material. If a distance of more than 25 cm. is employed, it is advisable to connect two or four cells in parallel: the effect is approximately proportional to the number, but it may be necessary to select cells which match each other's characteristics. In general, the cells are very equal in their output, and a comparison of cells five years old with cells one year old showed no significant difference.

In cases where high intensities and short distances are used, the galvanometer may be replaced by a direct reading microammeter. For example, using four cells in parallel at 12 cm. from the target, with an output estimated at 1,000 r., the reading was 12 microamperes: with a single cell it was slightly more than 3.

Such an arrangement has several advantages: it is compact and portable, it is not affected by atmospheric conditions, gives a continuous reading which immediately responds to fluctuations of the radiation produced by voltage changes or thermal variations in the tube. The cell can usually be placed in contact with the object radiated, and once calibrated, by means of a dosimeter or a biological test, can be relied on to give reproducible results. It can be recommended to all who require a rapid and simple method of X-ray dosage.

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June 7.

[1] NATURE, 141, 873 (1938).

Cytology of Metamorphosis in the Culicinæ

C. R. RIBBANDS[1], commenting on my recent communication[2], states that I apparently overlooked the work of Holt[3] on the gut of *Culex*. References to Holt's work may be found in two of my papers[4], which appeared in well-known journals during the past two years. Having been a student of Prof. Metz, I am also familiar with his work on the paired association of somatic chromosomes. Indeed the present investigation was undertaken at the suggestion of Prof. Metz and much of the work was done under his supervision.

Regarding the several points of disagreement between Holt's results and mine, it may be noted that the evidence for my results has been given briefly in four preliminary reports, referred to in this[4] and a former communication[2], and that a detailed account with photomicrographs is in the current issue of the "Contributions to Embryology" of the Carnegie Institution of Washington.

A possible explanation of our different results may be found in the technical advances of the past twenty years. Holt's work was based entirely on sectioned material. The iliac epithelium of *Culex* has the form of a narrow tube, the wall of which is a single layer of cells. These cells are usually in the shape of a flattened ellipsoid. The tube itself is not straight and different regions may be in different states of contraction and expansion. Judging cell size from sections of an organ of this type is very difficult, if at all possible. Camera drawings of such sections yield no certainty regarding cell size. Yet a few such camera drawings by Miss Holt are taken by Ribbands as showing conclusively the lack of correlation between cell size and chromosome number.

In addition to sections and aceto-carmine smears, my best evidence for a correlation between cell size and chromosome number came from whole mounts of the larval hind-gut, dissected out and stained by the Feulgen technique. Whole mounts prepared in this way are invaluable in the study of metamorphosis. All the cells are present whole, essentially undistorted and in their normal position. The preparation is transparent and the upper and lower walls can be examined under the oil immersion. In a series of such preparations, relative cell size is apparent, and the fate of each tissue during metamorphosis can be clearly followed.

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[1] Ribbands, C. R., NATURE, 141, 920 (May 21, 1938).
[2] Berger, C. A., NATURE, 141, 834 (May 7, 1938).
[3] Holt, C. M., *J. Morph.*, 29, 607 (1917).
[4] Berger, C. A., *Proc. Nat. Acad. Sci.*, 22, 186 (1936). *Am. Nat.* 71, 187 (1937).

I REGRET that I wrongly concluded[1] that Prof. C. A. Berger had overlooked the work of Holt[2], but no reference to it appears either in his original letter[3] or in either of the other two preliminary accounts referred to therein in which he outlined his results, some identical with those of Holt, others in contradiction to them. His communications contained no mention of his own technique, which therefore could not be compared with that of Holt.

If chromosome number is correlated with cell size in this instance, another example is added to a long list of similar cases[4], but examples of lack of correlation are still known[4]. Berger's data relative to cell size have not been published, but he states that in the ileum of *Culex pipiens* the smallest cells, without complexes, have a nuclear diameter of 3μ, and that "greatest diameters of nuclei range from 10μ to 17μ"[5], these latter cells having complexes of up to 192 chromosomes[3]. Holt illustrated a prophase nucleus (Plate 2, Fig. 19) containing only 18 chromosomes, which had a greatest diameter of about 13μ. Since Holt's drawings are from sections, it is unlikely that the nucleus has been artificially flattened, as it could be when using either smears or the new method which Berger describes above, and therefore this one example indicates that there is no exact correlation between chromosome number and nuclear volume in this tissue. Cell volume is even less likely to be proportional to chromosome number, since instances are known in which chromosome volume affects nuclear volume without altering cell volume[6].

None of the six preliminary reports of Berger give any proof of his more important disagreement with Holt's results, concerning the possibility of a regular reduction in the chromosome numbers in these cells, so I await his detailed account in the hope of a solution both of this problem and of the one concerning correlation between cell size and chromosome number.

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[1] Ribbands, C. R., NATURE, 141, 920 (May 21, 1938).
[2] Holt, C. M., *J. Morph.*, 29, 607 (1917).
[3] Berger, C. A., NATURE, 141, 834 (May 7, 1938).
[4] Darlington, C. D., "Recent Advances in Cytology" (2nd Ed. London, 1937), 221–228.
[5] Berger, C. A., *Anat. Rec.*, 67, Suppl. 1, 63 (1936).
[6] Darlington, C. D., "Recent Advances in Cytology" (2nd Ed. London, 1937), 55.