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Indicated Biological Effect from the 9 July 1962 High Altitude Nuclear Test

by
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The occurrence of the 9 July, 1962 nuclear explosion was coincident with a series of mating tests in a long term experimental program devoted to examining reproductive variations in DROSOPHILA MELANOGASTER fruit flies. Continuous inbred matings were prepared to investigate the influence of various natural environmental parameters on progeny yields. New generations consisting of 6 pairs of flies were placed in fresh cultures every few days, using as parents flies from the preceding generation. By chance a number of new generations were initiated on the 9 July test date. Previous studies (Levengood and Shinkle, 1960) have shown that the critical period in the life cycle, that is the interval showing the greatest sensitivity to changes in environment, is the 72 hr covering the day before, the day of, and the day after the initiation of a new culture.

The 9 July test was approximately at the midpoint (09:00 UT) of this observed 72 hr critical period of apparent environmental sensitivity in the developing zygote. The data were not examined for an effect of the nuclear test until it was noticed that a consistent, and in some cases an unusually pronounced, decrease in progeny yield occurred in the same generation in a total of 8 separate test cultures. The 9 July matings were in the F_9 of test sequences which were subsequently extended to the F_{15} generation. The variations in the F_9 could not be explained by the test conditions (magnetic fields) since controls also showed the minima; nor could the effect be attributed to abnormal changes in natural exogenous environmental parameters such as solar flares or cosmic rays. The purpose of this communication is to suggest a possible influence from the high altitude radiation field on progeny yields.

MATERIALS AND METHODS

Cultures bottles (5 cm diameter and 11.5 cm high) were placed in pairs on the north (N) and south (S) poles of permanent magnets. The pole faces were rectangular shape (3.3 cm by 3.9 cm) and were vertically directed with an 8 cm separation from pole center to pole center. The field strength at the pole centers was 1,000 gauss. Medium (cornmeal-molasses type with propionic mold inhibitor) was poured into the bottles to a depth of 2.5 cm and at the medium surface the field strength was 350 gauss. The detailed configuration of the magnets and positions of the culture bottles has been presented by Levengood (1965).

The bottles were left in position on the magnets during the entire period from mating (Ore-R strain) to eclosion of the new generation. The parents were left in the bottles for ten days then removed. The progeny counts were conducted for 8 days starting with the day the new flies emerged. Six pairs of flies were randomly selected for starting each new generation and repeated filial generation crosses were made after the F_1. Both the control cultures and those in the magnetic field were initiated on the same dates.

The mean laboratory temperature was 22°C with a ± 2°C extreme variation over the entire series of 15 generations. The laboratory was located on the second floor of a

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wood frame building. The magnets were located on wooden laboratory benches with an east (N) west (S) orientation in relation to the earth's geomagnetic field; the field of the test magnets was normal to the north south geomagnetic field.

RESULTS

Detailed variations in progeny throughout the entire 15-generation sequences, as related to changes in natural environmental parameters, are discussed by Levengood (1965). The chance probability of a minimum occurring from one generation point to the next was determined by assuming random fluctuations in the external environmental influences. The chance that a progeny count may increase, remain the same, or decrease provides a simple 1:3 probability for each condition. There is also a 1:3 probability that an increase will occur following a decrease; this gives a final 1:9 probability of a minima occurring at each generation point. Considering the 8 temporally corresponding series, the value $p < 0.02$ is obtained for the chance probability of simultaneous minima.

Of the 8 cultures showing the minimums, two were controls, 4 were grown in magnetic field environments, and 2 cultures were flies grown out of the field but taken from the previous generation which had been continuously exposed from the F_1 to the magnetic field environments. As previously indicated, all generations were initially started in the F_1 from an Ore-R stock culture.

The magnitude of the F_9 effect is shown in Fig. 1 for two control cultures and a pair from the magnetic field conditions. Two generation points before and after the F_9 mating are plotted for comparison. It may be seen in Fig. 1 that the decrease is most pronounced in progeny of control cultures.

In Table 1 are mean progeny values for two generations before and two after the 9 July test date, the F_9 values on the test date and the deviations from the mean. The controls disclose the greatest deviation whereas the generations from the magnetic field environments show a lower decrease in progeny.

TABLE 1. Comparison of the mean of four generations around the F_9 with the progeny from the 9 July, 1962 nuclear test date

Test series	Four generation mean and standard deviation including two generations before and two after the nuclear test (F_7, F_8, and F_{10}, F_{11})	Nuclear test F_9 progeny	F_9 variation from the four generation mean %
Control C_1	258.0 ± 35.2	76	- 70.6
Control C_2	216.2 ± 34.4	94	- 56.5
*C_N	277.9 ± 25.5	210	- 24.5
*C_S	265.5 ± 27.0	130	- 51.0
Magnet 1 N	271.7 ± 28.0	226	- 16.8
S	256.0 ± 34.8	183	- 28.6
Magnet 2 N	282.7 ± 74.0	145	- 48.8
S	251.7 ± 22.8	124	- 50.8

*) Generation grown out of magnetic field; P's taken from the preceding magnetic field exposed generation. Subscripts indicate pole from which the parent flies were taken.

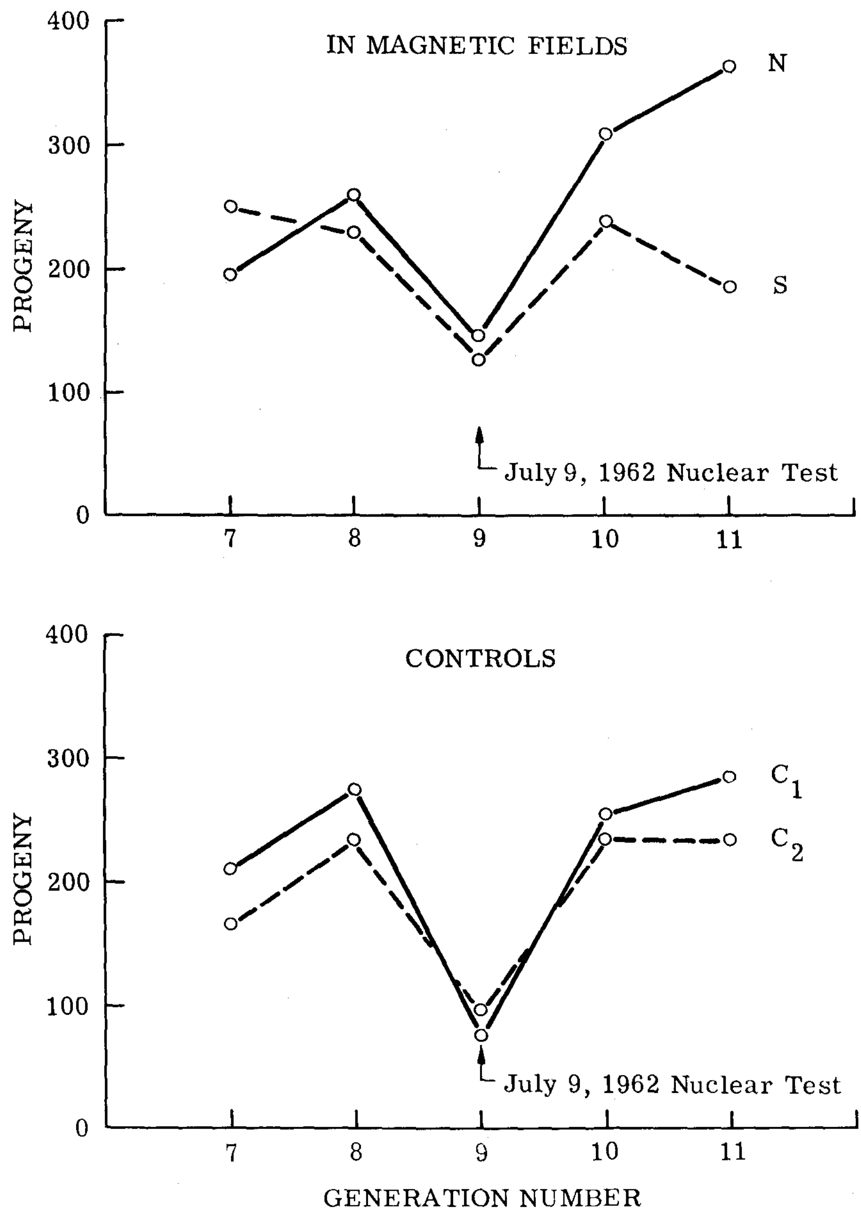

Fig. 1. Minima in progeny from generations mated on the high altitude nuclear test date

DISCUSSION

Although these F_9 test series are limited in number, the implications of these findings are discussed under the assumption that the simultaneous minimums in the curves indicate an effect from the nuclear test. Numerous reports have shown that this explosion dumped high energy charged particles into the earth's upper atmosphere. The majority of the particles ultimately trapped in the magnetosphere were electrons of energy around 0.5 MeV and located in a belt at approximately 1.3 earth radii (Hess, 1963). Measurements of flux were made in satellites and there appears to be little information regarding particle counts at the earth's surface. In a discussion of "prompt effects" Kenney and Willard (1964) suggest that magnetically trapped neutron-decay products entered the atmosphere. Their contour lines indicate approximately 20 neutrons/cm^2 in the midwestern United States, most of these decaying at around 70 km altitude. Assuming a small fraction of these neutrons reached the earth's surface, each decay beta with an energy of 0.3 MeV would form around 10^4 ion pairs. Thus, within the test bottles there may have been a sudden flux increase amounting to several hundred ion pairs per cm^3.

It is proposed that this flux increase had a direct effect on the reproductive responses. In the magnetic-field environment a significant portion of the electrons may have been deflected out of the test region. A 0.3 MeV electron approaching the equatorial plane of a test magnet within a field approx 1/10 the value at the poles ($H \sim 100$ gauss) would have a radius of curvature of approximately 10 cm. This radius could be of sufficient magnitude to deflect electrons out of the region covered by the culture bottles. This deflection might explain the lesser deviations of the F_9 generation from the mean values listed in Table 1.

The data in Table 1 also disclose that the cultures designated C_N and C_S grown one generation out of the field do not display as large a variation from the mean as the regular controls. Although the lower F_9 variations in the C_N and C_S cultures indicate that there may have been a transferred protective action, the data are insufficient to conclude that the difference between the control groups and the C_N and C_S groups is significant.

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ABSTRACT.- An influence of the 9 July 1962 high altitude nuclear test on the reproductive responses in DROSOPHILA cultures was indicated by the occurrence of simultaneous minimas in progeny curves. Progeny from cultures grown in magnetic fields disclosed less deviation from a four generation mean value than did progeny from control cultures. It is suggested that the magnetic fields deflected a portion of the increased 9 July radiation from the test region. Based on limited data, the possibility exists that a protective effect may have been transferred to first generation flies grown out of the magnetic fields.

ZUSAMMENFASSUNG.- Ein Einfluss des Kernversuchs in grosser Höhe vom 9.Juli 1962 auf die Reaktion von DROSOPHILA-Kulturen wurde durch das Vorkommen gleichzeitiger Minimas in den Kurven für die Nachkommenschaft angedeutet. Die Nachkommen aus Kulturen, die in magnetischen Feldern gewachsen waren, zeigten eine geringere Abweichung vom Mittelwert von 4 Generationen als die Nachkommen aus Vergleichskulturen. Es wird vermutet, dass die magnetischen Felder einen Teil der Strahlung vom 9.Juli vom Versuchsgebiet ablenkten. Es besteht die aufgrund begrenzter Daten gewonnene Möglichkeit, dass eine Schutzwirkung auf die erste Generation von Drosophila übertragen worden ist, die ausserhalb der Magnetfelder aufwuchs.

RESUME.- Les essais d'explosion atomique effectués à grande altitude le 9 juillet 1962 ont eu des répercussions sur des élevages de DROSOPHILA. On constante en effet des minimums simultanés dans les courbes de descendance. Les descendants provenant d'élevages placés dans un champ magnétique mentrent, en moyenne de 4 générations, une diminution moins marquée que ceux provenant d'élevages de comparaison. On suppose que les champs magnétiques ont fait dévier une partie des radiations du 9 juillet hors du champ d'essais. En se basant sur ces données fragmentaires, on peut admettre la possibilité d'un effet de protection transmis à la première génération des mouches élevées hors des champs magnétiques.