, J., Bull. Biol. *93* (1959) 472. A modified formula of David's medium was used in our experiments.
9 Kircher, H.W., in: Ecological Genetics and Evolution. Eds W.T. Starmer and J.S.F. Barker. Academic Press, Australia 1982.
10 Fogelman, J.C., in: Ecological Genetics and Evolution. Eds W.T. Starmer and J.S.F. Barker. Academic Press, Australia 1982.

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Inhibitory effect of some heteropolyanions on potato virus X[1]

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Summary. Heteropolyanions like 12-tungstozincic acid (i.i.), potassium 13-vanadomanganate (i.v.), potassium 13-vanadonickelate (i.v.) and sodium tungstoborate produced an inhibitory effect on potato virus X. Amongst these, tungstozincic acid was found to be the most potent.

Key words. Potato virus X; heteropolyanions; 12-tungstozincic acid; potassium 13-vanadomanganate; potassium 13-vanadonickelate; sodium tungstoborate; antiviral activity.

Biological roles of heteropolyanions in modifying the cell membrane and affecting the adsorption and penetration of viruses are well known[2–5]. The antiviral activity of silicotungstate, and its in vitro inhibitory action on murine leukemia, sarcoma virus[5,6] and other non-neogenic viruses have earlier been reported[7–9]. Silicotungstate has been found to inhibit Escherichia coli DNA and RNA polymerases extracted from mouse $3T_3$ cells[10]. The heteropolyanion tungsto 2-antimonate protected mice against Friend and plasma variant induced leukemias[5]. It had an antiviral effect and its action did not require direct preliminary contact between virus and product. The present report deals with the effect of 4 heteropolyanions, 12-