A Historic Dispute

Philosophers at War. The Quarrel between Newton and Leibniz. A. RUPERT HALL. Cambridge University Press, New York, 1980. xiv, 338 pp. $24.95.

Because of its duration, nastiness, and international scope and the stature of the protagonists, the dispute between Newton and Leibniz over the discovery of the calculus in the first decades of the 18th century has become the most famous or, perhaps, infamous of all scientific priority disputes.

We can, in the first place, set the historical record straight. We now know that Newton has priority in discovery, having developed the calculus from 1664 to 1666, some nine years before Leibniz independently discovered it in 1675. It is equally clear that Leibniz has priority of publication in 1684, for Newton was not to publish any of his complete mathematical works for another 20 years, when he appended his *De quadratura curvarum* to his *Opticks* (1704). To complicate matters, however, in 1676 Newton sent Leibniz two very long letters on mathematics, and during a visit to London Leibniz also studied some of Newton's privately circulated mathematical manuscripts. The two letters, however, dealt mostly with infinite series, containing only oblique references to the calculus, and, as surviving documents show, Leibniz was concerned only with Newton's work on series when he studied his early manuscripts. Newton's delayed publication and Leibniz's early access to Newton's work were to serve for each as the basis for charging the other with plagiarism.

A. R. Hall in *Philosophers at War* fully and ably describes this priority dispute from Newton's and Leibniz's initial discoveries and their first (amicable) interchange in the 1670's, through the early skirmishes to stake out priority, into the full-scale war precipitated by the Scottish mathematician John Keill, who suggested in a paper published in 1710 that Leibniz had plagiarized Newton. Leibniz wrote the Royal Society to request an apology for this slur. Instead, Newton, as president of the Royal Society, chose a committee to study the matter. He also wrote its report and prepared the *Commercium Epistolicum* (1712/13), which, supported by copious extracts from his early papers and correspondence, awarded priority to Newton without making any concessions to Leibniz. Newton then in 1715 anonymously (and, of course, favorably) reviewed the report in the *Philosophical Transactions*. Charges and countercharges continued to fly well after Leibniz's death in 1716.

Rather than writing a technical history of the calculus, Hall has chosen this episode to illuminate the character of the two protagonists and their scientific milieu. Though this was basically a wise decision (particularly since the eighth and final volume of D. T. Whiteside's edition of Newton's *Mathematical Papers,* covering precisely this period, will appear shortly) I think he has purged too much of the history of mathematics proper. Consequently, the intellectual excitement of these mathematical discoveries is lacking. Hall is perhaps at his best in

(224)

It muſt be allowed that theſe two Gentlemen differ very much in Philoſophy. The one proceeds upon the Evidence ariſing from Experiments and Phænomena, and ſtops where ſuch Evidence is wanting; the other is taken up with Hypotheſes, and propounds them, not to be examined by Experiments, but to be believed without Examination. The one for want of Experiments to decide the Queſtion, doth not affirm whether the Cauſe of Gravity be Mechanical or not Mechanical: the other that it is a perpetual Miracle if it be not Mechanical. The one (by way of Enquiry) attributes it to the Power of the Creator that the leaſt Particles of Matter are hard: the other attributes the Hardneſs of Matter to conſpiring Motions, and calls it a perpetual Miracle if the Cauſe of this Hardneſs be other than Mechanical. The one doth not affirm that animal Motion in Man is purely mechanical: the other teaches that it is purely mechanical, the Soul or Mind (according to the Hypotheſis of an *Harmonia Præſtabilita*) never acting upon the Body ſo as to alter or influence its Motions. The one teaches that God (the God in whom we live and move and have our Being) is Omnipreſent; but not as a Soul of the World: the other that he is not the Soul of the World, but *INTELLIGENTIA SUPRAMUNDANA*, an Intelligence above the Bounds of the World; whence it ſeems to follow that he cannot do any thing within the Bounds of the World, unleſs by an incredible Miracle. The one teaches that Philoſophers are to argue from Phænomena and *Experiments* to the Cauſes thereof, and thence to the Cauſes of thoſe Cauſes, and ſo on till we come to the firſt Cauſe: the other that all the Actions of the firſt Cauſe are Miracles, and all the Laws impreſt on Nature by the Will of God are perpetual Miracles and occult Qualities, and therefore not to be conſidered in Philoſophy. But muſt the conſtant and univerſal Laws of Nature, if derived from the Power of God or the Action of a Cauſe not yet known to us, be called Miracles and occult Qualities, that is to ſay, *Wonders* and *Abſurdities*? Muſt all the Arguments for a God taken from the Phænomena of Nature be exploded by *new hard Names*? And muſt Experimental Philoſophy be exploded as *miraculous* and *abſurd*, becauſe it aſſerts nothing more than can be proved by Experiments, and we cannot yet prove by Experiments that all the Phænomena in Nature can be ſolved by meer Mechanical Cauſes? Certainly theſe things deſerve to be better conſidered.

ERRATA. *Pag.* 199. *line.* 14. *put an* Aſteriſk (*) *after the Word* Letter.

The final page of Newton's anonymous "Account of the Book entituled *Commercium Epistolicum.*" [Reprinted in *Philosophers at War* from the *Philosophical Transactions* of the Royal Society, 1715] sketching the numerous "secondary" characters—scholars and gentlemen, curmudgeons and rogues—who became involved in the struggles. Newton and Leibniz are more difficult to portray, and his Newton is not quite crusty, aggressive, and arrogant enough for me.

By relating the dispute over the calculus to the broader philosophical dispute between the Newtonians and Cartesians, Hall adds a new element for evaluating the dispute and shows how much more was at stake than priority for the invention of the calculus, as if that were not enough. In the first decade of the 18th century, the new mechanics of Newton's *Principia,* in particular the concepts of force and gravitational attraction, were nearly universally rejected on the Continent as a reactionary return to occult forces, and Leibniz was one of the most vociferous critics of Newtonian natural philosophy. Yet by mid-century Newton's mechanics and entire natural philosophy dominated European thought, so that in this aspect of the dispute the Newtonians prevailed. The Leibnizian notation and school (led by such luminaries as Jakob and Johann Bernoulli, the Marquis de L'Hospital, and Pierre Varignon) already dominated the calculus at the turn of the century and beginning of the dispute, when Newton's early mathematical work was still unpublished and largely unknown. Yet, as Hall argues, with the publication of many of his earlier mathematical treatises, Newton succeeded in his goal of establishing his priority for the discovery of the calculus, thereby diminishing Leibniz's fame, if not his stature and influence. Though we may like to consider priority disputes futile and unbecoming to science, there is, as this book shows, very much to be gained through them.

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Toxicology

Quantitative Toxicology. Selected Topics. V. A. FILOV, A. A. GOLUBEV, E. I. LIUBLINA, and N. A. TOLOKONTSEV. Translated from the Russian edition (1973) by V. E. Tatarchenko. Wiley-Interscience, New York, 1980. xviii, 462 pp., illus. $32.50. Environmental Science and Technology.

This book is an attempt by a group of Leningrad toxicologists to present a systematic account of quantitative aspects of toxicology. Rather than updating the original book for the English edition, the authors prepared addenda to all the chapters except one that deals with the equilibrium distribution of nonelectrolytes between the environment and living organisms, a subject where no further developments have occurred.

Toxicity has been defined as the capability of a chemical to harm a living organism. It depends on the physical and chemical properties of the compound, on the characteristics of the organism with which the chemical interacts, and, above all, on the amount of the chemical that is absorbed by the organism, that is, on its dose. The relationship between the dose and the type and magnitude of the effects and the incidence of the effects in a population are the central concerns of toxicology. The effects also depend on the way in which the chemical is absorbed by the organism (inhalation, skin contact, ingestion, injection), how the dose is distributed in time (single dose, repeated doses, continued uptake), and on whether the magnitude of the dose is constant or variable. A deleterious effect may be caused by the parent compound or its metabolic products, which have to be identified. The transport, distribution, and elimination from the organism, both of the parent compound and of its metabolites, have to be evaluated. Effects may appear soon after exposure or may take considerable time to develop. Environmental conditions such as the presence or absence of other chemicals and the intensity of physical factors—light, temperature, humidity, radiation, and noise—may also modify the toxic action of chemicals. All these phenomena and processes have both qualitative and quantitative aspects. Statistical correlations and mathematical models may be useful tools in toxicology but are of limited value unless their biological basis is understood, at least to some extent. To express toxicological information in quantitative terms is a complex task, and the authors were wise to limit their presentation to topics with which they had personal experience. The monograph is largely based on Soviet literature and toxicological practice but includes selected references to the work done in other countries.

Of much interest is the discussion of "the relationship between the amount of poison and toxic effect" (chapter 2), for it considers threshold doses and concentrations, "toxic action zones," and maximum permissible concentrations. The view of the authors (p. 31) is that "the threshold dose depends not only on species and individual differences in sensitivity, properties of poison, and various other factors mentioned in chapter 1, but also, and perhaps first and foremost, on the method used to establish it" and that "the difficulty is compounded by the lack of agreement about what is to be considered a threshold effect." The concept of "toxic zones" has always caused misunderstanding because it has been defined in many different ways, even by Soviet toxicologists. The authors propose to define it as the slope of the dose-response line after is has been linearized. As regards methods for establishing maximum permissible concentrations, the authors think it would be desirable to make a detailed comparison of the different approaches that are currently used. It may then be possible to find principles for setting such concentrations that would be less subjective.

About a third of the book is devoted to a fairly complete and conventional treatment of the kinetics of absorption and the fate of chemicals in the organism. A new name, "toxicokinetics," is proposed. The treatment ends with an outline of an interesting but highly theoretical model for the kinetics of uptake of stable compounds.

According to some recent estimates, about 70,000 chemicals are currently used in various applications, and many of them have not yet been tested adequately, if at all. The number of chemicals is increasing rapidly; about 200 to 1000 new ones are put on the market every year. In order to reduce the cost of and time needed for toxicological assessment, an effort is being made in many countries to develop appropriate methods for screening and identifying those compounds that require long-term testing. One approach is to use rapid laboratory bioassays, such as those used in mutagenicity studies; the other is to use the relationship between chemical structure and biological activity. Soviet toxicologists have always paid considerable attention to such relationships and have developed a large number of empirical methods for calculating different toxicity indexes from physicochemical properties and even for estimating tentative maximum permissible concentrations of new chemicals. An extensive discussion of this approach is given in the last two chapters of the book. The authors recognize that the use of structure-activity relationships has had a rather limited success in predicting chemical carcinogenicity. Nevertheless, they consider it a useful tool in the selection of chemicals for laboratory testing.

Other topics discussed include quantitative evaluation of cumulative and of joint effects of chemicals.

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