essential repairs to their buildings can be undertaken. The medical students of King's College have already returned from Birmingham and the preclinical students of the Middlesex Hospital from Leeds, the London School of Medicine for Women is bringing back its preclinical students from Exeter and the London Hospital its preclinical students from Cambridge. The whole medical school of University College Hospital is also returning to London as the sector hospital which has been used for teaching is no longer available. Among the schools whose buildings have suffered extensive damage are University College and St. Bartholomew's Hospital Medical College, and these schools are considering schemes for temporary accommodation after the war so that their return to London need not wait upon the completion of the permanent buildings.

The Times, London, states that the Government of New South Wales is setting up a cancer institute at Sydney, the cost of which will be £100,000. Dr. Ralston Paterson, of the Holt Radium Institute, Manchester, England, is going to Australia to advise on the project.

THE British Institute of Chemistry hereafter will be known as "The Royal Institute of Chemistry of Great Britain and Ireland."

DISCUSSION

IMPLICATIONS INVOLVED IN MATHEMATICAL ADVANCES

HISTORIES of mathematics have seldom emphasized duly the fact that mathematical advances usually imply corresponding mathematical ignorance of the entire world up to the time when these advances were made. It is largely due to this fact that many educated people regard mathematics as a much older subject than it actually is. The numerous modern mathematical advances are greeted with applause, but their effectiveness would often be enhanced by exhibiting clearly to what extent they dispel ignorance relating to the same subjects. This is especially true as regards the history of mathematics since American contributions towards the advancement of this subject have thus far been unduly limited. Our writings thereon have been too largely confined to text-books which were usually not up-to-date even at the time of publication.

Advances in pure mathematics have always been within the reach of the poor and the rich alike since they required no expensive equipment. In this respect they differ widely from the achievements in warfare since the latter have always depended largely on the improvements in physical equipments, which, in turn, often encouraged the diffusion of mathematical knowledge. The free accessibility as regards advances in this subject constitutes an important element of its history because it tended to widen the variation of those working in this field. Those who contributed to the advancement of mathematics often worked in obscurity and with meager facilities.

For instance, J. V. Poncelet, who is commonly regarded as the creator of projective geometry, remarked in the first pages of his noted "Traité des propriétés projectives des figures" that this work was the result of researches which he undertook in the spring of 1813 in the prisons of Russia, where he obviously did not have much physical equipment for scholarly work. E. Galois, who greatly stimulated the early development of group theory, died before he was twenty-one years old when his work had as yet received little attention. He is the most conspicuous example of a mathematician whose present reputation depends almost entirely on the work of later writers who developed results which follow from ideas which he had announced but did not have time to master completely. His great modern reputation is evidence of a widespread desire on the part of the earlier mathematicians to give credit for the ideas which inspired their own work. It would be too idealistic to assume that this desire was universal or is universal now.

The history of mathematics is greatly enriched by the consideration of each decided advance in the light which it throws on the mathematical developments of all earlier times. For instance, the fact that H. Cardan published in his "Ars Magna" (1545) the earliest known solution of a quadratic equation having two complex roots sheds much light on all the earlier work relating to the quadratic equation, including that of the ancient Babylonians (about 2000 B.C.) and that of the ancient Greeks which was done more than fifteen hundred years later. The fact that the Norwegian surveyor, Caspar Wessel, published in 1799 the earliest satisfactory theory for operating with complex numbers by means of the fundamental operations of arithmetic throws much light on the extensive earlier use of these numbers during about two hundred and fifty years after the publication of Cardan's "Ars Magna."

This use of complex numbers before its legality had been established was not confined to mathematicians who received little recognition on the part of later writers on mathematics. It included Isaac Newton (1642–1727), who considered the number of the imaginary roots of an algebraic equation; G. W. Leibniz (1646–1716), who factored $x^4 + a^4$ into its linear fac-

tors and used them in the decomposition of fractions into partial fractions; John Bernoulli (1667–1748) who exhibited the connection between the arc tangent and the logarithm of an imaginary argument, and Leonhard Euler (1707–1783), who introduced in 1740 the use of imaginary exponents. The large number of interesting results which had been obtained by the use of complex numbers before the legality of this use had been proved may partly account for the fact that this proof failed to attract much attention until many years after it was first published. Correct results have frequently inspired faith in the correctness of the methods employed and were often accepted as proof of this correctness.

Although negative numbers were used much earlier than complex numbers, the solution of a quadratic equation having two complex roots seems to have preceded by about eighty-four years the solution of such an equation having two negative roots. The earliest known example of the latter appears in the "Invention nouvelle" by A. Girard which was published in Amsterdam, 1629. The late appearance of such a solution directs attention to the fact that the general use of negative numbers came much later than might be inferred from the modern early use of them in our schools. Among the late strong opponents to the use of these numbers was Robert Simson (1687–1768), who was professor of mathematics in the University of Glasgow for forty years after 1711.

Hence it results that what the modern high-school student is supposed to master easily gave much trouble to a noted professor of mathematics less than two hundred years ago. Possibly the concealing of difficulties in elementary mathematics is too frequently regarded as a simplification of the subject. While a clear explanation of the theory of operating with negative numbers does not seem to be older than the corresponding theory relating to complex numbers it is a clear exaggeration to assert that "the one glimmer of mathematical intelligence in the early history of negatives is the suggestion of Fibonacci that a negative sum of money may be regarded as a loss." This assertion appears in the "Development of Mathematics" by E. T. Bell (page 158, 1940). On the contrary, the ancient Babylonians already used the terms "tab" and "lal" with respect to numbers as we now use + and − to represent distances in opposite directions from a fixed line.[1]

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AN UNRECORDED CAUSE OF "RED WATER"

RED WATER has attracted the attention of seafarers since early times. Various marine organisms have been cited as giving rise to this phenomenon, frequently ascribed to one or another species of dinoflagellate, as, for instance, *Gonyaulax polyhedra* off our own west coast, but never before do trochophore larvae seem to have produced it.

In 1935 I had the good fortune of accompanying Captain Allan Hancock, of Los Angeles and Santa Maria, California, on another of his memorable Pacific Expeditions aboard his motor cruiser, the *Velero III,* now in the service of the U. S. Navy. The third of January saw us headed southward off the coast of central Peru, angling across the Humboldt or Peruvian current. During that afternoon, while a little more than 50 miles to the westward of the Lobos de Tierra Islands (6° 28′ S., 81° 51′ 30″ W.), many patches of "red water" were seen all afternoon. A sample dipped up in a bucket from one of them was preserved in formalin for later study.

The contained organisms, thought at the time of collection to be peridinians, though very much plasmolized as the result of preservation, were unmistakably some species of trochophore larva, either mollusk or annelid. Dr. Martin Johnson, of the Scripps Institution, in commenting on the material says, "There is a possibility that the larvae could be those of a bivalve mollusk—the trochophore stage of gastropods usually occurs while yet enclosed in a case. I was, however, unable to make out any shell gland, a feature characteristic of bivalves in this stage. The trochal cilia also seemed to be more characteristic of annelids." He adds that it was perhaps not possible to settle the question from the specimens at hand. It is to be regretted that these larvae were not sufficiently far advanced in development to permit definite determination.

As trochophores apparently have not heretofore been observed as causing "red water," the fact that they were present in such enormous numbers as to give rise to this phenomenon seems worthy of note. No temperature reading was made at the time of the taking of the sample, but while on the same course the surface temperature at 10:05 A.M. registered 19.50° C. (6° S., 81° 41′ W.) and at 5:30 P.M., 20.32° C. (7° 50′ S., 81° 53′ 30″ W.).

Besides Dr. Johnson, I am also indebted to Dr. Herbert Graham, Mills College, and Dr. Olga Hartman, Allan Hancock Foundation, University of Southern California, for critically examining the sample; and to Captain Allan Hancock for permission to publish these notes upon it.

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THE TEACHING OF TROPICAL MEDICINE

THE request of the armed forces that medical schools give more emphasis to tropical disease presents new

[1] *Cf.* O. Neugebauer, "Vorgriechische Mathematik," page 18, 1940.