TABLE 2

MORTALITIES IN SUCCESSIVE GENERATIONS OF HOUSEFLY STRAINS N, R, AND RX SPRAYED WITH A SOLUTION CONTAINING DDT, METHOXYCHLOR, CHLORDANE, LINDANE, TOXAPHENE, AND PYRETHRINS*

Strain N		Strain R		Strain RX	
Generation	Percent mortality	Generation	Percent mortality	Generation	Percent mortality
C	99	15	76	6	65
D	90	16	..	7	40
E	95	17	18	8	23
F	96	18	7	9	6
G	96	19	..	10	8
H	96	20	0	11	..
I	98	21	12	12	17

* Proportions as indicated in Table 3.

pounds. Strain RX shows no greater resistance than strain R to the mixture or to its components. It is also apparent (Tables 1 and 3) that strains R and RX show a similar degree of resistance to DDT, although the latter strain was not selected for resistance to DDT alone. Strain RX was tested for resistance to parathion and, on an LD_{50} basis, was found to be twice as resistant as strain N.

It appears, then, that strains R and RX show no specific resistance to the compounds for which they were selected, but rather show some degree of resistance to other compounds. Another point of interest is that the resistance of strains R and RX is practically the same for all of the six compounds tested. If resistance were strictly specific, strain R should be considerably more resistant to DDT than strain RX, and strain RX should be more resistant than strain R to the components of the insecticide mixture other than DDT and methoxychlor.

The question arises whether a portion of this general resistance may be due to increased vigor of the flies, resulting from several generations of selection for ability to withstand adverse conditions, i.e., poisoning by a toxic substance. Wilson and Gahan (*8*) concluded that their DDT-resistant laboratory strain was an unusually strong stock of flies, since the resistance was not specific for DDT but extended to several other insecticides. March and Metcalf (*7*), after studying three resistant wild strains and one resistant laboratory strain, concluded that the levels of resistance of each strain were specific for different insecticides and not general for all the insecticides tested. It is obvious that if a general level of resistance to several insecticides existed, all the resistance would probably be due to an increased vigor of the strain, rather than to the development of some protective mechanism against a specific poison. In strains that exhibit cross tolerance for several compounds, it may be that all of the resistance exhibited to chemicals other than the one for which the strain was selected is due to increased vigor and not to the functioning of a protective mechanism.

Experiments are being planned to determine to what extent, if any, increased vigor functions in the cross tolerances of resistant houseflies to other insecticides and in the selection for resistance to a given insecticide.

It is interesting to note that all strains showing cross tolerance only to analogues of the insecticide to which resistance was developed are wild strains (*1, 5, 6*) which obviously are not selected for resistance so severely, or interbred so strongly, as are laboratory strains. Resistance of a strain of *M. domestica* to several unrelated compounds seems to be related to a high level of resistance to the compound for which the strain was selected.

TABLE 3

MORTALITIES OF STRAINS N, R, AND RX WHEN SPRAYED WITH THE INDIVIDUAL COMPONENTS OF A MIXTURE OF INSECTICIDES

Insecticide	Quantity sprayed (g/1,000 cu ft)	Strain and percent mortality		
		N	R	RX
DDT	5.555	99	0.3	1
Methoxychlor	2.222	97	4	1
Chlordane	0.556	98	8	7
Lindane	0.167	100	72	61
Toxaphene	0.556	100	69	68
Pyrethrins	5.555	70	3	1
Mixture	Each component in above quantity	100	99	91

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A Semiautomatic Injection Apparatus for Use with Radioactive Solutions[1]

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In connection with the handling of highly radioactive or other dangerous materials, it is sometimes desirable to inject solutions into test animals by remote control. The apparatus described here affords a means of holding the skin of the animal in position while a hypodermic needle is automatically inserted. The apparatus is suitable for use with remote-control devices, and it has the

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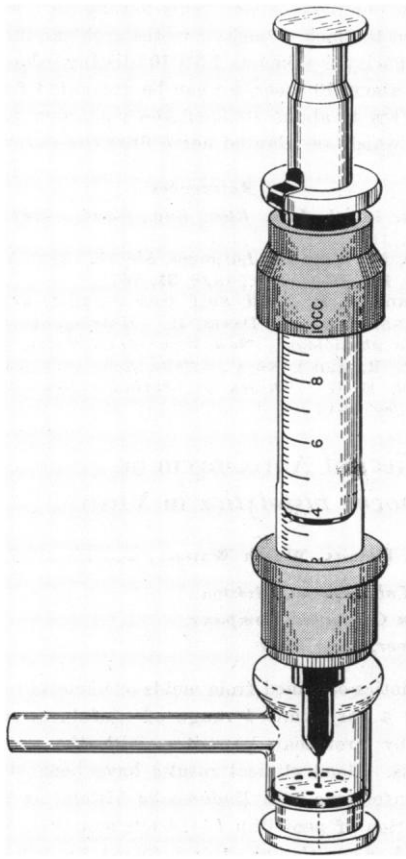

FIG. 1. Semiautomatic injection apparatus.

advantage that preliminary anesthetization or complete immobilization of the animal is not essential.

The apparatus illustrated in Fig. 1 was developed and tested in this laboratory. It consists of a glass tube with side arm, attached to a syringe. A perforated glass disk was sealed at a distance of ¼ in. from the end of the tube. A 26-gage, 1-in. hypodermic needle was attached to the syringe. The tube and syringe were connected by means of a ground-glass joint so that the end of the hypodermic needle extended out through the perforated disk. A screw connection in the position of the ground-glass joint could be substituted as a means of varying the length of projection of the needle.

In operation, the syringe is filled with the solution to be injected; it is then attached to the tube with a suitable length (¼ in. was used in our experiments) of the hypodermic needle extending through the perforated disk into the open end of the tube. The open end of the tube is placed against the skin of the animal to be injected, and suction is applied by attaching the side arm of the tube to a water aspirator. The plunger of the syringe should be held in place during this time. The skin is sucked back against the perforated disk and the needle is thus automatically forced through the skin. The injection is then made subcutaneously by simply pushing the plunger in; then the suction is immediately released and the apparatus withdrawn.

Preliminary tests were made on the shaved belly of the rat. The apparatus was found to work very successfully if a sharp needle of the proper size is used. By connecting a suitable extension rod to the plunger of the syringe, injections could be made at considerable distances from the test animal. With slight modification (proper adjustment of the length of needle extending through the disk) intraperitoneal injections were possible.

The Informational Capacity of the Human Ear

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New concepts of the nature and measure of information (*1*, *4*) have made it possible to specify quantitatively the informational capacity of the human ear. A published estimate (*5*) gives 330,000 as the approximate total number of monaurally distinguishable tones of all frequencies and intensities. Dividing this figure by ¼ sec, the approximate average time necessary for the discriminations measured, 1.3×10^6 is arrived at as the total number of distinguishable tone choices the ear can make in a second. The same figure can be obtained by an independent calculation. An extrapolation of Gabor's data (*1*) on the efficiency of perception of "logons," or elementary signals, up to 16 kc gives an average of 18% of the total, or 5,800, as the number perceptible in 1 sec. Using the Riesz intensity discrimination data (*3*), a weighted average of 230 j.n.d.'s (just noticeable differences) of intensity for pure tones can be obtained, over the whole frequency range. If it is assumed that the number is the same for an individual logon, a total of $230 \times 5{,}800 = 1.3 \times 10^6$ distinguishable tones/sec is calculated, in complete agreement with the figure estimated by the first method.

To express the capacity of the ear in the conventional informational units of "bits" (binary digits)/sec, it is necessary to inquire how many of the distinguishable tones are independent of each other. A crude procedure is to assume that neighboring logons can be independently perceived. The total number of bits/sec will then be the product of 5,800, the number of logons/sec, by the average number of bits/logon. The latter figure is calculated from the Riesz data (*3*) to be 8.2, by taking the weighted average of the $\log_2$ of the number of intensity j.n.d.'s at each frequency. By this procedure, about 50,000 bits/sec is the estimated informational capacity of the ear.

Since neighboring frequencies are known to mask one another, this figure is certainly high. Wever's recent critical review (*7*) presents convincing evidence that the masking is due both to peripheral and central interference phenomena. However, calculation of the effect of mask-

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