NO was respired by rats in these preliminary experiments to have achieved detectable levels of HbNO by ESR measurement. On this basis, CO and NO appear not to act similarly in the biological milieu and NO may not achieve contact with blood. On the other hand, the observed decrease in spin intensity of both HbNO and MHbNO solutions in the presence of O_2 suggests slow oxidation of NO or HbNO, which process may also occur in vivo. Animal experiments are being continued along these lines (*13*).

K. M. Sancier
G. Freeman
J. S. Mills
Stanford Research Institute, Menlo Park, California

References and Notes

1. *Quarterly Contaminant Report No. 9* (Air Pollution Control District, County of Los Angeles, 1962).
2. A. J. Haagen-Smit in *Air Pollution*, A. C. Stern, Ed. (Academic Press, New York, 1962), vol. 1, chap. 3, pp. 41–64.
3. E. L. Gray, S. B. Goldberg, F. M. Patton, E. Kaplan, *A.M.A. Arch Ind. Health* **10**, 418, 423 (1954).
4. G. Pflesser, *Arch. Exptl. Pathol. Pharmakol.* **179**, 545 (1935).
5. Q. H. Gibson and F. J. W. Roughton, *J. Physiol. London* **136**, 507 (1957).
6. C. D. Coryell, L. Pauling, R. W. Dodson, *J. Phys. Chem.* **43**, 825 (1939); J. S. Griffith, *Proc. Roy. Soc. London Ser. A* **235**, 23 (1956).
7. W. Gordy and H. N. Rexroad, *Free Radicals in Biological Systems* (Academic Press, New York, 1961), p. 263.
8. Nutritional Biochemical Corp. (2×).
9. All gases obtained from the Matheson Co.
10. Varian Associates.
11. L. Heilmeyer, *Spectrophotometry in Medicine* (Hilger and Watts, London, 1943).
12. J. R. Goldsmith, in *Air Pollution*, A. C. Stern, Ed. (Academic Press, New York, 1962), vol. 1, chap. 10, pp. 335–386).
13. This research was supported jointly by the Department of Health, State of California, and the National Institutes of Health, U.S. Public Health Service.

28 May 1962

Sterility in the Mexican Fruit Fly Caused by Chemicals

Abstract. Chlorambucil, 4-{*p*-[bis(2-chloroethyl) amino] phenyl} butyrate, administered in food to the Mexican fruit fly *Anastrepha ludens* (Loew) inhibits the growth of testes and reduces egg hatch to almost nothing. Oviposition is not affected. The compound 4-amino-1H-pyrazolo (3,4-d) pyrimidine sulfate inhibits the growth of ovaries and reduces oviposition and fertility.

Certain chemicals cause sterility in *Drosophila melanogaster* (Meig.) (*1*) and the house fly (*Musca domestica* L.) (*2*). Knipling (*3*) has outlined the concepts of the sterile-male method of insect population control with chemical sterilants.

In Mexico and Hawaii an intensive search is under way to find chemicals capable of causing sterility in or otherwise adversely affecting the reproductive processes of tropical fruit flies. Such chemicals are needed for the laboratory production of sterile flies that can be used in research on the sterilization method of control or eradication.

Candidate chemosterilants (*4*) in acetone mixed with a food (*5*) consisting of granulated sugar and orange crystals, supplemented with protein hydrolyzate, were administered continuously to Mexican fruit flies [*Anastrepha ludens* (Loew)] beginning on the day of emergence. Temperatures ranged from 75° to 80°F and relative humidities from 30 to 60 percent. From 40 to 50 pairs of flies were used in each test.

Eggs were taken (*6*) a few days after sexual maturity and at intervals thereafter during a period of approximately 15 days. The eggs were incubated on pieces of moistened blotting paper. The larvae were reared in a medium consisting of ground carrots and yeast (*7*).

Consumption of Chlorambucil at concentrations of 0.03 and 0.1 percent by parent fruit flies allowed development of some progeny beyond the egg stage and the emergence of a few adults. Consumption at 0.3 percent yielded no adult progeny (Table 1). With 4-amino-1H-pyrazolo [3,4-d] pyrimidine sulfate at 0.3 percent the average oviposition rate was 0.6 egg per day, and some adult development occurred. When these two compounds were combined, each at a 0.15 percent concentration, they had the same effect as 0.3 percent Chlorambucil alone.

Mortalities of adults feeding for 32 days after emergence on the three treated diets approximated the mortality of the controls. Sexual vigor and behavior were normal. At the lowest concentration neither chemical appeared to affect adults of the F_1 generation.

In another test male flies held separately were fed 0.1 percent concentrations of Chlorambucil for the first 14 and 21 days and then mated with females that had eaten only normal foods. Both the fertility of eggs and adult emergence were exceedingly low. A 7-day feeding period by the males prior to mating was not enough to cause appreciable sterility. When females consumed this sterilant for a comparable period before mating with normal males, there was no effect on fertility.

When newly hatched Mexican fruit fly larvae were reared in carrot-yeast media containing 0.0125 to 0.15 percent Chlorambucil, they completed develop-

Table 1. Effect of chemosterilants on reproduction of laboratory populations of the Mexican fruit fly.

Dosage (percent)	Eggs: Total laid	Eggs: Per fly on days taken	Percent: Eggs hatching	Percent: Adults developing
		Chlorambucil		
0.03	1481	9.1	5.8	1.8
.1	1498	6.2	0.7	0.13
.3	1387	4.8	2.2	0
		4-amino-1H-pyrazolo [*3,4-*d] *pyrimidine sulfate*		
0.03	1852	7.6	66.1	13.1
.1	1303	5.6	35.7	6.2
.3	172	0.6	8.7	1.7
		Mixture equal parts both above materials		
0.03	2236	8.6	56.8	17.0
.1	2230	7.5	6.9	0.4
.3	1430	5.2	1.3	0
		Untreated replicates		
1	2003	7.3	83.2	35.0
2	1894	6.8	79.9	34.7
3	1982	7.6	88.1	30.7

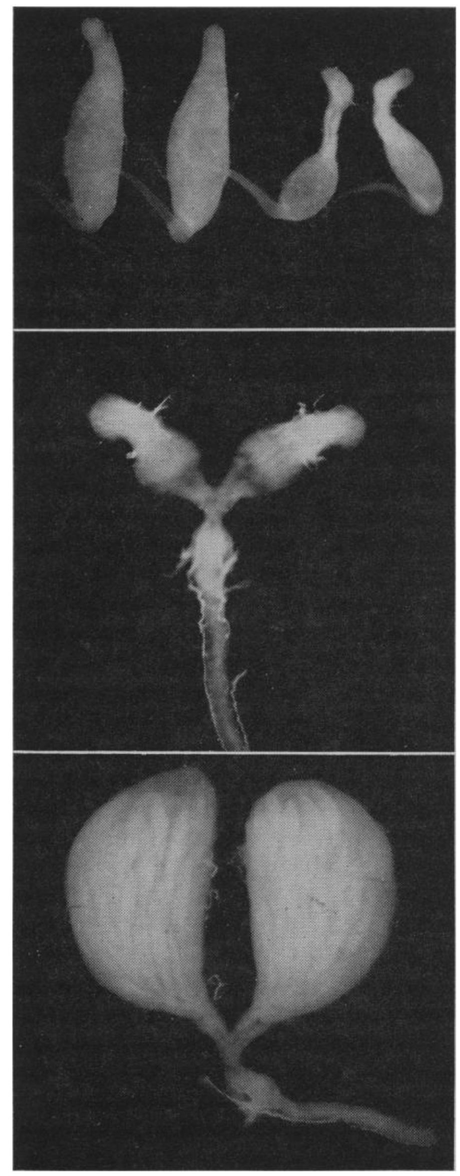

Fig. 1. Testes (top) of Mexican fruit fly, abnormal in treated flies on right and normal on left (× 20). Ovaries (middle) abnormal in treated flies, and (bottom) normal (× 10).

ment to the pupal stage but no adults emerged. Flies developing from larvae reared in media containing 0.0063, 0.0125, and 0.025 percent of 4-amino-1H-pyrazolo [3,4-d] pyrimidine sulfate were small, but they reproduced normally.

When consumed by newly emerged flies in sufficient quantities for 14 days, Chlorambucil almost completely prevented growth of testes and 4-amino-1H-pyrazolo [3,4-d] pyrimidine sulfate prevented the growth of ovaries (Fig. 1). The toxicity of these compounds to warm-blooded animals may preclude their use on field crops. However, further investigations may lead to the synthesis or discovery of other compounds that can be used safely on field crops.

J. G. SHAW
M. SANCHEZ RIVIELLO
Entomology Research Division, U.S. Agricultural Research Service, Mexico City, Mexico

References and Notes

1. E. O. Goldsmith and I. Frank, *Am. J. Physiol.* **171**, 726 (1952).
2. N. Mitlan, B. A. Butt, T. J. Shortino, *Physiol. Zool.* **30**, 133 (1957); N. Mitlan and A. M. Baroody, *J. Econ. Entomol.* **51**, 384 (1958); N. Mitlan and A. M. Baroody, *Cancer Res.* **18**, 708 (1958a); L. C. Labrecque, P. H. Adcock, C. N. Smith, *J. Econ. Entomol.* **53**, 802 (1960).
3. E. F. Knipling, *Science* **130**, 902 (1959).
4. Compounds were furnished by the Pesticide Chemicals Research Branch of the Entomology Research Division, U.S. Agricultural Research Service.
5. R. H. Rhode, *J. Econ. Entomol.* **50**, 215 (1957).
6. M. McPhail, F. E. Guisa, *ibid.* **49**, 570 (1956).
7. G. L. Finney, *ibid.* **49**, 134 (1956).

29 March 1962

Effects of Perceptual Training at Three Age Levels

Abstract. Children 6, 7, and 8 years old were first tested for their ability to reverse figure and ground and then given special training in this skill. Although all the children's ability improved greatly with practice, the initial differences between the age groups were still apparent both immediately and 1 month after training.

On the basis of numerous cross-sectional investigations with children, Piaget (*1*) and his colleagues have suggested that many complex perceptual phenomena—such as illusions, size constancy, and figure-ground reversal—are neither entirely innate nor entirely learned but rather derive from the interaction of maturation and experience. Our study was designed to test this developmental hypothesis by attempting to train children at different age levels to reverse figure and ground when both figure and ground were meaningful images. Figure-ground reversal involving the identification of meaningful images was chosen for study because, in the absence of special training, the reversal increases gradually during middle childhood (*2*). Two questions were asked: (i) Can children at different age levels profit from training in reversing figure and ground? and if so, (ii) Are the initial differences between the age groups affected by special training?

Subjects for the study were 69 children (23 at each age level from 6 to 8 years whose mean ages were 79 months, 91 months and 103 months, respectively) attending the University Elementary School at U.C.L.A. The materials consisted of two sets of 8- by 10-inch cards containing ambiguous black and white figures and a set of cardboard shields cut so that when they were placed over the drawings the hidden (reversed) figures were immediately apparent (Fig. 1). The average correlation between the two sets of drawings (based on a separate study of 150 children aged 6 to 12 years) was .56 ($p < .01$).

Each child was pre-tested on one set of cards (form A) immediately prior to training. The testing consisted of showing the child the cards one at a time and asking him, "What do you see? What does it look like?" Immediately after this test, the child was trained on the second set of cards (form B). Training involved providing the child with successively more direct and revealing clues to the perception of the hidden figure. The first clue was the statement, "Some children see more than one thing. Do you see anything else besides a ——?" (whatever the child had seen). If this clue did not prompt a reversal of figure and ground, a second clue was given, "Sometimes children see a —— (whatever figure the child had not seen) in the picture. Do you see a ——?" If the child replied that he did see the figure, he was asked to point out the parts to insure that he was not responding to suggestion. Those children who still did not see the figure were given a third clue. This time the cardboard shield was superimposed on the drawing and the previous question was repeated. The youngster was again asked to point out the parts to insure that he actually saw the reversed figure. Each child was trained to the point where he could

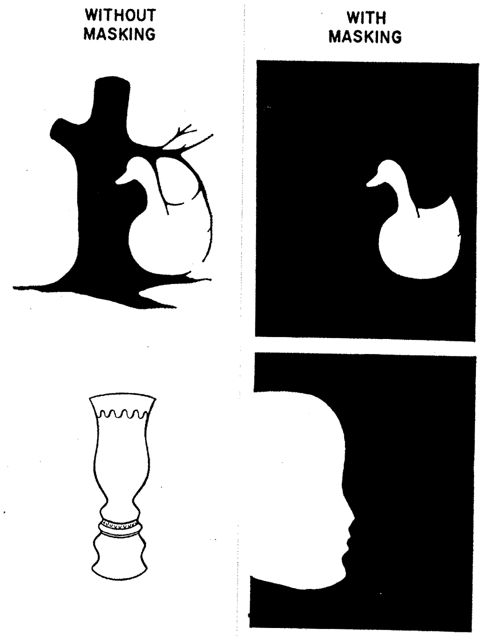

Fig. 1. Illustration of the training procedure showing two of the figures with and without masking.

indicate the parts of all the hidden figures in form B. Immediately after the training the child was again tested with form A, and then retested with the same form (A) a month later. The child's score was the number of figures he perceived of the 24 possible figures contained in the drawings of form A.

The results of the experiment were assessed by means of an analysis of variance for two variables (three age levels and three tests with form A). All three groups made significant ($p < .01$) improvement which was maintained over a month's time. There were also significant differences ($p < .01$) between the age groups both initially and on the subsequent testing.

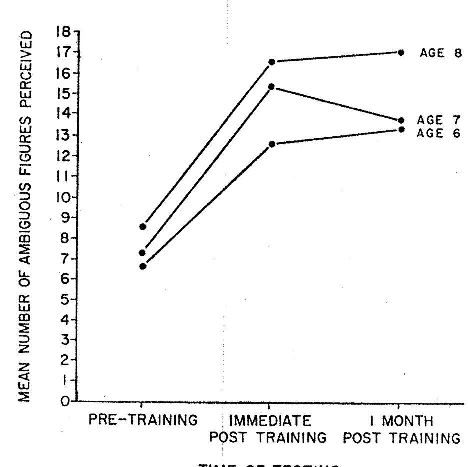

Fig. 2. Effects of perceptual training on ability to reverse figure and ground at three age levels.