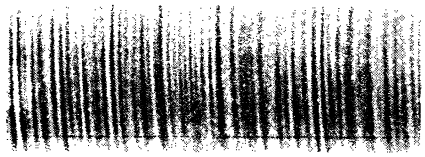

Fig. 2. Slip lines on the convex surface of a plane bent sapphire crystal. (× 125)

volutes, yet the normals to these planes are preserved as straight lines. Accordingly, if polygonization can be induced in such a sample, then the positions of the dislocation walls should be defined by planes normal to the plane of the figure and parallel to the optic axis.

It is pertinent to realize a significant difference between the structures of an edge-type dislocation in a simple metal such as zinc and a structurally similar crystal such as sapphire. In the former, a single extra partial plane is required as an insert, whereas for the latter a double one is needed. Thus, for sapphire, it will be composed of contiguous planes of oxygen ions and aluminum ions, respectively. Since polygonization requires both glide and climb of dislocations, it is therefore implicit that the process necessitates self-diffusion of both types of ions.

In order to evaluate these various simple concepts, the following experiment was performed. A long, single crystal rod of Linde synthetic sapphire was plane bent in an oxygen-gas flame at a temperature of the order of 1800°C. Microscopic examination of the deformed sample showed well-developed slip lines (Fig. 2) when viewed normal to the axis of bending but none could be detected when viewed parallel to the axis, in accordance with the requirements for plane bending. Significantly, no evidence was obtained for polygonization at this stage.

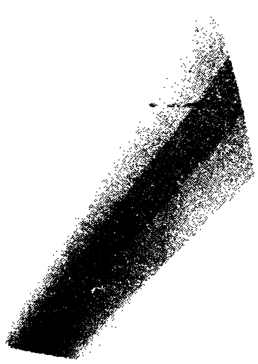

Fig. 3. Portion of a plane bent and polygonized sapphire crystal, viewed parallel to the axis of bending. For photographing, the sample was immersed in ethylene iodide and illuminated by transmitted polarized light. (× 18)

The sample was then annealed in the flame for 10 minutes at a temperature of the order of 2000°C. After this treatment, striking evidence for the expected polygonization was obtained, as is shown in Fig. 3.

With this discovery of polygonization in plane bent sapphire, it was clear that polygonization of a plane bent crystal of zinc should produce an identical macrostructure. This prediction has been fully verified by my colleague, J. J. Gilman (5).

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17 June 1955

On Responsibility of Scientists

In his informative article, "The work of many people" [*Science* **121**, 267 (1955)], Edward Teller discusses the role of scientists in the development of the atom and hydrogen bombs. I feel that, in view of the fundamental assistance that the scientist might give in helping to understand and ameliorate the present world tension, I should present to the readers of *Science* a humanistic point of view, which I am sharing with others and which is at least complementary to the one set forth by Teller.

I fully realize that the purpose of Teller's article was not the discussion of the wider cultural background against which the development of the atom bomb must be seen. Yet in the last two paragraphs the awful gravity of the human situation springs into focus. Teller states: ". . . I also believe that we would be unfaithful to the tradition of Western civilization if we were to shy away from exploring the limits of human achievement. It is our specific duty as scientists to explore and to explain. Beyond that our responsibilities cannot be any greater than those of any other citizen of our democratic society. . . . To be in possession of this instrument [thermonuclear weapon] is an even greater challenge to the free community in which we live. I am confident that, whatever the scientists are able to discover or invent, the people will be good enough . . . to control it for the ultimate benefit of everyone."

Teller's faith in the organizing ability of the human community is a healthy sign, but we must also admit that there are many who have long observed the dangerous course that Western civilization has been taking, and they are alarmed that atom and hydrogen bombs have, at this point, become, so to speak, the symbol of man's ability or inability to practice ordinary human virtues on a world-wide scale. The mere creation of fear and of weapons has in the past never produced a turn of heart among potential trouble makers. The delicate equilibrium of international and interhuman relationships is now taxed to the utmost by conflicting ideologies and self-propelling material interests. So, many of us would rather not wait until the control of those disorganizing forces becomes even more urgent as a result of more dreadful external castastrophes. One of the chief dangers is that we continue to apply too simple and too static a formula to the present situation. We scientists are readily tempted to succumb to this tendency, since, in the traditional thinking of science, the idea of automatic scientific and social progress has been prominent. I believe that our hope lies in an ever-growing understanding of the psychological and historical factors that control man's destiny and that everyone should try to acquire and help to disseminate such understanding. Let me be more specific.

The majority of scientists, in speaking of the principles of their profession, readily identify themselves with an ideal that has its main origin in the 17th-century individualistic and cultural renaissance. But history shows that the purity of an original ideal, whether religious or scientific, whether envisioned by an inspired individual or a small brotherhood, changes when it is forced to operate within the more material medium of human society. Science has been no exception to this process, which was pointed out especially by Lewis Mumford and Arnold Toynbee. "Why is this secular cult of science," wrote Toynbee (*New York Times Magazine,* 26 Dec. 1954), "not enough? Because science operates in a medium from which it can never detach itself. Our Western science is the child of moral virtues; and it must now become the father of further moral virtues if its extraordinary material triumphs in our times are not to bring human history to an abrupt, unpleasant and discreditable end. . . . The virtues of prudence, self-control, tolerance, wisdom, and—far above all these—love have become necessities of life in the literal sense."

There are, I am confident, many among us who share this growing general awareness that such laws of human behavior are now more important than material interests, theories of supply and demand, systems of attack and counterattack, and so forth. In the necessary process of spiritual renewal and of humanization of social behavior, the scientist can and must accept a load as heavy as that which any other responsible citizen will bear. He will accept more than his share if he pauses to compare the spirit from which science originally sprung with the present threat of total scientific extermination. But he will be doing less if he harbors the notion that his human duty ends with professional achievement or with his gifts of technical results and inventions.

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University of Pennsylvania, Philadelphia
4 March 1955

I am convinced that one should consider the consequences of technical developments extremely seriously. On the other hand, the effect of these technical developments, and especially of these new weapons, is clear enough to every thinking person. Under these circumstances, there is no reason to believe that a scientist has more sound judgment in the evaluation of the impact of discoveries than any public-minded person. I am, of course, very much interested in the impact and the consequences of these discoveries, but I feel that there is a danger that whatever opinion I voice in this matter may be taken too seriously because of the accident that I happened to be a part of the development. In my article, I felt that it would be of most help to remind the reader of the confidence we should have in one another as human beings in solving such difficult problems.

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1 August 1955

On "An Application of Statistics"

In a recent communication [*Science* **121**, 402 (1955)] Frederick Sargent reported a coefficient of simple linear correlation of -0.611 between the number of letters in the name of a month and the mean monthly precipitation at Chicago in that month. He states that "this association was significant at the 5-percent level," and gives a value of $0.05 < P < 0.025$. (Presumably the signs of inequality have been reversed through an error of typesetting.) He goes on to say that "these associations have proved to be useful teaching examples of what can be done by the application of statistics, for here are significant correlations without *a priori* or *a posteriori* bases."

The example is, indeed, a useful one, although the interpretation might differ from that implied. Sargent says that he has been "searching for a phenomenon that would illustrate" the truism that "the mere fact that two variables are significantly correlated by accepted statistical treatment of valid observations does not *ipso facto* prove that the correlation has any biological meaning." In his search, he turned up this example (and another that he describes as "suggestive but not statistically significant.")

If Sargent's search covered as many as 20 examples, we would expect, even though there was not correlation on an *a priori* or *a posteriori* basis, that one of the samples might be "significant at the 5-percent level." This means merely that the sample shows as much correlation as one would get one time in 20 from uncorrelated data.

Sargent's example does not in any way indicate that the statistical methods are wrong, or that "one can prove anything by statistics." It indicates merely that he had patience enough to look through a score or more of cases for a class illustration. His results are useful enough so that I shall be glad to use them with my own students.

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19 August 1955

Proliferation of Mature Fruit Pericarp Tissue Slices in vitro

The comparatively high rate of metabolic activity of the avocado fruit (*1*) has suggested that an investigation of the developmental histology might offer an explanation of this rather unusual physiological behavior. Studies of the mitotic activity and cell enlargement in the mesocarp, which comprises the major portion of the rather homogeneous pericarp, have indicated that maximum cell volume is attained when the fruit reaches about half its ultimate size and that cell division in the pericarp continues throughout the fruit life on the tree (*2*). Most other fruits reported in the literature are characterized by a period of cell division that lasts from 2 to 4 weeks following pollination. Subsequent fruit-size increase then results almost entirely from cell enlargement.

The rather unusual mitosis-cell enlargement relationship within the avocado and the physiological behavior suggest the maintenance of a juvenile state throughout the fruit life or a continuous meristematic condition of the "otherwise mature" pericarp parenchyma. Attempts have been made to tissue-culture this pericarp wall, the cells of which contain large amounts of oil.

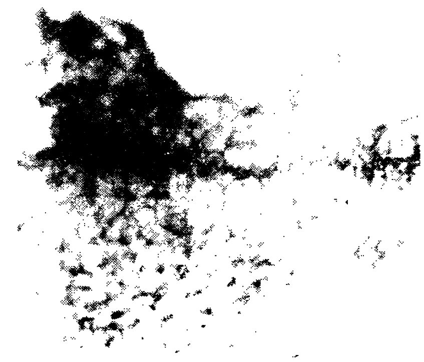

Fig. 1. Proliferation of tissue disks from mature avocado fruits grown on agar nutrient media.

Disks of tissue 8 mm in diameter and 1 mm thick from horticulturally mature fruit were planted on agar media, utilizing a general formula (*3*). Within 3 or 4 weeks cellular proliferation on the upper surfaces of the disks has been observed (Fig. 1). This has resulted in some cases from the development of a parenchymatous cell mass over the entire upper surface, giving rise to a "pad" six to eight or more cells thick. Some disks develop a meristematic layer parallel to, and three or four cells layers beneath, the exposed surface. A few disks have produced clusters of cells from isolated areas at apparent random points on the upper surface of the disk. There has been little indication of tissue differentiation under the limited environmental conditions studied. Attempts are now under way to investigate the environmental factors that affect these cultures and to make subcultures of these proliferating cell masses.

Although reports exist concerning culture of ovaries and other tissues of immature fruits, it is thought that proliferation *in vitro* of pericarp tissue from horticulturally mature fruit has not been demonstrated previously.

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13 June 1955