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Comparison of Surface Pore Morphology of Two Brands of Membrane Filters

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The surface pore morphology of two brands of membrane filters was studied by using scanning electron microscopy. The differences observed are presented as a possible explanation for reported discrepancies in coliform recovery from water.

Over the last several years, the membrane filter (MF) technique for enumeration of coliforms in water has been adopted by most laboratories involved in this type of analysis in the United States. The protocol for this test is clearly outlined in the 13th edition of *Standard Methods for the Examination of Water and Wastewater* (1). *Standard Methods* imposes no requirements on the water laboratory in regard to quality control of MFs used. The manufacturers, however, are required to certify through laboratory tests that their MFs "provide full bacterial retention, stability in use, freedom from chemicals inimical to growth and development of bacteria and satisfactory speed of filtration" (1).

Problems with the MF technique have been noted by many workers in the past 2 years. Presswood and Brown (4) reported that Gelman (GN-6) filters recovered an average of 2.3 times more fecal coliforms in a given suspension than did the Millipore (HAWG 0470) filters. Schaeffer et al. (5) reviewed the data of Presswood and Brown (4) and reported that Gelman filters recovered more total coliforms than did Millipore filters but the same number of fecal coliforms. Hufman (3) determined that the MF fecal coliform test was dependent on the brand of filter employed and concluded that the test cannot be recommended as a laboratory tool for *Escherichia coli* enumeration. These authors presented possible explanations of discrepancies, including sterilization methods (2, 4), pH (4), and toxic effects. Recently Sladek et al. (6) presented a pore morphology explanation in which they concluded that the surface structure of the membrane is the primary factor in fecal coliform recovery. They also presented data suggesting that neither the method of sterilization nor the chemical composition of the filters has any significant effect on the recovery rate. The purpose of this report is to examine the pore morphology of two brands of filters by using scanning electron microscopy.

Three types of filters were examined: Millipore HCWG 047S3 (lot no. 37158-10; designated pore size: 2.4-μm surface, 0.7-μm retention), Millipore HAWG 047S1 (lot no. 27528-23; designated pore size; 0.45-μm retention), and Gelman GN-6, 64776 (lot no. 81091; designated pore size: 0.45 μm). Micrographs were taken using a Coates and Welter CWICSCAN 100-2 scanning electron microscope. The membranes were coated with approximately a 20-nm layer of a 60% gold-40% palladium alloy. Care was taken not to exceed magnifications of ×5,000 because the electron beam tended to distort the filters at higher magnifications.

The pore morphology theory of Sladek et al. (6) states that fecal coliforms need to be completely immersed with nutrients for optimum recovery rates. The HA filters (Fig. 1) require the organisms to be on the surface of the filter. Because of this, portions of the bacterial cells are not covered with nutrients. The locally hypertonic areas of these incompletely covered cells result in plasmolysis. The new HC filters (Fig. 2) allow the cells to be cradled below the surface due to the surface pore structure. Smaller pore openings in the depths of the filters keep the organisms from passing through the filters. These totally immersed bacteria have a much better chance of beginning multiplication and thus forming a countable colony.

If the theory of Sladek et al. is valid, micrographs of GN-6 filters would show many large surface pore openings. The GN-6 micrograph does indeed show this (Fig. 3). Although the surface pores are not as large as those seen in the HC filters, they are distinctly larger than those observed on the HA filters. This fact supports the work of Sladek et al. (6) and provides a possible explanation for coliform recovery discrepancies.

This report shows the need for an in-depth study of all brands of MFs in respect to pore morphology. I also feel that the facts presented here, in addition to those established previ-

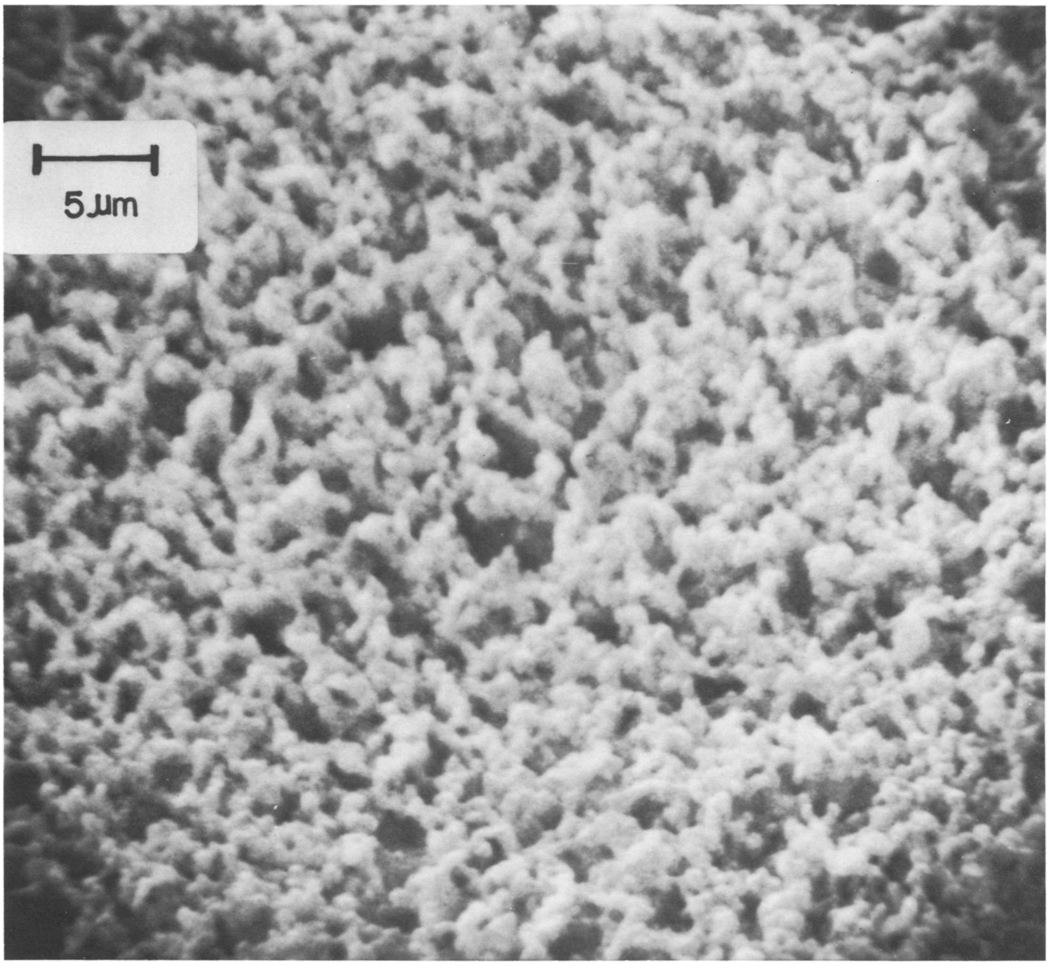

FIG. 1. *Millipore HA filter.*

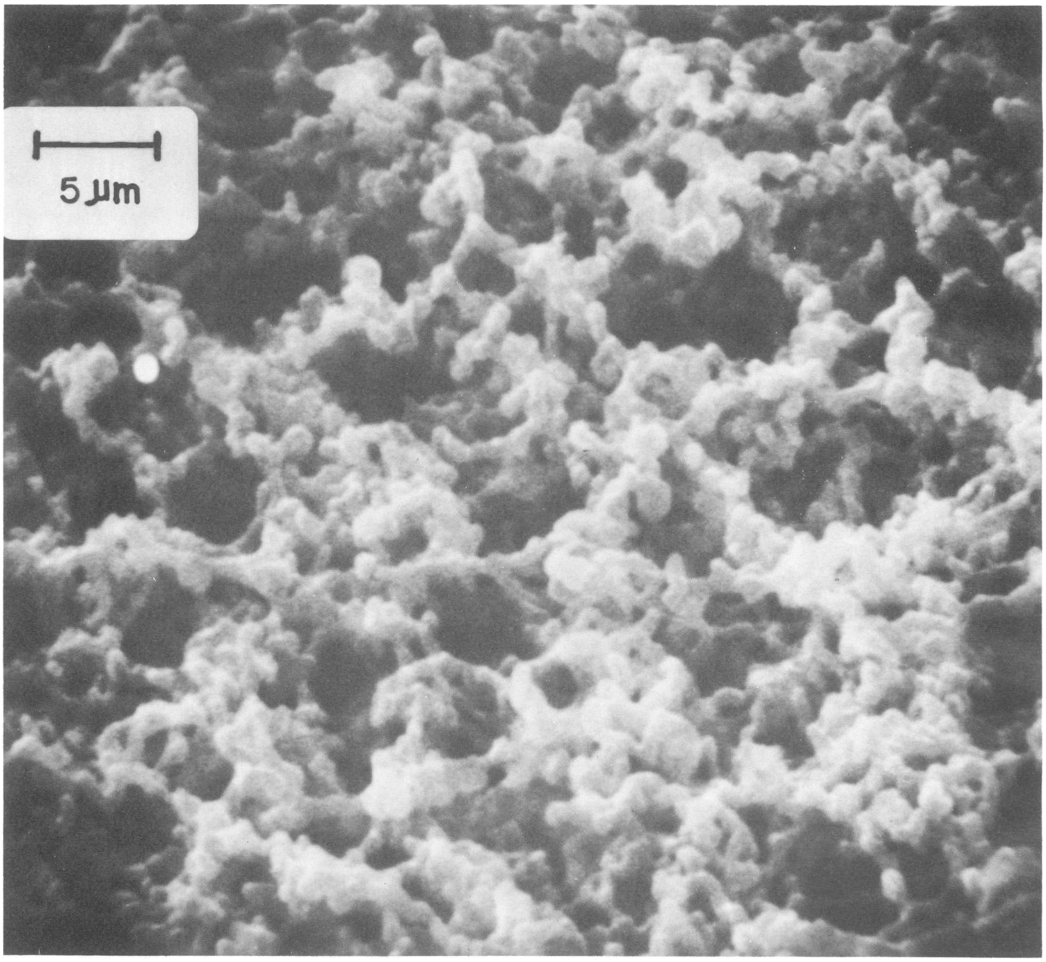

FIG. 2. *Millipore HC filter*.

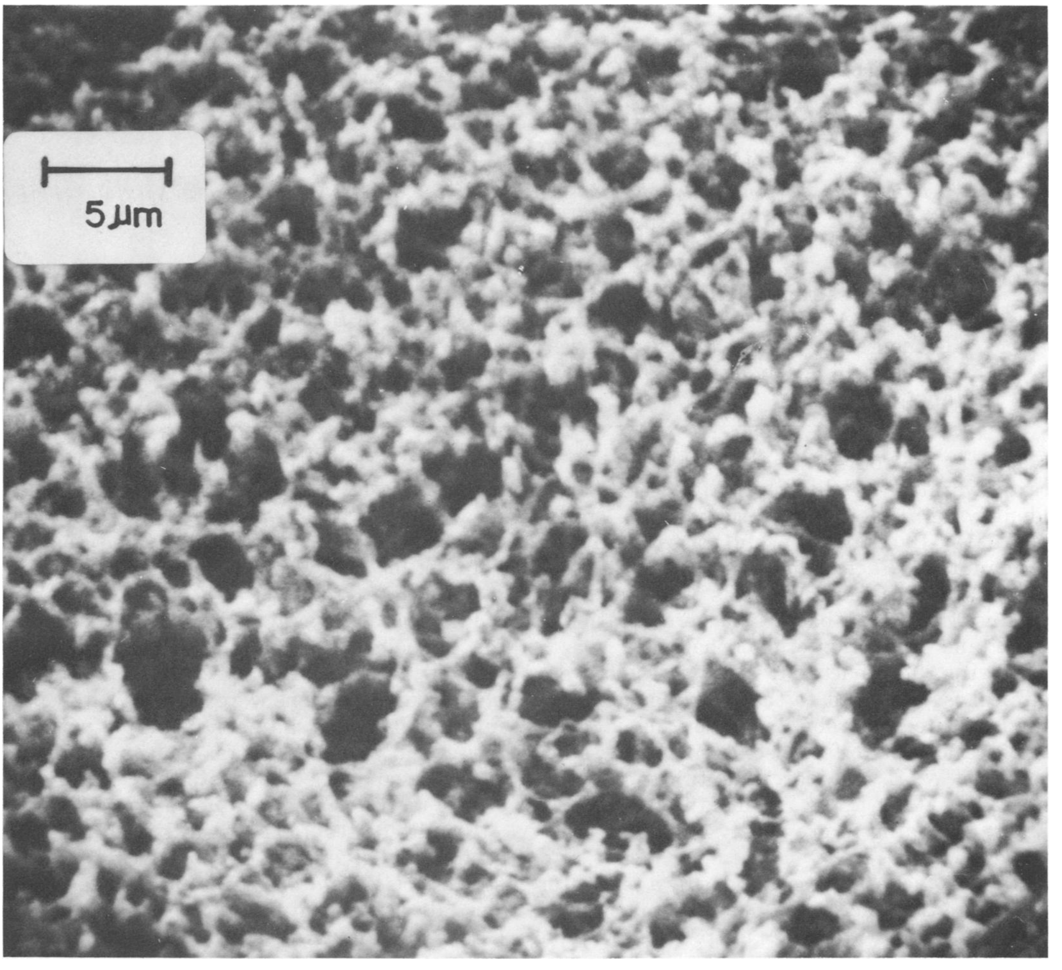

FIG. 3. *Gelman GN-6 filter.*

ously, indicate the need for a concise quality control procedure for certifying MFs for coliform recovery. Environmental microbiologists must also address themselves to restructuring the requirements of the MF coliform recovery membrane to include surface structure detail as well as pore size of the filter.

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