film is touched lightly at several points with a needle that has previously been in contact with the insecticide. This seeding induces centers from which a regular branching crystallization proceeds rapidly through the film as it dries. If it dries too rapidly the celloidin hardens before crystallization is complete. This is prevented by covering the films after about 45 sec with a shallow lid, to reduce the rate of evaporation (a flat brass ring 2 in. in diameter and a second cover glass are convenient). The

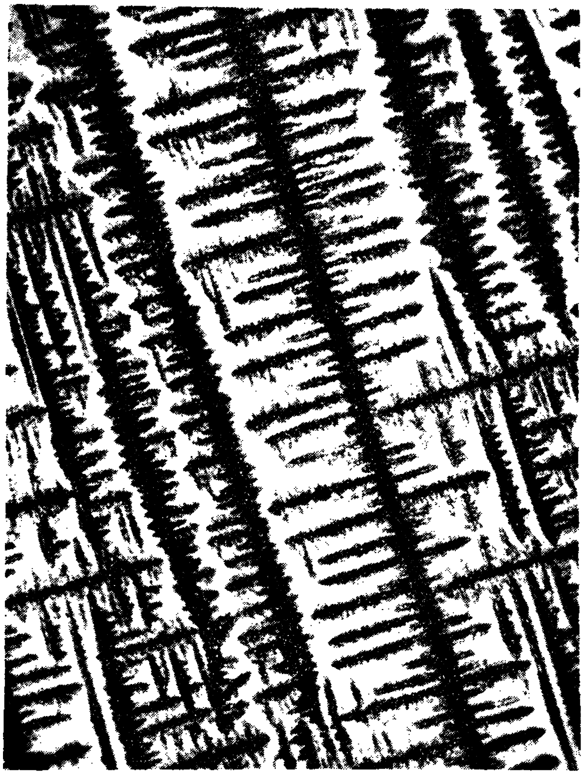

FIG. 3. Detail of structure of crystals deposited from a 1% solution of γ-hexachlorocyclohexane (×120).

celloidin base is estimated to be approximately 0.15 μ thick when dry. A small proportion of films have to be discarded because of irregular or unevenly spaced crystallization. Less seeding is needed in γ-hexachlorocyclohexane than in DDT; and less is needed in the higher concentrations of either, crystallization being more rapid and spontaneous. When crystallization is complete and the celloidin hardened, the cover glasses may be stacked up for a time until needed; a standard 5 in. × 3 in. card index drawer equipped with slotted racks is convenient for storage. The films of DDT are more persistent than those of γ-hexachlorocyclohexane.

The general appearance of part of the DDT deposit showing the centers from which crystallization radiates is shown in Fig. 1. Fig. 2 shows detail of DDT crystal structure under magnification, and Fig. 3 that of the more angular deposit of γ-hexachlorocyclohexane. Fig. 4 shows a simple test chamber convenient for use with *Drosophila melanogaster* Meig. The chamber is made by clipping two cover glass films face to face, separated by a brass ring 3/16 in. thick and of internal diameter equal to the deposit circle. Such rings may be made by sawing off pieces 3/16 in. long from standard heavy-gauge brass pipe of suitable size.

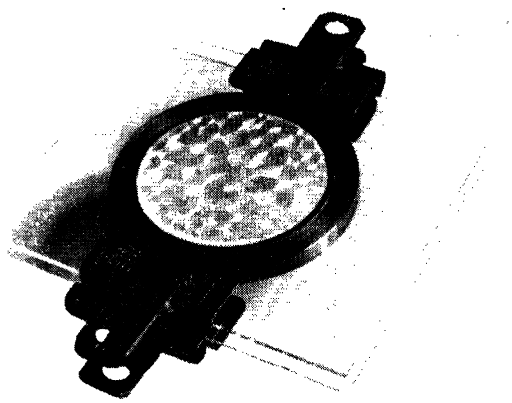

FIG. 4. Test chamber made by clipping two cover glass films face to face, separated by a brass spacer ring.

Anesthetized insects are introduced into the chamber and exposed for varying periods of time. They may be anesthetized again for removal by slipping a strip of paper impregnated with ether between the ring and the upper cover glass, the glass being first moved a little to one side so that the deposit is off center and the ether strip does not touch it. The data obtained are susceptible to the usual probit analysis treatment. The great convenience of the method lies in the rapidity with which films can be made and in the large number of tests that can be carried out simultaneously.

X-Radiation from Electron Microscopes

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We have had occasion recently to monitor our electron microscope for x-radiation while taking motion pictures of electron microscope images (*3*). The survey was necessary from a health standpoint because the microscope was being operated under abnormal conditions, which were optimum not only for the motion-picture techniques but also for the production of x-rays. Following the published work of Silverman *et al.* (*2*) on the same subject, the results of the survey may be of interest and are reported here along with the data of surveys conducted on 3 Detroit instruments operating under normal conditions.

The abnormal conditions for motion-picture work are: (1) the final viewing screen is tilted at an angle of about 30 degrees, and (2) the usual 25-mil condenser aperture is opened to 50 mils. Thus, a more intense beam is allowed to strike an inclined target with a corresponding increase in x-ray hazard. Some remarkably high dosage rates were recorded for these circumstances. Fig. 1

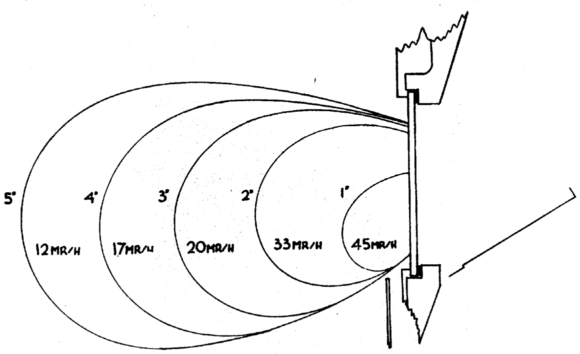

FIG. 1. X-ray isodose curves from an EMU electron microscope at the location of the final viewing screen, the microscope set up for motion-picture studies.

shows rough isodose curves at the final viewing screen. The distances were measured from the microscope window to the unshielded, nylon window of the meter, and since the meter consisted of a chamber 8 in. long, the isodose curves may extend as much as 4 in. farther out than shown. If an individual spent 2 hr with his eye at the 45 mr/hr position while focusing, he would be close to exceeding the formerly recommended maximum of 0.1 r per day. There would be danger of superficial erythema, especially to the eyes, which are prone to develop cataracts under low-voltage x-radiation. Lead glass can be used as an effective shield, or ¼-in. plate glass will interpose 2 half-value layers to reduce the radiation considerably for motion-picture work.

Hillier (*1*) has recommended that the x-ray level be measured and guarded against whenever the nature of electron microscopic work involves the use of a condenser aperture greater than is supplied with the original instrument. This observation is supported by the present work.

A Tracerlab "Cutie-Pie" portable survey meter, which is an ionization chamber of an integrating type, was used for taking the measurements. When the readings were taken the meter was assumed to be bathed with radiation. Table 1 gives values of the dosage from the

TABLE 1

Instrument	Location of dosage	Maximum dosage (varying condenser aperture) (mr/hr)	"Normal" dosage (mr/hr)	Specimen holder present
Edsel B. Ford	Top port	10	10	
Institute, 50-mil	Intermediate screen	65	24	Yes
condenser aper-	" "	230		No
ture: gun	Final screen	40	10	Yes
saturated	" "	40		No
at 500 µa				

microscope when it is set up for motion-picture studies. The dosage is measured at points directly in front of, and 3 in. from, an EMU microscope. The instrument in the "normal" operating condition means, with a saturated, biased source, no objective aperture, condenser current set so that one square in the specimen screen is illuminated, and the final magnification × 5,000.

We have not found that dangerous overdosages may be received from microscopes operated under so-called normal conditions with the usual 25-mil condenser aperture and an untilted final screen. To check this and to offer a suitable comparison with Silverman's report, 2 microscopes in addition to our own have been surveyed in the vicinity of our laboratory (Table 2). The data are

TABLE 2

Instrument	Location of dosage	Maximum dosage (mr/hr)	"Normal" dosage (mr/hr)	Specimen holder present
Henry Ford	Top port	0	0	
Hospital, gun	Intermediate screen	13.5	11.0	Yes
saturated	" "	45.0		No
at 200 µa	Final screen	2.5	1.0	Yes
	" "	4.0		No
General Motors	Top port	0	0	
Research, gun	Intermediate screen	3.5		Yes
saturated	" "	22.0	6	No
at 350 µa	Final screen	2.5		Yes
	" "	5.0	1.0	No
Edsel B. Ford	Top port	10.0	10	
Institute, gun	Intermediate screen	17.0	7.5	Yes
saturated	" "	65.0		No
at 500 µa	Final screen	7.5	0	Yes
	" "	10.0		No

taken again under the same conditions as in Table 1, except that the screen is not tilted and a 25-mil condenser aperture is used. In Table 2 it is seen that for the instruments operated in a normal fashion the dosages are low, and, unless an operator remained for unusually long periods or was constantly closer than 3 in., he would be well within tolerance limits. However, since normal operation is likely to be defined in a variety of ways, because there are so many variables in a measurement of this sort and because tolerance limits are being subject to constant revision, it is recommended that instruments be monitored by individual laboratories.

Maximum dosages are given in the table, which are maximum only for the conditions cited, namely, for variations in condenser current. Dangerous maximum dosages are recorded, but the conditions giving rise to them are usually transient in the microscope, and it is doubtful that personnel would receive daily doses above tolerance from them. A specimen holder (without a specimen screen) reduces the dosage considerably, and in all cases it seems that the *dosage from the intermediate screen* is that to be most guarded against. This may be made negligible by discarding the angled screen and using one that presents a flat surface to the incident beam. Further protection can be secured at the intermediate level by use of the magnetic shielding provided.

X-radiation from the top port, which might have been expected to be the most intense, is apparently eliminated by supplying the microscopes with lead glass. The intermediate and final levels do not seem to be so much protected in these 3 microscopes. The x-radiation from the top port can also be minimized by discarding the angled screen.

References

1. Hillier, J., and Ellis, S. G. *J. appl. Phys.*, 1949, **20**, 700.
2. Silverman, L. B., Elliott, S. B., and Greenfield, M. A. *Science*, 1949, **110**, 376.
3. Watson, J. H. L., and Preuss, L. E. *J. appl. Phys.*, Sept., 1950.

A Low-Temperature Incubator

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Occasionally the need arises for an accurate and versatile low-temperature incubator or BOD box, but the purchase of a commercial unit is not always justified. In this laboratory a large incubator operating at 28° C and containing 4 fluorescent light fixtures was required for the incubation of microbiological assay tubes of *Euglena gracilis*. Commercial BOD boxes available at that time did not have adequate usable incubating space to serve this purpose, but a standard household refrigerator was easily converted into a large-capacity, low-temperature incubator.

The conversion was accomplished by building and inserting on the top full-width shelf of the refrigerator the unit shown schematically in Fig. 1. Dimensions have been omitted, since actual construction details depend upon size and position of shelves and freezing unit in the refrigerator being converted. This conversion unit effects the isolation of the cooling coils of the refrigerator from the rest of the box, and, by means of controls, the desired temperature of the remainder of the box can be maintained. No mechanical modifications of the refrigerator are necessary, the unit is easily removed to allow normal use of the refrigerator, and the refrigeration mechanism is not put under any strain. The necessary materials, a sensitive thermoregulator and a relay, a coil heater, a fan, and various other items, are readily obtainable.

The freezing unit is isolated from the rest of the box with rigid insulation board (¾-in. Celotex sheathing) partitions. The edges of the insulation boards are edged with rubber weatherstripping to form a snug seal at the back wall, side wall, top, and door of the refrigerator.

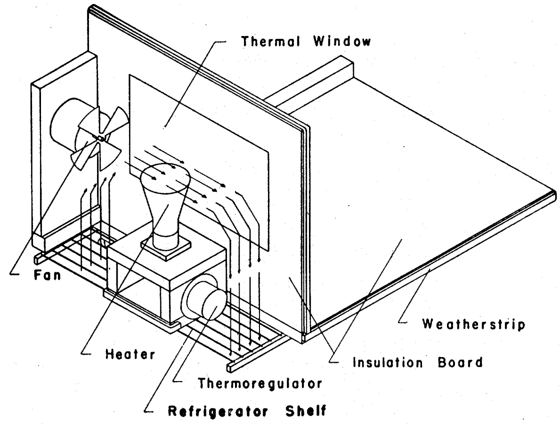

FIG. 1.

The isolated freezing unit is thus allowed to operate normally, and the amount of "cold" transferred to the rest of the box can be controlled by means of a "thermal window," a sheet of metal fitted into an opening in the vertical insulation board next to the freezer. This window acts as the cooling surface for the air in the rest of the box and is made large enough to transfer more heat than is produced by the fan motor and other heat sources.

The temperature of the circulating air is then adjusted by a heater coil that is actuated by a thermoregulator assembly. The heater and thermoregulator are placed, as indicated, on a support that also serves to force the seal of the unit to the side walls, and to direct the flow of air. The fan is attached to a wooden support that also reinforces the partitions, and is placed so that by its direction of rotation it draws air up from the box, forcing it past the thermal window and heater, and down into the box again (Fig. 1). The sensitive bimetallic end of the thermoregulator is placed below the fan so that it is affected by the air coming up from the box. The relay control box is placed outside the refrigerator. Necessary electrical wiring to the fan, heater, and thermoregulator is passed between the box and the rubber insulation of the door.

With the refrigerator operating at a temperature colder than is necessary, the thermoregulator can be adjusted to maintain the desired temperature in the box. Temperatures ranging from 7° to 40° C can be maintained, with no greater variation than ± 1° C throughout the incubating space.