the bibliographic references that accompany each chapter are well chosen, and the story is fascinating of how many advances in different and apparently unrelated fields of medicine have been correlated to advance knowledge. The final chapter gives a fair and impartial account of the current trend towards the socialization of medicine.

The second edition of "A Hundred Years of Medicine" bids fair to achieve the general popularity it deserves. After a seven-years' sleep, and in a new dress, at last the book will come into its own.

REGINALD FITZ

CALCULUS

Calculus. By LYMAN M. KELLS. Prentice-Hall. $3.75.

PROFESSOR KELLS'S attractive new book can be warmly recommended as an introduction to the calculus. He has given real life to the fundamental abstract ideas, by well-chosen and often original verbal and pictorial illustrations (there are 325 figures). In the same spirit, he has driven home the practical value of the calculus as a method by an immense variety of concrete problems. The result should be to embed the calculus permanently in the thinking processes of even mediocre students, and the reviewer intends to try the text in his own first-year courses.

On the other hand, he does not feel that Professor Kells's book will develop sufficiently the critical ability of more advanced students. No warning is given that one may be led into error by believing the "obvious," and no apology is made for introducing convenient "assumptions" in order to minimize the difficulties of proof. In fact, the "proof" at the top of page 409 is grossly wrong; so is the "assumption" at the beginning of §174; the function $\exp(-1/x^2)$ being a well-known counter example which appears in most rigorous texts. When such errors are corrected in later editions together with numerous misprints, the book should be admirably suited to first-year students.

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SPECIAL ARTICLES

THE RED AND GREEN LIGHTS OF THE "RAILROAD WORM"

A FEW luminous animals are known which emit light of two different colors. One of the most striking of these is the South American railroad worm or "ferrocarril," of the genus, Phryxothrix, a beetle of the family Phengodidae, related to fireflies. The adult male has typical beetle characteristics and long branched antennae. The adult female, nearly two inches long, is larviform, with eleven pairs of brilliant greenish yellow luminescent spots on the sides of the body and a red luminous area in the head. The larvae of both male and female also possess similar luminescent spots. In North America, the rare closely related insect, Phengodes, occurs, with rows of green lights, but lacking the red light in the head.[1]

Thanks to the kindness of Dr. H. L. Parker, of the U. S. Department of Agriculture, I have recently received from Uruguay several living specimens of Phryxothrix in excellent condition. One was an adult female and the others probably larvae. They showed no light when at rest but if disturbed very slightly, by knocking the table gently or blowing air over them, they responded by shining the red light. When the disturbance was greater the rows of greenish lights also appeared and the animal explored its environment with a brilliant display of pyrotechnics. The red light in the head resembled the tip of a glowing cigarette. Sometimes all and sometimes only certain of the greenish lights would be turned on. Later the greenish lights went out while the red remained on for some time, finally to disappear as the animal became quiet again.

With these specimens it has been possible to determine the nature of the red luminescence. There are three ways in which a red light might be produced: (1) By emission of red wave-lengths, a red chemiluminescence; (2) by the presence of a red color screen transmitting red but absorbing other wave-lengths; (3) by red fluorescence of a compound, excited by shorter wave-lengths emitted by some chemiluminescent reaction. The first method is the one used in producing the red light, as indicated by the following experiments.

If the red luminescent material is dissected out of the head of Phryxothrix and examined on a slide in day-light, no red pigment can be detected.[2] The tissue appears colorless and the easily visible (in the dark) red luminescence could not be due to a red color screen or to absorption by the chitin of the head, which is a light brown in color.

When hydrogen or nitrogen gas is passed over the excised red luminescent tissue in the dark, the red light disappears, and if the potentially luminous substance is now exposed to near ultra-violet light without the visible (from a mercury arc filtered through Wood's

[1] See the description in "Living Light," by E. N. Harvey, Princeton University Press, 1940, p. 69.

[2] A very weak solution of some red compound might be present, too dilute to appear red by absorption but concentrated enough to luminesce with a red emission. The luminescence of colored compounds can be detected in concentrations too weak to appear colored.