length of training, and improvements of work methods and conditions.

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HOW BIG IS A CELL?

IN classes in elementary biology some attempt is usually made to relate the world revealed by the microscope to the world as we know it with our unaided eyes. In these attempts it has been particularly difficult to compare the scales of the two worlds. For the comparison one needed an every-day object large enough to come within the range of a microscope's field of view. In teaching a class in elementary botany, it occurred to me that the thickness of a page in a book might be so used. The students were asked to determine the figures for themselves, by measuring the thickness of 100 pages of an actual book, dividing by 100 to obtain the value for one page, and then multiplying by 1,000 to convert the reading into microns. Most text-book paper is around 50 microns thick.

In one laboratory course the idea was pushed even further and the students were required during the first exercises with the microscope to rule their drawings with faint lines, 55 microns apart in the scale of the drawing. The finished work then showed what the cells in question would have looked like if seen against the ends of pages in the text-book. I can not be sure that all this was much help to the students, but I have found from experience that it has been very useful to me. Not only has it helped to relate more effectively the two worlds in which I spent most of my time, but it has given me a much better working knowledge of the relative sizes of different plant cells.

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SCIENTIFIC BOOKS

Halley's Comet in its Appearance of 1909–1911. By NICHOLAS T. BOBROVNIKOFF. Publications of the Lick Observatory, Vol. XVII, 309 to 482, 1931.

EVERY one interested in comets to the slightest degree knows of the important papers already published by Bobrovnikoff upon this subject. It is therefore no surprise to find this last perhaps the most complete study of a comet's appearance that has ever been published. Its length and the great detail in which the author describes striking phenomena are justified both by the importance of Halley's Comet, as a typical comet and historically, and by the wealth of data at his disposal.

Working at the Lick Observatory, he used as the basis of his discussion the 438 plates of the comet secured there and 271 selected reproductions from plates taken elsewhere. The former were taken mostly by Dr. Heber D. Curtis, with the writer of the present review much of the time as his assistant. Curtis had intended to work up these himself, but the opportunity for fully doing so never came, though he did publish a preliminary paper (Pub. A.S.P., 22, 117, 1910), and made a number of calculations and notes for the longer one. Therefore Curtis generously turned over everything to Bobrovnikoff, who has, here and there, used some of these calculations in his discussion.

In the space available here, one can call attention to but few of the salient points among the great number of interesting conclusions. The nucleus is proved to have exerted appreciable repulsive forces upon matter forming the jets; in it, however, no rotation was shown, and on several occasions changes of an explosive character were detected therein. For instance, on May 24 a five-fold increase in its size was noted during the exposure of one plate. The threatened breaking up, however, was always followed by a collapse. The jets, composed of cyanogen, were actual matter being expelled. For those in the prolonged radius-vector the nucleus showed repulsive forces of from 1 to 6 times gravitation. The envelopes, in the forms of approximate catenaries, expanded outward at the rate of about half a kilometer per second. The velocity of expansion of the halos was of the same order.

A new determination of the mass of the comet comes out to be of the order of 10^{-10} that of the Earth. This confirms the growing conviction of many of us that some older estimates of the masses of comets were absurdly low. The tail of the comet proved to be double, Tail I having a slight departure from the prolonged radius vector of the orbit, but Tail II making an angle of about 40°. Apparently CO^+ was the chief constituent of Tail I, Tail II shown by diffused solar light and to a lesser degree also by the light of glowing CO^+. In I, the average repulsive forces ranged from 10 to 20, but for the condensations in I these numbers increased to from 20 to 150; in II they were in general < 0.3. He concludes, therefore, that, while the Bessel-Bredichin mechanical theory of comets' tails is sufficient to explain the observed facts, the latter's actual classification is inadequate and that at least four classes are needed, with a great extension of his ideas as to the maximum magnitude of the repulsive forces. It was further shown that not only