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

[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.

from spreading." Amoebas circumvent contingencies as they are presented, and the future constitutes a factor in their conduct as it does in that of men.

The following statement by Hyman (*9*, p. 72) calls for comment: "Kepner and his students conclude that *Microstomum* seeks hydras 'for the purpose' of obtaining their nematocysts 'in order' to use these nematocysts against prey. The question whether *Microstomum* is able to capture prey without the use of nematocysts is not considered by these authors; the lack of this control weakens the whole argument."

Had she read all our papers upon microstomum's nematocysts more carefully, she would have discovered that we had not used the word "prey" at any place, though we had quoted Martin (*10*) as having used it. It was not our "argument" that these flatworms need nematocysts to "capture prey." They obviously do not need these "guns" ordinarily to obtain food any more than a soldier ordinarily needs his gun to capture food.

In reading our papers recently I was surprised to find that they actually contain some evidence that microstomum may use its nematocysts "in order to capture prey." For example, Martin (*10*, p. 268) found "one of the commonest enemies of *Microstomum* appears to be *Chaetogaster,* which devours it greedily." It is my inference that Martin's microstoma must have lacked nematocysts, for several years later we found loaded microstoma, living in an adjacent pond, feeding freely upon chaetogasters. This suggests that our loaded microstoma were using their alien nematocysts in order to capture "one of their commonest enemies" for food.

Finally, we find that we actually recorded two examples in which a microstomum had immobilized a stenostomum by means of nematocyst-wounds and then ingested the wounded prey.

In the face of this evidence, the burden of proof seems to lie upon the shoulders of those who deny that microstomum sometimes uses its alien "guns" to capture food, just as a soldier may sometimes use a captured enemy gun to capture the enemy's calf.

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Erratum

It has been called to our attention that in the Nov. 9 issue of SCIENCE (114, 516 [1951]), the death of **Professor H. Galliard,** of the Faculté de Médicine de Paris, Institut de Parasitologie, was erroneously reported.—Editors.

Book Reviews

Oeuvres Complètes de Christiaan Huygens: Supplément, à la Correspondance, Varia, Biographie de Chr. Huygens, Tome XXII. The Hague: Martinus Nijhoff, 1950. Published for the Société Hollandaise des Sciences, 921 pp.

This volume completes the collected works of Christiaan Huygens (1629–95), one of the great men of science in the seventeenth century, whose many contributions to science include the optical principle that bears his name, the modern pendulum clock escapement, improvement of the telescope and consequent resolution of Saturn's ring, and the analysis of forces in uniform circular motion. This edition was initiated by the Dutch Academy of Sciences in 1885, and the first volume appeared in 1888; Volumes 16–22 have been edited by J. A. Vollgraff, and the preceding ones by D. Bierens de Hahn, J. Boscha, and D. J. Korteweg, respectively. The first ten volumes contain correspondence (both letters by Huygens and those written to him), the remaining volumes being devoted to special scientific topics—mathematics, probability, dioptrics, physical optics, astronomy, horology, cosmology, dynamics—including annotated editions of his printed works as well as shorter pieces and manuscript notes.

This last volume contains a supplement to the published correspondence, various small items omitted from previous volumes, a bibliography of the material published by Huygens in his lifetime, marginal notes made by him in reading the *Acta Eruditorum,* a facsimile of the bookseller's catalogue of Huygens' library, and a 400-page biography of Huygens by Vollgraff. The latter is a mine of information concerning every aspect of Huygens' life and the development of his thought. Since Huygens traveled widely, was well acquainted with the leading scientists of his day, as well as being keenly interested in scientific questions of every sort, this biography contains an abundance of material for anyone interested