cannulated and the opposite pulmonary vessels tied off. A tracheal cannula was inserted and attached to a source of oxygen under intermittent positive pressure. The animal's blood was placed in a reservoir kept under slight negative pressure by the action of a rotary pump (*5*), and circulated through the isolated lung, which was inflated 12 times/min by positive pressure. No effort was made to keep the lung at body temperature. High oxygen content of the blood was promptly achieved and maintained for periods of 60–90 min.

To test further the ability of the removed lung to oxygenate blood, the circulating system was stopped and the blood replaced by intensely cyanotic blood from another animal. The pump was then started again, and blood samples withdrawn from the pulmonary veins at 5- to 10-sec intervals. These were analyzed for oxygen content by the Scholander syringe method. The results of two experiments are graphically depicted in Fig. 1.

From the results shown, it is evident that the blood was completely oxygenated during a single passage through the isolated lung. In the case of the second procedure illustrated, the reservoir was kept at an abnormally high negative pressure, resulting in gross pulmonary edema sufficient to produce considerable frothy secretion in the tracheal cannula. Despite this limitation, oxygenation, although less complete than usual, was rapidly achieved and maintained.

The results indicate that the isolated lung, up to 90 min after removal from the body, and not subjected to any special care or treatment, is capable of oxygenating blood rapidly flowing through it. Certain limitations remain as yet undetermined. These include the longest interval following removal during which function is retained, the maximal blood flow permitting efficient oxygenation, and the maximal duration of function under mechanical propulsion. Whether the isolated lung releases any noxious substances that may injure an intact animal is as yet unestablished.

Further application of this form of oxygenation to experimental, and presumably clinical, surgery involves several hemodynamic considerations. It is questionable whether a single propulsive mechanism will maintain normal pressures and flow through the greater circulation and allow sufficient residual pressure to maintain adequate flow in the pulmonary bed, especially since aeration is accomplished by positive rather than negative pressure. Since a second pump may be necessary, analogous to the two sides of the heart, the problem of maintaining equal outputs of the two pumps will arise.

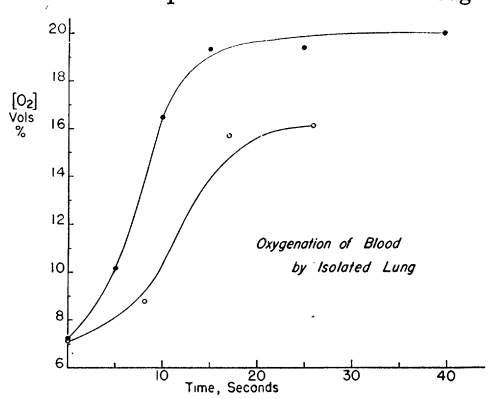

FIG. 1. Rapid oxygenation of deeply cyanotic blood circulated through an isolated lung receiving oxygen under intermittent positive pressure. ●—Expt. 1; ○—Expt. 2.

These factors are of future concern. Of interest is the fact that a relatively simple use of a natural oxygenator—an isolated lung—may make possible the diversion of blood from the heart. For the physiologist, it may permit more efficient perfusion of isolated organs for the investigation of their functions.

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Duration of Action of Residual DDT Deposits on Adobe Surfaces

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Observations made in different countries on the effectiveness of DDT residual deposits in anopheline control reveal that far from uniform results are obtained by different workers. Causes for this lack of uniformity may rest in several factors. The mosquito species being studied is undoubtedly an important factor, or at least a confusing one, since species differ markedly in habits, including house-resting habits, and also possibly may differ in response to minimal exposures to DDT. Observations of Muirhead-Thomson (*1, 2*) with *Anopheles gambiae,* for example, do not parallel observations of Wharton and Reid with *A. maculatus* (*3*), Swellengrebel and Lodens with *A. aconitus* (*4*), Bertram with *A. minimus* (*5*), or Downs and Bordas with *A. pseudopunctipennis* (*6*). Another factor of undoubted importance is the surface on which the DDT is being sprayed. Clapp *et al.* (*7*), Sundararaman and Peffly (*8*), and Maier *et al.* (*9*) have shown that surfaces of different construction materials commonly used in the tropics will retain DDT activity for varying periods of time.

Soil, as sun-baked adobe bricks, or as a plastering mixture of wet soil alone, or wet soil mixed with substances such as straw or manure, and applied over a wall of woven reeds or branches (*bajareque*) is a very

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common construction material in the tropics. Clapp *et al.* (*7*), using panels made from an alluvial clay, and Sundararaman and Peffly (*8*), using panels made from clay-cowdung mixtures, noted that the DDT rapidly lost its effectiveness on such a surface, and observations from many regions of the world, including those of Muirhead-Thomson in West Africa (*2*), Maier *et al.* in Venezuela (*9*), and Gaud *et al.* in Morocco (*10*), indicate that they observed a loss of DDT activity in a period of a few weeks or months. Puri in India (*11*) noted that the loss of activity may vary considerably in different regions of the same country.

Earlier observations reported from Mexico by Downs *et al.* (*12*) showed that with some adobes there was evidence of persistence of DDT activity for a period of years, and results of investigations of this problem are here reported.

In our experiments, adobe bricks from different regions of Mexico were obtained. These bricks contained added straw or sand reinforcement as used in the region. Four soils were selected, one from Mixquic, Distrito Federal, derived from lake-bottom loamy soil with high organic matter content; one from Acatlipa, Morelos, of sandy clay; one from the delta of the Rio Coyuca, Guerrero, of deltaic deposit, and one from Tuxpan, Michoacan, of a red, clayey soil. All these regions are malarious. DDT water-wettable powder (Santobane #50 W, Monsanto Chemical Company) was sprayed on the bricks at a rate of about 200 mg DDT/sq ft. The approximate amount sprayed on each brick was determined by quantitative chemical analysis (using an alkali dehydrochlorination method) of deposits on filter papers placed at each side of the brick. For the biological tests colony-reared *A. aztecus* and *A. albimanus* were employed. Some 15 mosquitoes, anesthetized with CO_2, were placed on the surface to be tested, under a Petri dish containing a wad moistened with sugar solution, and left for exposure periods of 15 min and 1 hr. After exposure the mosquitos were again anesthetized and transferred to a clean sheet of paper under a Petri dish with a wad of sugar solution, and were held for 23 hr. Mortality was recorded at 15 and 30 min and at 1, 2, and 24 hr after exposure. All tests were rigidly controlled, both with parallel runs on unsprayed bricks and with runs on cloth panels treated with accurately determined deposits (10, 25, 50, and 100 mg/sq ft) of 75% *para-para'* isomer of DDT, deposited on the cloth panels from an acetone solution. Duplicate runs were made at each testing period.

Soil analyses were made as follows: pH determined with Beckman potentiometer on a fresh 50% water suspension of soil; soluble chlorides by washing a 10-g sample of soil with hot water several times in a Buchner funnel and determining the chlorides by the Volhard method; base exchange capacity using the technique of the Association of Official Agricultural Chemists (*13*). Total calcium and total aluminum were determined after alkaline fusion. Fe was determined by three different procedures: first, after alkaline fusion, to determine total Fe; second, after hot concentrated HCl extraction, to determine total extractable Fe present in the form of oxides and hydrated silicates; and, third, a method using nascent hydrogen reduction in a concentrated oxalate medium, as described by Jeffries (*14*), to determine Fe present in the form of oxides only. Soils extracted by the latter technique were tested for catalytic dehydrochlorination of DDT and were found to have lost about 90% of their catalytic activity.

The technique for determining the breakdown of DDT by different soils is a modification of the technique developed for determining catalytic dehydrochlorination of DDT by Fleck and Haller (*15*). Measured amounts of DDT and soil are placed in a U-tube, immersed in an oil bath at 130° C, and clean, dry air blown across and collected in a beaker of water, agitated by a mechanical stirrer, and with phenolphthalein added as indicator. Decinormal solution of KOH is added from a burette, and the evolution of HCl plotted against time. A detailed report of this technique will be published at a later date.

Results of biological tests are summarized in Fig. 1. It is evident that there is a very marked difference in duration of effectiveness of the DDT residual deposit. Soil from the Distrito Federal has allowed the DDT to retain a high degree of activity for nearly 3 full years, and is still active at time of this writing. Soil from Morelos held activity for a year and more, whereas the soils from Guerrero and Michoacan inactivated the DDT in 3–6 months.

When these soils were tested to determine their activity in catalyzing the breakdown of DDT (75% *para-para'* isomer) at 130° C, the same relationships were observed (Fig. 2). The soil from the Distrito Federal does not initiate a reaction at all in 3 hr; the

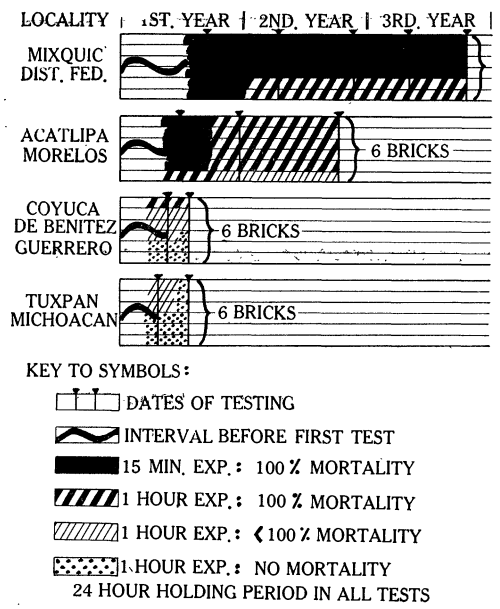

FIG. 1. Duration of action of residual DDT on adobe surfaces.

soil from Morelos initiates a reaction which decomposes about 10% of the DDT; the soil of Guerrero, a reaction which decomposes about 20% of the DDT; and the soil from Michoacan, a reaction which decomposes about 90% of the DDT. All evidence to date shows that the undecomposed residue of DDT remains active, thus indicating that a soil can be saturated, and after this saturation point is reached, undecomposed DDT remains and may accumulate with repeated sprayings. Experiments using varying proportions of DDT and soil will be reported in a later publication.

Chemical analyses of the soils (Table 1) reveal that those soils which catalyze the decomposition of DDT most effectively are the soils highest in Fe and Al. Alkalinity of the soils would not appear, from these results, to be a significant factor in catalyzing the DDT breakdown, nor does it appear to be related to adsorptive properties of the soils, as measured by the base exchange capacity.

Fleck and Haller (*15*) showed earlier that Fe and Al catalyze the decomposition of DDT. It is reasonable to assume from the above data that these substances, in complex and active form in the soil, are responsible for the phenomenon here reported, although the action of other, undetermined substances is not necessarily excluded.

Tests run in our laboratory with $FeCl_3$ and $AlCl_3$ added to the DDT in the reaction tube indicate that $FeCl_3$ catalyzes the decomposition of DDT at a very much faster rate than $AlCl_3$, and that for a given concentration of catalyst, $FeCl_3$ will decompose much more DDT than will $AlCl_3$. Apparently, therefore, Fe in the soil plays a much more important role than Al in catalyzing the decomposition of DDT. Tests using $FeCl_3$ have shown that very small amounts of Fe are necessary for the reaction (1 molecule of Fe will catalyze the decomposition of approximately 160 molecules of DDT, the reaction finally stopping, apparently as a result of accumulation of DDT decomposition products). In the case of soils, we have found that 50 mg of soil (Guerrero #1) will decompose only 1.0 mM of DDT, whereas the total amount of Fe present in the same soil should account for approximately 30 times this amount. It is therefore our deduction that only a small fraction of the Fe present in the soil is available in active form to catalyze this reaction. The figures for Fe in the form of oxides more closely parallel the data on catalytic activity of soils than do the figures for total Fe and for hot HCl extractable Fe. This, plus the observation that soils extracted by the method of Jeffries have lost most of their catalytic activity, leads to the conclusion that it is the readily available iron oxide fraction of the soil that is responsible for the catalytic activity.

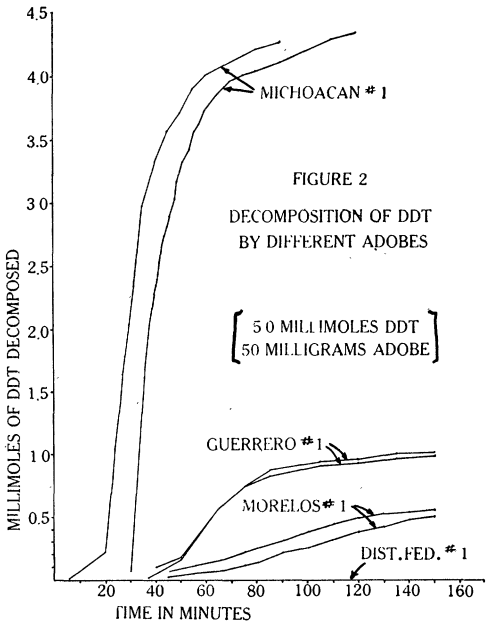

FIG. 2. Decomposition of DDT by different adobes.

Demonstration of the marked variability in the activity of different soils in catalyzing the decomposition of DDT may well help to explain some of the divergent reports on DDT action appearing in the literature.

The method for determining the reactivity of different soils is of potential importance in the rational planning of malaria control campaigns. A given soil

TABLE 1

CHEMICAL ANALYSES OF SOILS FROM DIFFERENT REGIONS OF MEXICO*

Soil	Humidity (per cent)	Loss on calcination (per cent)	pH	Base exchange capacity (mEq/100 g)	Soluble chlorides (per cent Cl−)	Silica (per cent SiO_2)	Total Ca (per cent)	Total Al (per cent)	Fe		
									Total (per cent)	Hot HCl extract (per cent Fe)	Extractable oxides (per cent Fe)
Distrito Federal #1	9.67	17.2	8.33	48.0	0.06	42.9	3.67	9.9	7.13	1.8	0.74
Morelos #1	4.66	4.5	7.45	16.4	0	54.6	1.75	6.67	17.0	2.54	1.29
Guerrero #1	1.11	5.02	8.30	16.7	0	39.2	0.71	12.7	19.2	5.7	1.65
Michoacan #1	6.21	11.3	6.75	17.2	0.004	41.5	2.57	7.2	25.7	11.5	9.29

* All percentages are referred to dry weight of soil.

can be tested in 3 hr, eliminating the need for more time-consuming chemical analyses, and up to four soils can easily be tested at the same time, by suitable arrangement of the apparatus. At present, soils from every town receiving DDT residual spraying in Mexico are being analyzed and classified.

The problem of very rapid decomposition of DDT when in contact with some soils demands the development of a practical method to avoid such decomposition. Laboratory tests we have made of the duration of DDT residual deposits on whitewashed surfaces confirm the observations of Maier *et al.* (*9*) and of Hadjinikolau and Busvine (*16*) that such surfaces retain DDT activity for relatively long periods of time. Hadaway and Barlow (*17*) report rapid loss of DDT activity on whitewash when sprayed with kerosene solutions and emulsions. The whitewash they used contained Fe (calculated as 2.6% Fe_2O_3). Further work of Barlow and Hadaway (*18*) with suspensions of water-wettable powder gave much better results. Furthermore, Clapp *et al.* (*7*) show that adding salt to the whitewash mixture lengthens the time of action of the DDT. It is probable that Maier's recommendation that walls be whitewashed before being sprayed with DDT will provide a solution to the problem presented, provided that whitewashes with low Fe content are used. A field trial of this hypothesis is now under way at Tuxpan, Guerrero. A search is also being made for substances which, when mixed directly with the DDT suspensions in the spray tanks, may inhibit the rapid decomposition of the DDT through inactivation or blocking of the catalyst, and still be cheap enough to be used in control campaigns.

Here it may also be remarked that DDT-kerosene solutions applied to adobe not only will carry the DDT in solution deeper into the adobe, out of effective range as a contact insecticide, but will also place the DDT in much closer contact with the Fe in the adobe than when DDT suspensions are used. This may help in clarifying further the relative inefficiency of such DDT-kerosene solutions, reported earlier by Barlow and Hadaway (*18*).

The reported observations may also have a bearing on problems presented by the use of DDT in agriculture. Detoxification of DDT-poisoned soils by dilute $FeCl_3$ solutions is a possibility.

Addendum: Since this manuscript was submitted for publication a paper describing the change in physical status of DDT applied to mud surfaces has appeared (*19*). We have also observed this phenomenon, including the loss of DDT activity biologically long before it disappears chemically. We feel that sorption is the first step in the process of catalytic decomposition. Sorption, in soils high in iron, takes place very rapidly (in Michoacan #1, 7 days for a 250 mg/sq ft deposit of DDT), and the reaction of catalytic decomposition at normal environmental temperatures delays for weeks or months. The reaction of catalytic decomposition at 130° C affords a rapid method for foretelling the capacity of a soil for inactivating DDT.

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A Simple Humidifying System for a Small High-Humidity Room[1]

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In attempting to construct and set up an *Avena* assay room,[3] the problem of producing and maintaining constant humidity at abnormally high levels (80–90% relative humidity) is one of primary consideration. In addition, the room must be thermostatically controlled (24°–26° C). Therefore, any method of humidification involving the use of heat, such as heating coils in a water bath, must fall within the range of the temperature tolerance (1°–2° C). In order to avoid the possible difficulty that the latter method poses, a simple, nonheating humidifying system was devised. A spray-atomizer–type humidifier, designed for a room of about 500 cu ft, was used.

The humidifier (Fig. 1 and Fig. 2, *D*) was constructed from No. 28 gauge galvanized iron, by locking and soldering. The baffle and top bracket, the latter of which holds the humidifier to the ceiling, were riveted onto the cylinder. A metal lip extends out (Fig. 1, *B* and *C*) from the front at the base of the opening. The purpose of this is to catch occasional drops of water that collect because of the direction of air flow, on the top edge of the front opening; it also serves to force the misty vapors upward, allowing for

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[2] The authors wish to extend thanks to M. Brymer, Sheet Metal Division, for assistance in construction; to George A. Reed, research engineer of Tuskegee Institute, and to M. Love, architect, for assistance in design and drawings, respectively.

[3] A darkroom for the specific bioassay determination of plant auxins, using the Went *Avena* technique.