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was supported by funds provided by
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# Asbestos Versus Nonasbestos Fibers

## Ultramicroscopic Criteria


*Paul Gross, MD; Robert T. P. deTreville, MD, Sc D; and Martin N. Haller, Pittsburgh*



**To classify usefully fibrous dusts inhaled by urban populations, it is suggested that they be categorized initially as asbestos or nonasbestos fibers. This would supply information sufficient for statistical significance and reduce analytical requirements, saving time and money. The ultramicroscopic criteria of asbestos fibers are ends which have profiles characterized by step-like interruptions up or down from each other, as seen at a magnification of 20,000 or 25,000 X under the electron microscope, and a surface view (scanning electron microscope at the same magnification) characterized by parallel longitudinal lines that delineate the fibrils. The ultramicroscopic criteria of nonasbestos fibers viewed at 20,000 or 25,000 X magnification are ends which have uninterrupted linear profiles, and a surface view devoid of longitudinal parallel lines.**


FIBROUS dust particles are ubiquitous.[1] Many are of respirable size and can be recovered quantitatively from lungs with ferruginous bodies that develop from some inhaled fibers.[2] The finding of ferruginous bodies in the lungs of urban dwellers has been interpreted by some to indicate pollution of community air with asbestos dust.[3,4] As an extension of this interpretation, it was predicted that asbestotic pulmonary fibrosis would result in urban dwellers who were inhaling asbestos fibers from the wearing down of automobile brake-linings and from the weathering of various asbestos-cement products.[3] It was even suggested that an increase in the prevalence of lung cancer and mesothelioma may be attributable to inhalation of such polluted community air.[5]

The concern aroused by this interpretation stimulated an investigation which ascertained that ferruginous bodies were not specific indications of the presence of asbestos fibers, since a number of fibrous dusts other than asbestos could produce structures indistinguishable from asbestos bodies.[2] This suggested that the presence of pulmonary ferruginous bodies in urban populations is not necessarily an index of atmospheric pollution with asbestos dust. It is important to determine if urban populations the world over[3-9] are exposed to potentially harmful asbestos dust and, if so, to what extent. Such determination requires identification of the naked fibers and central cores


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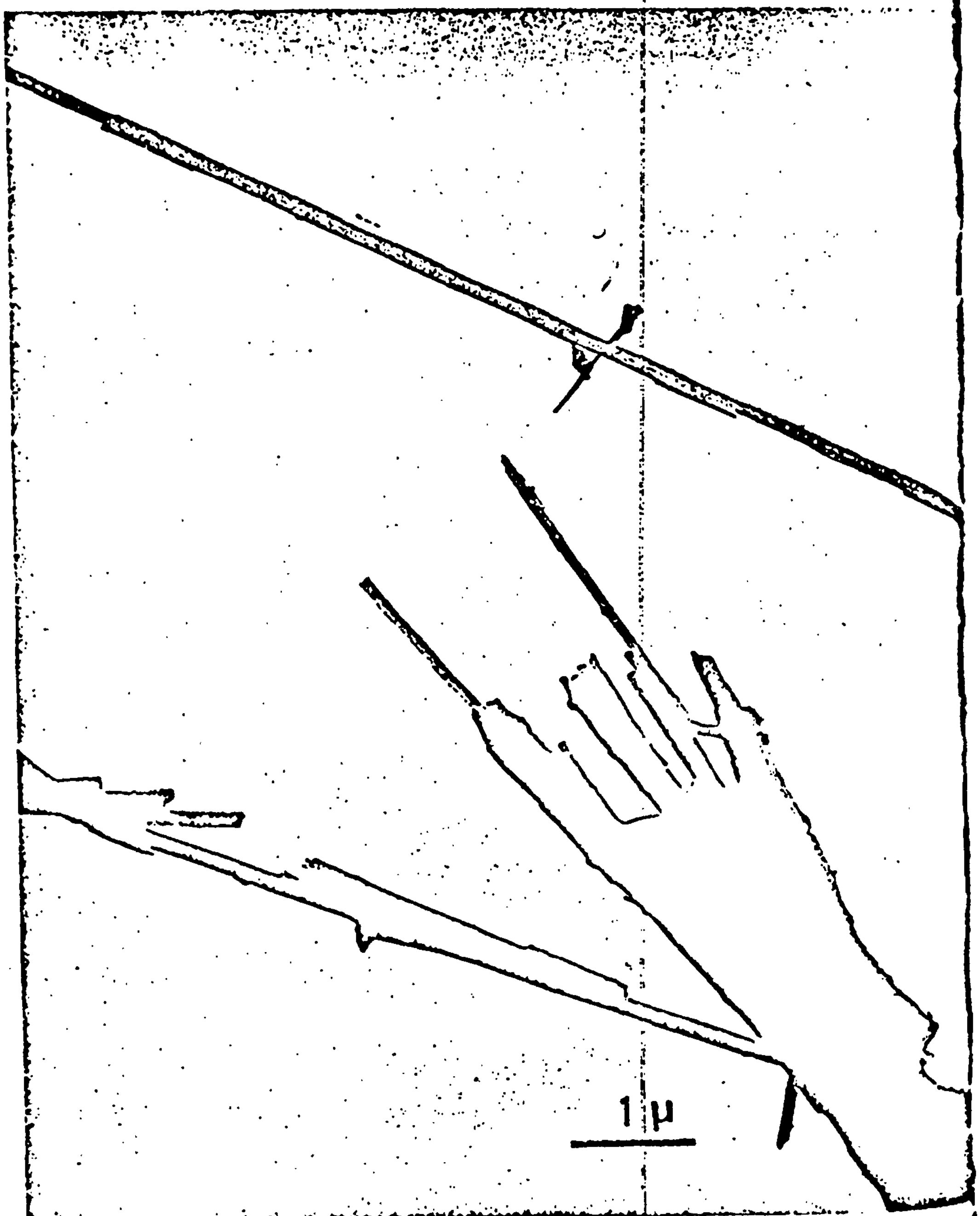


Fig 1.—Splayed end of asbestos fiber (crocidolite) showing step-wise interruptions in profiles of various subunits, indicative of various levels at which fractures of still smaller subunits occurred (× 20,000).

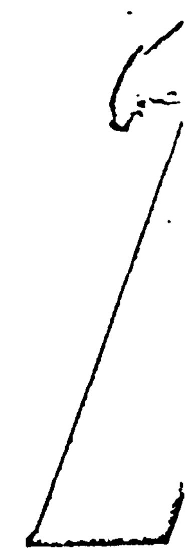

Fig 2.—End of
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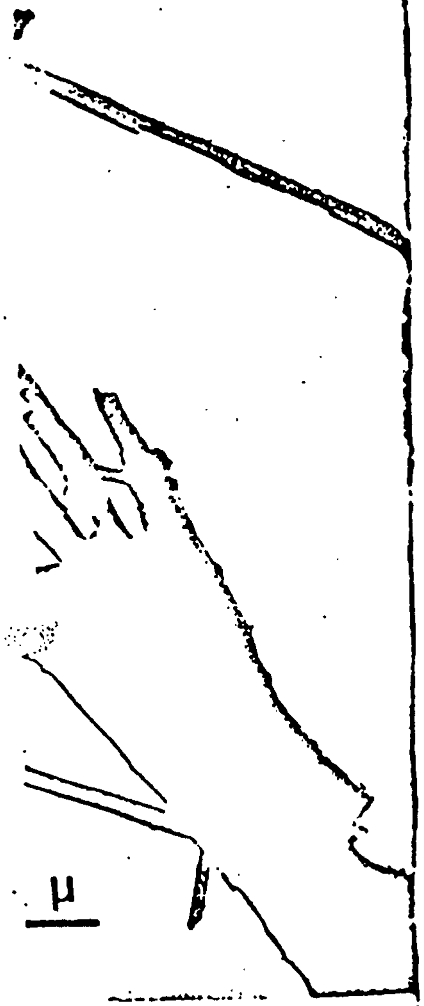


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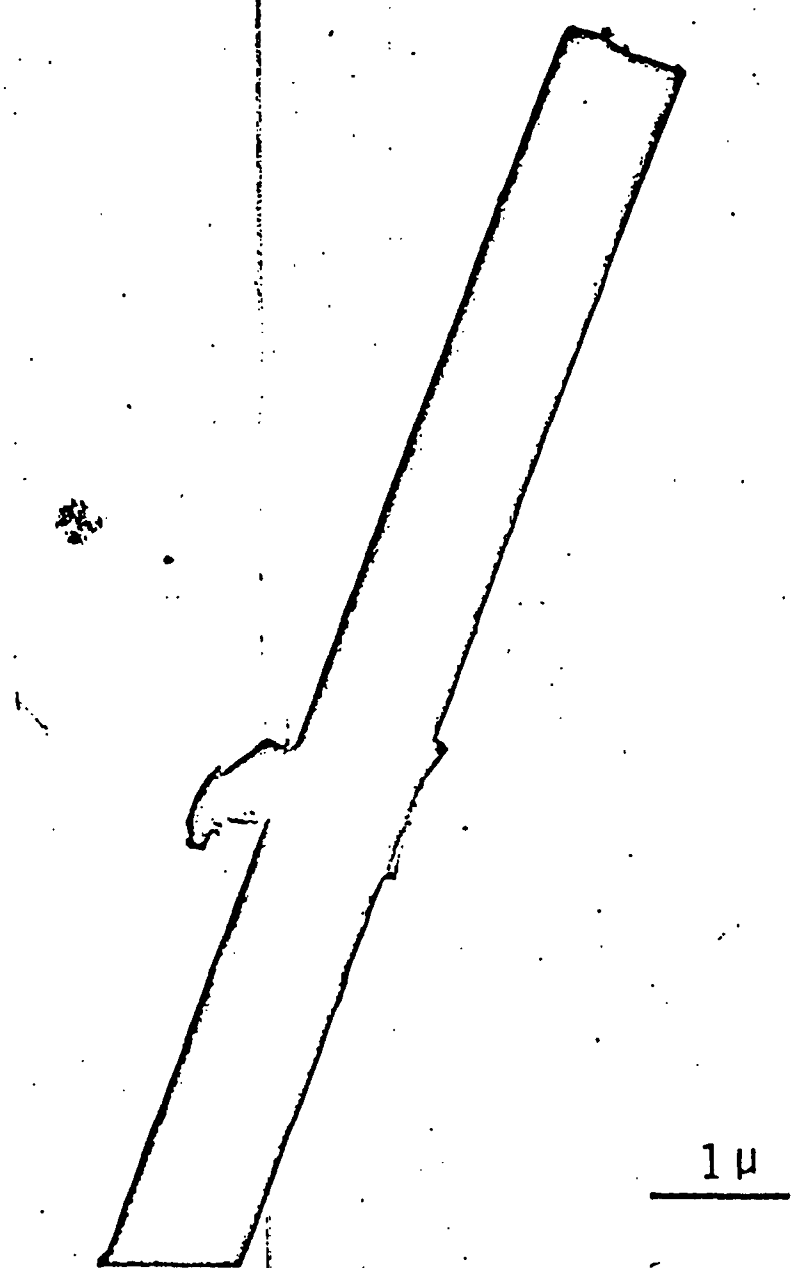


Fig 2.—End of nonasbestos fiber (ceramic aluminum silicate) showing uninterrupted linear profile characteristic of fiber of homogeneous composition (× 20,000).



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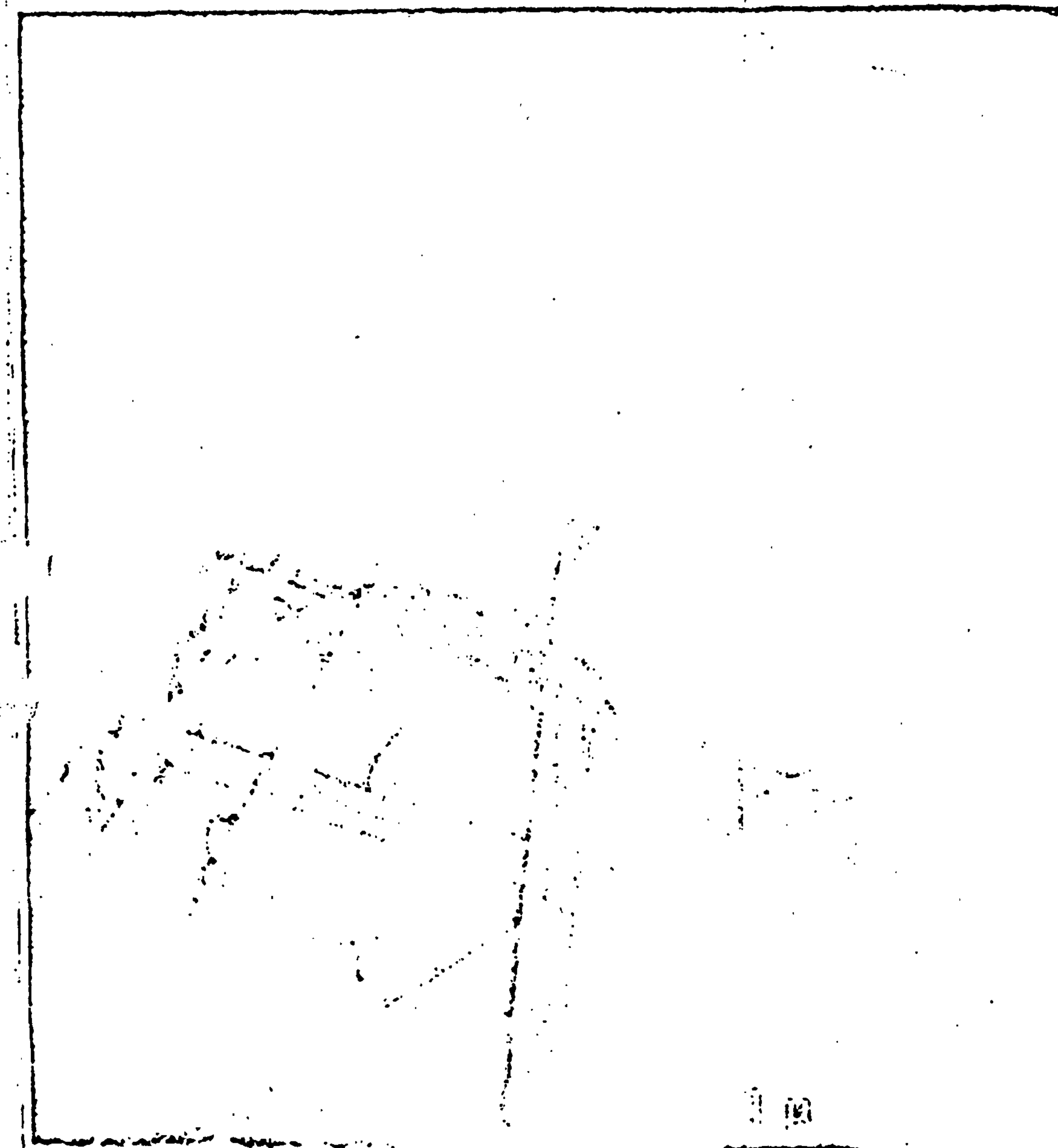

Fig 3.—Surface view (scanning electron microscope) of asbestos fiber (amosite) showing longitudinal lines that delineate fibrils composing fiber and their stepwise configuration at one end (× 20,000).

Fig 4.—Surface vi
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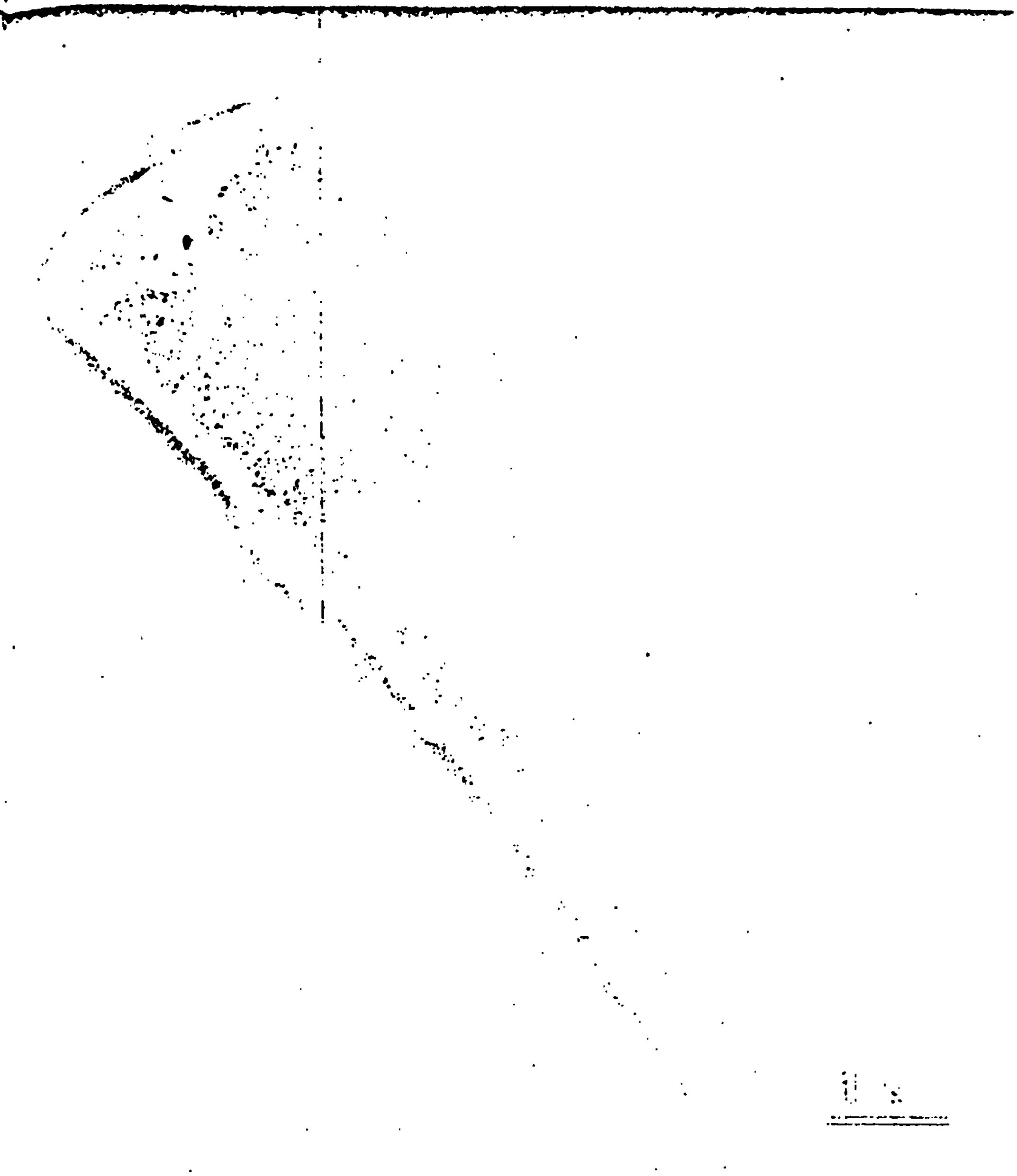

fiber (amosite) showing longitudinal
ıfiguration at one end (× 20,000).

Fig 4.—Surface view (scanning electron microscope) of nonasbestos fiber (glass) showing smooth, convex surface devoid of longitudinal parallel markings (× 20,000).





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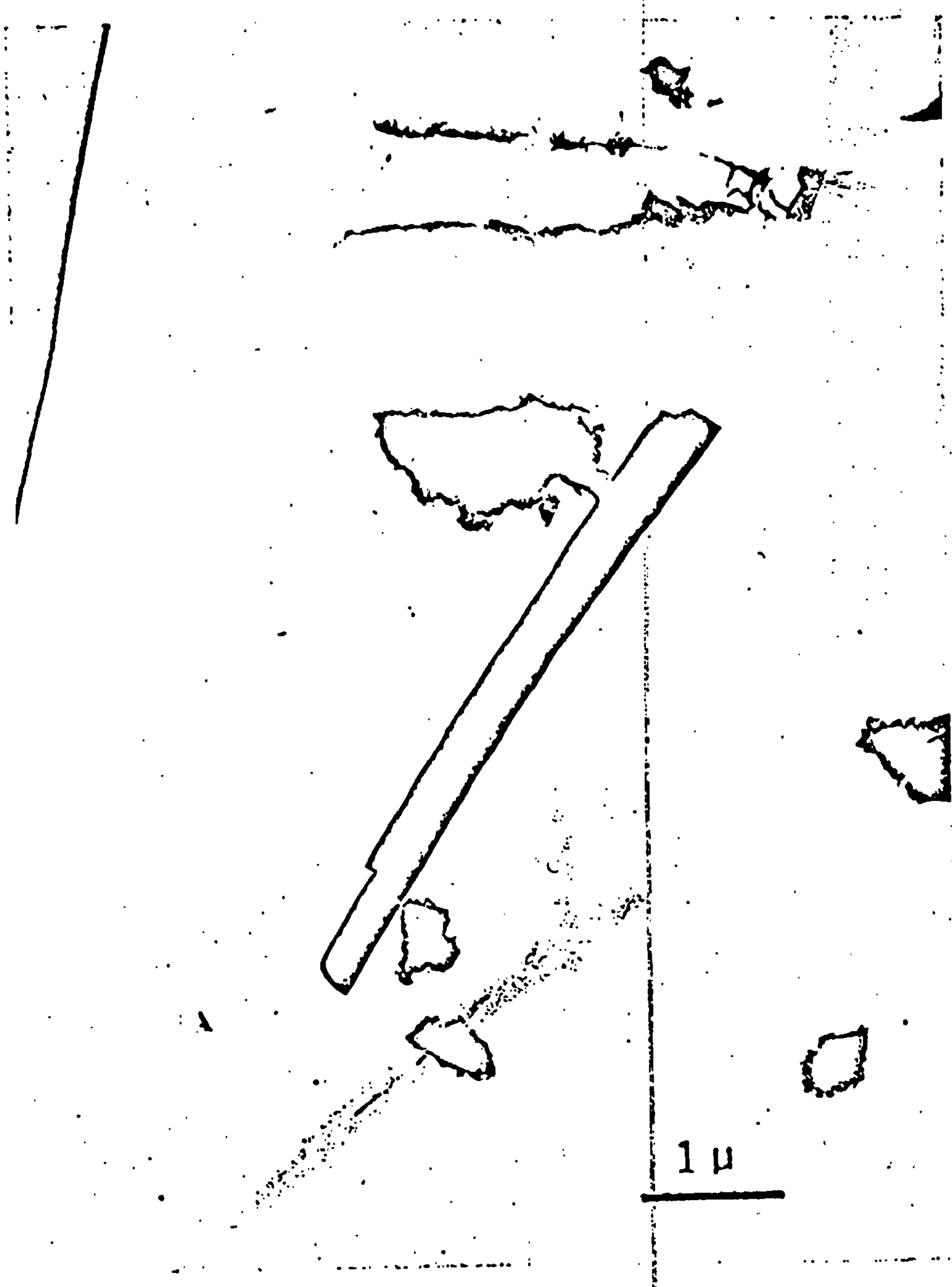


Fig 5.—Two parallel glass fibers in apposition which show one-step profile; paucity of steps and width of uninterrupted rectilinear or curvilinear profile indicates nonasbestos fiber (× 20,000).





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## Materials and Meth

The classification of inhaled
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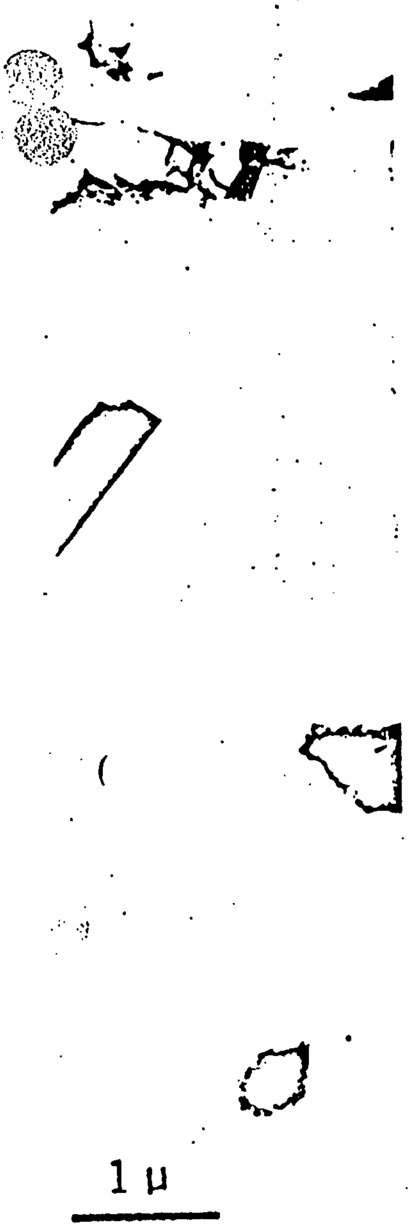


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of ferruginous bodies isolated from lungs of urban dwellers in sufficient numbers to yield statistically significant data.

Although identification of the central fiber of ferruginous bodies and of naked fibers has been accomplished by electron diffraction[10] and electron microprobe analysis,[11] these techniques are laborious and time consuming. Furthermore, for the large-scale investigation necessary to obtain statistically reliable data, extensive use of the above techniques could prove enormously expensive, since it would tend to monopolize the costly equipment involved and the time of trained technicians.

Also, the need exists for a method which would facilitate acquisition of necessary data rapidly and economically. This communication suggests a means to satisfy these needs. A procedure, essentially a screening method, is described for classifying naked fibers and the central filaments of ferruginous bodies into asbestos or nonasbestos fibers. The cores of ferruginous bodies are made accessible for such classification by freeing them from the encrusting ferruginous shell by chemical or physical means, ie, either with oxalic acid or ultrasonic vibrations.

## Materials and Method

The classification of inhaled fibers isolated from lungs[12] is based on the fact that asbestos fibers are composed of compactly apposed finer fibrils, whereas nonasbestos fibers are homogeneous units. Because of this difference in structure, the fractured ends of these two types of fibers differ in a very important way. The end of an asbestos fiber is irregular and resembles that of a bundle of fragile sticks which has been broken transversely. As might be expected, different fibers of the bundle break at somewhat different points. At an appropriate magnification, therefore, (as described below, using electron microscopy) the fractured end presents an irregular profile with multiple step-like projections and depressions, some of the steps being shallow and others deep (Fig 1). In contrast, inhaled transparent fibers other than asbestos but of similar diameter are likely to be homogenous in character, and, because of this, to fracture so as to present uninterrupted linear profiles at the fractured ends (Fig 2).

Another important difference between inhaled asbestos and nonasbestos fibers is also based on the multi-unit composition of asbestos fibers and the unitary structure of nonasbestos fibers. A surface view (scanning electron microscope) of the former at a magnification of approximately 20,000× shows longitudinal, parallel delineation of individual fibrils (Fig 3). The surface view of a nonasbestos fiber is devoid of such longitudinal lines (Fig 4).

To test the validity of these concepts, electron photomicrographs were made of the ends of several chrysotile, amosite, and crocidolite fibers, as well as the ends of a similar number of glass, ceramic aluminum silicate, and silicon carbide fibers, all of which had diameters within a range of 0.1μ to 2.0μ. Without the observer's knowing the identity of the fibers on the photographs, the latter could be sorted easily, quickly, and correctly into asbestos and nonasbestos categories based on the above concepts. A magnification of 20,000 or 25,000× appeared optimal for this purpose.

However, the method is not free of possible error. According to the findings of J. P. Leineweber, PhD, (written communication, October 1969), the ends of occasional asbestos fibers, particularly those substantially thinner than 1μ, may cause them to be categorized wrongly. For such fibers, higher magnifications and use of the scanning microscope is advised.

## Comment

A basic criterion of asbestos fiber identification is its tendency toward longitudinal splitting. Initially, there was uncertainty in some photographs in which several fibers known to be glass (one thick and one or two much thinner) were found parallel and in close apposition, giving the appearance of possible longitudinal splitting (Fig 5). The profiles of the fractured ends were interrupted also. However, the interruption consisted of only one or two steps; and there was sufficient width of uninterrupted linear profile to allow differentiation from asbestos. As the diameter of the fiber in question decreases, the component subunits also become smaller so that the magnification must be increased to visualize them. The chance for error appears to increase with substantial decreases in diameter below 0.1μ. However, inasmuch as the average diameter of naked fibers isolated from lungs of city dwellers in our experience is about 2μ (unpublished data), we believe the chance of error will be small.

If a fiber is classified as "asbestos," it will be desirable to confirm this and determine whether it may have been derived from industrial products, which are chiefly chrysotile, amosite, or crocidolite fibers. Other forms of asbestos such as tremolite or actinolite are thought to be the general urban population's chief nonoccupational exposure. In part, such exposure comes from cosmetic talc, eg, as found in cosmetic and dusting powders. Talc is also widely used in industry, eg, in rubber tire manufacturing, and in agriculture as a vehicle in which to administer pesticides.

Use of electron diffraction or microprobe techniques required in such cases or both involves a much smaller number of examinations, with consequent savings of time involved with research and equipment and of research dollars—all of which are in critically short supply. In addition, this will speed collection and evaluation of data and help resolve important questions concerning adequacy of health protection of the public.

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### WHAT HAS AFFLUENCE DONE TO AMERICA?

The fact of affluence itself erodes much of the reason for commitment to the old capitalistic values. It is hard to maintain commitments to self-discipline and to achieve in occupation if one is living in an environment of received abundance. It is significant that the students who are involved in protest in their colleges are primarily from the upper income levels. The students from lower income levels are less apt to be so involved. The capitalistic culture, which Marx thought would be opposed primarily by the working class is instead being confronted by a portion of the educated middle class, not because of deprivation, but in part because of affluence; not solely out of self-interest or oppression, but because of the perception of the oppression of others.

This sentiment has strength because the emphasis on competition, success, and self-discipline in the established culture are in tension with its capacity to guarantee a decent standard of living for the members of society. The values of capitalism are scarcity values, not values for an affluent society. The puritan today is a deviant; the emphasis is on self-fulfillment rather than self-control as a central virtue. Self-discipline has come to mean the ability to express impulses in one's private life while maintaining a fully rational impersonal perspective in one's work.—Flack R: Value conflicts and the American middle class, in The Acquisition and Development of Values, Perspectives on Research, report of a conference, May 15-17, 1968, Washington, DC, National Institute of Child Health and Human Development, p 7.



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