of the amine and on the pH (Pigman, Cleveland, Couch, and Cleveland. *J. Am. Chem. Soc.*, 73, 1976 [1951]). Isomerization may result during the period of combination. Isbell and Frush (*Ibid.*, 72, 1043 [1950]) showed that the curve for hydrolysis rate *vs* pH of one of these compounds is similar in shape to typical pH-activity curves for enzyme-catalyzed reactions. This analogy is interesting, even if not more significant.

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Photoinactivation of Indoleacetic Acid

IN A recent issue (SCIENCE, 113, 300 [1951]), R. G. Ferri and R. Guidolin state that "... the photoinactivation of indoleacetic acid (phytohormone) by riboflavin discovered by Galston ... should be explained by a mechanism in which riboflavin did not act specifically, since the same inactivation could be brought about by many different substances. Although chemically unrelated, all these compounds had in common the property of fluorescence." This statement is based on an article by M. G. Ferri (*Arch. Biochem. Biophys.*, 31, 127 [1951]), in which it is shown that many fluorescent substances can in fact sensitize the photoinactivation of indoleacetic acid.

These authors fail to consider two points: (*a*) The fact that riboflavin is not specific, for the reaction is well known, and is alluded to in my paper (SCIENCE, 111, 619 [1950]): "... other fluorescent pigments, some of a non-biological nature, are also effective in such reactions. ..."

(*b*) The reason for considering riboflavin to be *the* effective pigment is that the action spectrum for the destruction of indoleacetic acid by a plant *brei* corresponds extremely well with the absorption spectrum of riboflavin (*Am. J. Botany*, 36, 773 [1949]). Although this is not absolute proof that riboflavin participates in the reaction, it is certainly very strong evidence. In any event, it rules out the other fluorescent pigments discussed by the above authors, on the grounds that their absorption spectra do not fit the photoinactivation data.

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IT SEEMS to us that Dr. Galston feels we did not fully recognize the great importance of his discovery. That is not so. As can be seen from the quotation Dr. Galston made from our paper, we have clearly given him full credit for the most important finding that riboflavin induces the photoinactivation of indoleacetic acid.

On the other hand, though it does not seem particularly important to us, we do not quite agree with his statement that "The fact that riboflavin is not specific for the reaction is well known and is alluded to in my paper" [his present letter].

It is true that such an allusion was made, but only in a very general way, when Dr. Galston states (SCIENCE, 111, 619 [1950]): "Thus it is clear that riboflavin may cause the photochemical alteration of many different kinds of molecules, both large and small. It should also be pointed out that other fluorescent pigments, some of a non-biological nature, are also effective in such reactions."

In M. G. Ferri's paper, on the other hand, a very particular statement is made (*Arch. Biochem. Biophys.*, 31, 127 [1951]): "These results indicate quite clearly that the induction of the photoinactivation of indoleacetic acid (IAA) is by no means a peculiarity of riboflavin but is a property common to many fluorescent substances."

Thus the situation, as we see it, is that, whereas Galston made a very general statement, M. G. Ferri made a specific one, based on many experimental data.

As for Galston's second comment, that only riboflavin can be concerned in the photoinactivation of indoleacetic acid by a plant *brei*, we do not wish to discuss it, since in our paper we were not concerned with this problem.

We agree with Dr. Galston that his is very good evidence that riboflavin participates in the reaction of the plant *brei* he studied—namely, the *brei* of etiolated pea epicotyls (*Am. J. Botany*, 36, 773 [1949]). However, we feel that plant *breis* of various other species should be studied before the participation of other fluorescent substances can be definitely ruled out.

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Polymerization by Means of High-Energy Electrons

THE report of J. V. Schmitz and E. J. Lawton (SCIENCE, 113, 718 [1951]) on initiation of vinyl polymerization by high-energy electron irradiation evoked long-submerged memories of this writer's and his associates' work of two decades ago. The work took its origin in 1931 from a discussion of the requirements of receptacle surface conditions for the delay in coagulation of blood extravasates, during which the young physicist associate of our Central Laboratory and Hormone Research Institute of the City of Mannheim recalled an earlier observation that vacuum-tube irradiation increases the water repellency of glass surfaces. Experiments in which glass slides were exposed in cathode-ray tubes confirmed the observation. Analysis of the experiments indicated that the stopcock grease evaporating from the connections of the tube to the evacuation pump was responsible for the phenomenon, and disclosed the repellency to be the property of a minute film formed on the exposed glass surfaces. The film was strongly adherent to the glass and highly resistant to various kinds of harsh chemical and mechanical treatment. Our observations held out not only the promise of a particularly costly method of producing plastics, but also that of methods for imparting weather- and wither-fast surfaces to many sorts of indoor and outdoor objects and water-shedding surfaces to glass panes, of producing insulating coatings, of liquefying gases, etc., and of inducing types of chemical reactions not easy to activate by means of thermic or photo-energy, or pressure.

Because of these possibilities, the study was continued, first in the cathode tube, later with the electron beam from a "window tube," accelerated by a high-voltage field (500,000 v), part of the endeavors being directed to delineating the range of substances susceptible to this type of polymerization and part to defining the underlying chemical mechanism. It turned out that all organic substances studied were polymerizable. Chemicals as diverse as fatty oils, retene, glucose, and paraffin were all converted into films with the above characteristics, when exposed in a thin layer on a glass slide. The diversity of susceptible substances and the decrease in oxygen content of glucose after its conversion to the polymer suggested that the electron impact is capable of ejecting both hydrogen and various substituents from their bonds with C, in preference to the breaking of C—C bonds, and of activating the freed valences for intermolecular bondings.

Just as these investigations were reaching the stage of making quantitative comparisons of the susceptibilities of the various substances with improved equipment, the Herostratic firebrands of 1933 halted them, dispersed the members of the team and its records, and even smothered contact, continuation, and recollection by the blanket of an intimidation- and terror-borne amnesia. This background of frustration, together with the writer's frankly confessed innocence in all matters pertaining to electrophysics, should suffice to make it clear that these historical reminiscences are not intended to raise any claim of that *vanitas vanitatum,* priority. They are, however, believed to deserve brief mention because, despite their fragmentariness and lack of detail, they may contribute some qualitative information to the results of the admirably careful and expert quantitative investigation of the G-E investigators. Their work could indicate that the presence of double bonds is a prerequisite of successful attack of the high-energy electrons. Our observations show that saturated compounds also are readily polymerized; they do not preclude the possibility that the tension prevailing at sites of unsaturation favors activation, which may find expression in quantitative differences.

The effect upon the glass surface was first reported in a subordinate sentence in a publication of the 1880s; its author, who thus deserves the laurel of priority—although he may have been unaware of the mechanism—is Heinrich R. Hertz; but, unfortunately, this writer is unable to recollect the literature in which the quotation appears, or the source of the electron beam employed in those early experiments. Even the fragmentary information reported here would not have been obtained if the writer's laboratory had not been distinguished by such members as the keen physicist whose name is buried in the aforementioned nazigenic gap of memory, and the biochemist Erich Adler, of Stockholm.

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Food Reactions of Amoebas and the Manipulation of Nematocysts of *Hydra* by *Microstomum*

In 1910 Rhumbler (*1*) described two significant types of food reactions of an amoeba, naming them *circumfluence* and *circumvallation.* In circumfluence, food is engulfed by the amoeba's body flowing intimately about it, as a drop of oil flows about a bit of sand. In circumvallation, the amoeba surrounds a motile object of food in a wide embrace, but at no place in contact with the food.

Two of us (*2*) showed how variable were the details of circumvallation.[1] Goldstein (*3*) recorded that a given amoeba could use either circumfluence or circumvallation in a sustained food reaction to a given object of prey, as the situation demanded.

My students and I had overlooked Rhumbler's paper, so we unwittingly corroborated his observation. Looper (*4*) observed that a filopod also captured food by these two methods. We observed these reactions on the part of two amoebas, in addition to Rhumbler's one, and upon a filopod (to Rhumbler's none). Hyman (*5*) later included both lobopods and filopods, thus corroborating both our work and Rhumbler's.

Rhumbler did not note the highly significant fact that circumfluence is correlated with the ingestion of nonmotile food, whereas circumvallation is correlated with the capture of motile prey that presented the contingency of escape (*6, 7*). He sought to reduce these reactions to terms of the past and present, and attempted to establish an analogy between melting paraffin flowing about a heated glass bead and circumvallation. We indicated that the future, as well as the past and present, was a factor in amoebas' reactions to food. Hyman (*5*, p. 122) corroborated this feature of our work when she wrote: "Lobopods and filopods employ circumfluence (Fig. 37 D) in ingestion of immobile prey but capture active prey by *circumvallation.*"

In my recent studies, I have observed that some motile objects of food present a peculiar feature. These move at a uniform rate, like a marble down a slight incline. Their projected paths are predictable. Amoebas ingest such food objects (diatoms and fission algae) by circumfluence, just as a man lays hold of a rolling marble directly without being concerned about probable lines of escape.

So it happens that an amoeba's conduct is much more complex than Loeb (*8*, p. 321) had in mind when he wrote that amoeba's movement "differed little

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[1] Frank R. Lillie wrote that he was pleased to publish this paper in the *Biological Bulletin,* since it indicated how highly educated were Virginia amoebas.