producing perfect preparations for photomicrographic work. Figures 1 and 2 illustrate the results obtained with the modified technique as applied to \emph{P. salinaria} and \emph{Sarcina litoralis}, the two halophiles chiefly responsible for the reddening of salted hides and codfish.

**A SIMPLIFIED DEVICE FOR CONTINUOUS GROWTH OF MICROORGANISMS**

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One of the frequent problems of the microbiologist is to obtain microorganisms grown under the same chemical and physical conditions. A number of methods have been published providing satisfactory means to maintain a culture in continuous growth (Monod, Ann. inst. Pasteur, 79, 390, 1950; Novick and Szilard, Cold Spring Harbor Symposia Quant. Biol., 16, 337, 1951; Kubitschek, J. Bacteriol., 67, 254, 1954) and it has been the common assumption that the microorganisms are physiologically identical under the conditions described. Evidence in favor of this assumption will be published elsewhere.

Although the apparatus so far described in the literature are suitable for specialized problems, they lack the simplicity desirable for routine work in microbiology. This communication presents a modification of the chemostat of Novick and Szilard offering a reduction in cost and ease of operation and maintaining at the same time a reasonable level of accuracy.

Figure 1 shows the complete apparatus with the exception of the air supply and the constant temperature bath which are standard equipment in any laboratory. The apparatus is made of three pieces connected with glass joints and held together by springs. Each part is autoclaved separately and then, after the medium in the Erlenmeyer flasks has equilibrated with room temperature, the apparatus is assembled upside down, inverted and suspended from a ring stand over the constant temperature bath so as to have the culture submerged completely. The method is based on the delivery of nutrient solution at a constant rate into a constant volume of culture. The nutrient solution contains limiting amounts of an essential metabo-

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2 The complete apparatus may be obtained from the Erway Glass Blowing Co., Oregon, Wisconsin.
A BACTERIOPHAGE FOR AZOTOBACTER

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Although Den Dooren de Jong (Arch. Mikrobiol., 9, 223, 1938) has reported an appearance in old cultures of azotobacter which were suggestive of phage lysis, he was unable to isolate the agent, and no report of the isolation and characterization of an azotobacter phage has appeared in the literature. After many attempts we have isolated from soil an agent that forms plaques on the green pigment producing strains of Azotobacter agile which are designated as A. vinelandii. It does not form plaques on the non-pigmented strains which are generally labeled A. agile. It can be plated with equal efficiency on Wisconsin strains O and K and on Texas strain 5 as well as on a series of single biochemical mutants (leucineless) and double biochemical mutants (leucineless-isoleucineless) derived from the Texas strain. It plates with a much reduced efficiency on the strain which was secured some years ago from the American Type Culture Collection No. 7432. Strains of A. agile (non-pigmented) 4.4, S-2, 7494 and 9040 yielded no plaques, nor were any plaques observed with the three strains of A. chroococcum which were tested.

In liquid cultures a phage titer of 10⁶ can be obtained, but the culture never clears completely, since a rough non-encapsulated strain always arises and appears to be resistant. Even on solid media the rough strain occupies the plaques, and we have never observed a plaque that was completely free from the nonencapsulated cells. Infected cultures present an abnormal morphology which has not as yet been studied in detail. The phage has been stored in the refrigerator for over a year without loss in titer. It is relatively sensitive to centrifugation; 30-minute centrifugation at 10,000 gravity in the refrigerated centrifuge destroys the infectivity and electron microscope pictures show cytological damage. Concentrated filtrates shadowed with chromium show the phage to have a head about 90 mₜₚ in diameter and a tail 150 mₜₚ long.

The apparatus as described here has been used in this laboratory for a period of 5 months with flow rates ranging from 0.7 to 15 ml per hour. Fifteen determinations of the time necessary to deliver 2 ml gave an average of 34.3 min with a standard deviation of 1.2 min and a spread from 33.5 to 35.0 min using 3.5 ml per hr flow rate. The average flow rate during an 8-day period was 1.98 ml/hr with a spread of 1.8 to 2.2 ml/hr with a standard deviation of 0.23 ml/hr.

For routine work it is advisable not to use selective media and to start a fresh culture every 10 days if selection of mutants is to be avoided. In our laboratory, using Escherichia coli with genetic markers, we have not detected selection over periods ranging from 10 to 20 days using an average generation time of 5 hours.