relationship between i_p and t. Rewriting equations (1) and (2) we get

$$E = E_0\left(1 - e^{-\frac{t}{CR}}\right) \quad (1)$$

$$e_g = \frac{1}{b}\, ln \frac{i_p}{A} \quad (4)$$

substitution of (1) in (3) gives

$$e_g + E_c = E_0\left(1 - e^{-\frac{t}{CR}}\right) \quad (5)$$

substituting for e_g in (5) from (4) and solving for t we get

$$t = -RC\, ln\left[K - \frac{1}{bE_0}\, ln\, i_p\right] \quad (6)$$

where $K \equiv 1 + \frac{1}{E_0}\left[\frac{1}{b}\, ln\, A - E_c\right]$

Inserting the values for E_c, E_0, A and b for the specific case given in Fig. 3, equation (6) reduces to the following form:

$$t = -RC\, ln\, (0 \cdot 244 - 0 \cdot 206\, ln\, i_p) \quad (7)$$

Points computed from the above relationship have been marked as circles along with the experimental plot in Fig. 3. The divergence of the computed points from the experimental curve for values of i_p above 2·5 ma. is due to its departure from the relationship given by equation (2) in that region; however, this has been advantageous here for extending the region of linearity.

In actual rig-up the instrument employs two identical Western Electric Telephone Relays operating on a current of about 1·0 ma. through the coils energised by external agencies *via* the two pairs of terminals provided. The timing circuit utilises a Western Electric mica condenser and wire-wound resistances whose values are accurately determined. Three such resistances are selected by switch Q for three ranges covering 0·1-4·0 seconds. Inclusion of a further lower range may not be possible due to the finite time lag in the electromagnetic relays used. Great care has to be taken to prevent electrical leakage by mounting all the components of the timing circuits on high insulators; relay contacts should be kept clean and should have a high leakage resistance, an indication of which is the constancy of a reading over comparatively much longer duration. The low filament current (60 ma.) of the tube 1D5GP permits a complete dry battery operation, which, besides making the instrument self-contained, offers steady potentials essential for preserving the calibration. Provision is made to check all the voltage on the meter by pressing the appropriate pushbutton switches A, B and C as shown in Fig. 1.

The instrument has been developed in the laboratory in connection with measurements of sound intensities at various levels during its grow and decay in a reverberation chamber. It will also be found useful in a variety of fields where intervals of time are to be determined with a fair degree of accuracy.

The author is indebted to Mr. B. Subramaniam, B.SC. (HONS.), for the necessary data embodying Fig. 2.

1. Puckle, O. S., *J.I.E.E.*, 1942, **89**, Part III, 100. (See also *Time Bases*, 1943, Chapman & Hall Ltd.) 2. Walker, E., *Jour. Frank. Inst.*, 1941, **231**, 373. 3 Puckle, O. S., *Loc. cit.*

INFLUENCE OF MERCURY ON INSECT EGGS—PART II

BY

B. KRISHNAMURTI AND M. APPANNA

(*Entomological Laboratory, Department of Agriculture, Bangalore*)

I. Internal changes caused by the penetration of mercury vapour into the eggs

EGGS of *Corcyra cephalonica*, 16-hours old, were exposed, for 48 hours, to the lethal dose of mercury previously determined, in a closed cylindrical jar of known volume. Necessary controls were maintained.

Microtome sections of exposed and sound eggs were examined.

The sections of the sound eggs revealed a normal proliferation of the cells and the formation of the embryo; the differentiation of the midgut and the floating cells within the lumen and the epithelial cells lining the midgut could all be clearly observed (see Fig. 1).

Sections of the exposed eggs showed little definition of the cells; the cytoplasm and nuclei were found in different stages of disintegration. The midgut could not be distinguished nor the epithelial cells. A heavily stained mass of fat, albuminoid and disorganised yolk was seen to fill the entire space (Fig. 2).

A 48-hour period of exposure was adopted since it represents the minimum period of mercury to penetrate and kill the eggs. Ninety-six hours' exposure showed complete destruction of the cellular and nuclear structures. The shrinkage of the disintegrated matter resulted in the formation of a blank cavity. Heavy precipitation was also quite evident.

These observations show that mercury vapour disintegrates the cellular contents and structures either partially or completely depending on the length of exposure.

II. Effect of mercury in grainfilled space

The dosage of 0·03 gm. of mercury effective in 3,300 c.c volume of empty space, did not prove uniformly effective against eggs placed at different points in a similar volume of grainfilled container. Only eggs, kept at a depth of 2·5 cms. below the level of mercury, were killed. Tests were, therefore, conducted with higher weights of mercury to find out the minimum lethal dose for 3,300 c.c. of grainfilled space. The eggs were placed at the middle and also at the bottom of the grainfilled receptacle; the mercury was placed at the top. The results are given in Table A.

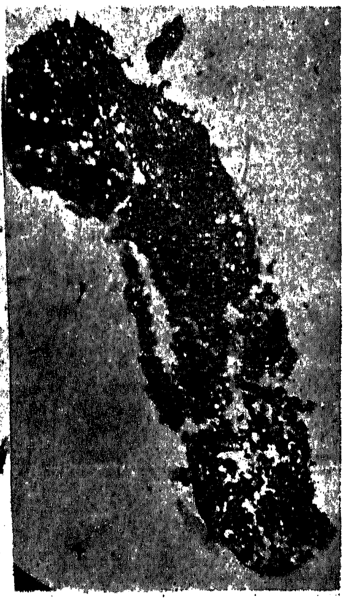

FIG. 1 FIG. 2

1. Longitudinal section of sound egg (nearly 64 hours old showing the normal formation and development of larval embryo.

2. Longitudinal section of affected egg (nearly 64 hours old) showing mostly heavily stained fat and other disorganised materials.

TABLE A

Weight of Mercury	Percentage of Kill
0·03 gm.	Nil.
0·04 ,,	Nil.
0·05 ,,	82
0·06 ,,	100
0·10 ,,	100
0·40 ,,	100

III. Correlation between volumes of empty and grainfilled spaces and the effective lethal doses of mercury

A series of tests were made to determine the lethal doses of mercury for increased volumes of empty and grainfilled spaces. In all the tests, mercury was placed at the top and the eggs at the bottom of the receptacles. Volumes (of empty space) such as 4,000, 6,600, 8,000 and 10,800 c.c., were used (Table B).

TABLE B

Volume	Empty Space		Grainfilled Space	
	Weight of Mercury	Percentage of Kill	Weight of Mercury	Percentage of Kill
4000 c.c	0·05 gm.	100	0·10 gm.	100
6600 ,,	0·06 ,,	100	0·12 ,,	100
8000 ,,	0·10 ,,	100	0·20 ,,	100
10800 ,,	0·18 ,,	100	0·36 ,,	100

Similar volumes of grainfilled space were also taken and different weights of mercury used in each case, in order to fix the effective doses for those volumes. In all these cases, the mercury was placed on the top surface of the grain and the eggs exposed, one lot at the middle and the other at the bottom. It was considered necessary to have this arrangement in these tests, since, in natural storage of grains either in bins or bags, the insect infestation (egg stage especially) is mostly always confined to the surface layers and very rarely extends to the deeper ones; the mercury vapour traversing downwards, would affect the eggs not only in the layers of the grain immediately below the surface but also those in the central and deeper layers, if for some reason (in the case of loosely packed grain for example) eggs get laid even there.

In all these volumes there is seen a gradual increase in the weight of mercury corresponding with the increase in the volumes of both empty and grainfilled spaces.

IV. Correlation between the effective doses of mercury for similar volumes of empty and grainfilled spaces

From Table B it can be seen that the effective dose for any one volume of empty space is about half that for the same volume of grainfilled space. This simple ratio of 1:2 in the case of these particular volumes tested may possibly hold true for still higher volumes of space under similar air-tight conditions.

V. The actual minimum effective (lethal) doses of mercury

It was observed in all the experiments made with the minimum effective doses of mercury for the several volumes of empty and grainfilled spaces, that the mercury did not vapourise completely during the period (the normal period required for unexposed eggs to hatch) it was allowed to act on the eggs, but that a portion of it remained over as solid metal. This residual mercury was weighed in each case and the difference between the weight of the metal originally determined as the minimum effective dose and the residual mercury was noted. The difference proved to be that actual weight of mercury which was definitely used up in the form of vapour during the period of each experiment. This weight of mercury is, therefore, to be considered as the ultimate and actual minimum effective dose as against the original weight which can only be the apparent minimum dose.

It might be mentioned here that though the apparent effective weight of mercury is many times more than the actual effective weight, quantities of mercury less than the minimum apparent effective weight (for a given volume) of mercury were not found to be effective. This may be because of the limiting factor—the normal period of hatching of the eggs (four days)—during which time the vapour pressure inside the container has to attain the optimum to affect the eggs.

One of the aims of these experiments was to see if any definite ratio existed between increasing volumes of empty and grainfilled spaces and respective effective doses of mercury. Referring to the figures in the tables, it is, however, seen that no clear and definite ratio appears to exist between either the apparent minimum weights of mercuty or the actual minimum weights of mercury with reference to increases in volumes of space. This is probably partly because the increases in volumes of space so far employed in these experiments are so small that the corresponding effective minimum weights differ very little from one another or remain practically the same.

VI. *Effect of actual minimum weight of mercury in the form of amalgam on* Corcyra cephalonica *eggs in a given volume of grainfilled space*

A series of confirmatory tests were made with the actual minimum weights of mercury (as shown in Table C) for given volumes of grainfilled space. Being very small quantities, mercury was spread on copper foils and were kept at the top surface of the grains, the eggs being placed at the bottom. Table D gives the results.

TABLE C

Volume	Empty space			Grainfilled space		
	Apparent effective weight of mercury	Actual effective weight of mercury	Percentage of kill	Apparent effective weight of mercury	Actual effective weight of mercury	Percentage of kill
3300 c.c.	0·0306 gm.	0·0006 gm.	100	0·0600 gm.	0·0006 gm.	100
4000 ,,	0·0508 ,,	0·0007 ,,	100	0·1012 ,,	0·0008 ,,	100
6600 ,,	0·0600 ,,	0·0014 ,,	100	0·1203 ,,	0·0014 ,,	100
8000 ,,	0·1010 ,,	0·0016 ,,	100	0·2008 ,,	0·0016 ,,	100
10800 ,,	0·1800 ,,	0·0024 ,,	100	0·3650 ,,	0·0024 ,,	100

TABLE D

Volume	Actual weight of mercury in amalgam	Percentage of kill
3300 c.c.	0·0006 gms.	100
4000 ,,	0·0009 gms.	100
6600 ,,	0·0014 gms.	100
8000 ,,	0·0016 gms.	100
10800 ,,	0·0026 gms.	100

It could be seen from Table D that the actual minimum weight of mercury for a given volume of enclosed grainfilled space, when used as an amalgam, proved to be effective against the eggs. In all the trials the mercury volatilised completely with slight traces at the sides of the copper foils where mercury was invariably thicker than in the centre. Such residual deposits in majority of the cases weighed not more than 0·0001 gm. each.

ACKNOWLEDGMENT

We are very thankful to the Agricultural Chemist and his assistants, for active help in weighing minute quantities of mercury in the chemical laboratory.

CONCLUSION

From the foregoing observations it may be concluded that:—

1. Mercury vapour penetrating the egg of *Corcyra cephalonica* prevents normal embryonic development by causing a destructive disorganisation and disintegration of the cytoplasmic and nuclear structures of the cells.

2. A simple ratio of 1:2 is noted to exist between the minimum effective weights of mercury in certain similar volumes of empty and grainfilled spaces used.

3. No definite ratio is evident between increases in the volumes of empty and grainfilled spaces and the corresponding increases in the minimum effective weights of mercury.

4. The actual minimum effective weight of mercury for any volume of empty or grainfilled space, is only a fraction of the apparent minimum effective weight for that volume.

5. The actual minimum effective weight of mercury for any volume of grainfilled space, if used in the form of an amalgam, is also found to be effective against the eggs.

GEOPHYSICAL PROSPECTING

GEOPHYSICAL methods of prospecting mineral ores and oil resources have assumed great practical importance in U.K. and U.S.A., particularly in the latter country, and spectacular results have been obtained through the application of these methods. Instances of large-scale mapping of ore beds in India, by the application of geophysical methods are few, and for this reason, the results obtained by a party of the Survey of India on the manganese beds in Parsoda area (C.P.) by the use of the gradiometer, reported in the latest issue of the *Journal of Scientific and Industrial Research*, are of more than usual interest. In the area surveyed, a manganese reef has been successfully located. The pattern of the profiles, and the magnitude and depth of the subsurface bodies, have been determined. In alluvial areas of the type surveyed, where no outcrops are available to indicate what is below, geophysical methods are of particular value. They provide valuable preliminary indications and save the expense of sinking random pits. Definite information regarding configuration and depth of the sub-surface body can be obtained by one or two borings.