able error decreased from 103^{σ} to 35^{σ}. Moreover, the upward rest was longer in the first part of the practice than the other three phases combined; but at the close of the series it was the same as the downward rest, thus showing that the greatest gains in voluntary activity are those resulting from the practice of the weakest and less exercised muscles.

IV. *Estimation of time.*—After a number of preliminary tests the intervals, 82 Σ, 100 Σ and 164 Σ were chosen. The practice lasted from 8 to 16 days, on seven subjects.

The results justify the following conclusions: (1) The estimate of a given interval varies for different individuals both with and without practice. (2) Practice on the same interval may cause the variation from the given interval to increase with one person and decrease with another. (3) Time-estimate is a personal factor depending upon (*a*) the nature of the person, whether of an impulsive or quiet temperament, and (*b*) upon the point of the fixation of the attention, whether to the sensory or the motor side. (4) There is no indifference 'point' from which the subject does not vary with long continued practice. The changes that practice produces in the estimation of time are probably due to fixing the attention on the movement to be performed, in which case the estimate is shortened in accordance with the growth of automatic control, or to the sensory side, in which case the time-estimate is made longer by practice.

V. *Regulated rhythmical action.*—In arranging apparatus for this experiment the probable error was found for the EDISON phonograph to range from 0.2% to 0.7%; for the LUDWIG kymograph by BALTZAR, from 0.2% to 2.0%; for a drum run by an EDISON motor driven by carefully tended EDISON-LALANDE batteries, from 0.1% to 0.3%. The PFEIL marker was found at a break of the circuit to have a latent time ranging from $1.1 \pm 0.09^{\sigma}$ with the magnet cores distant from the armature to $14.7^{\sigma} \pm 0.03^{\sigma}$ with the cores close to the armature. At a make the latent time ranged from $1.8^{\sigma} \pm 0.1^{\sigma}$ to $1.3^{\sigma} \pm 0.5^{\sigma}$. With this marker the make is nearly as good as the break except for its slightly greater irregularity. The DEPREZ marker from VERDIN showed a latent time at the break of $3.8^{\sigma} \pm 0.07^{\sigma}$ and of $2.5^{\sigma} \pm 0.64^{\sigma}$ at the make. Changes in the adjusting spring did not make any great change in the figures. The probable error of the spark records was found to be $\pm 0.25^{mm}$ independent of the speed of the drum.

In beating time in unison with a sounder-click each subject had his own constant error; this was generally negative; that is, the subjects generally beat time before the click occurred. With practice the negative constant error tended steadily to decrease, to become positive and to increase positively. The irregularity steadily decreased.

VI. *Free rythmical action.*—The seven subjects were required to beat time without any objective signal. The interval chosen at the start was unintentionally shortened with the progress of the experiment; it was also shortened from day to day. The irregularity decreased in like manner.

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NATHAN RUSSELL HARRINGTON.

NATHAN R. HARRINGTON, of Cleveland, Ohio, died in the Sudan on July 26, 1899. He was acting for the second time as leader of the Senff Zoological Expedition, sent out under the direction of Columbia University, through the liberality of Mr. Charles H. Senff, of New York City. The party consisted of Mr. Harrington, Instructor in Biology in Western Reserve University;

Dr. Reid Hunt, of the Johns Hopkins Medical School, and Mr. F. B. Sumner, fellow in Columbia University. Their chief object was to procure the long coveted eggs and early stages in development of Polypterus bichir of the Nile and other African rivers, one of the most ancient and least modified types of living fishes, and one of the most interesting vertebrates whose development yet remains to be studied by modern zoological methods.

Last year Mr. Harrington and Dr. Hunt explored Lake Menzaleh and several hundred miles of the river north of Damietta, spent two months at Mansourah, forty miles from the sea; made many observations on Polypterus alive, and brought home valuable material illustrating the anatomy of this and other Nile fishes. They found, however, that eggs of Polypterus obtained as late as August 30th, were still immature, and they were obliged to come away without getting the embryological stages sought for.

Harrington returned from this expedition with a wider knowledge of the world, a greater circle of friends and a keener zeal to extend the bounds of zoology. Although he was just beginning his career as a teacher and a great variety of work was pressing to be done, the Nile country was ever in his mind, and great was his satisfaction when he was again sent into the field.

Letters to friends during the early weeks of summer showed that new obstacles had arisen which threatened to remove every chance of success. The fish were scarce in the lower Nile and the region traversed by the upper Nile, where they were supposed to abound, was not yet open to travelers. After destroying the rule of the Mahdi, the English authorities were naturally reluctant to admit strangers to the newly recovered territory. Harrington's earnestness and tact however prevailed, and the party was permitted to proceed to Atbara, a small village and military post 1200 miles north of Cairo by river.

The circumstances of Harrington's illness and death have been told in the letters of Dr. Hunt, and from them we are permitted to narrate the following facts. Early in July Harrington went up the Atbara river with a member of his party and spent a night in the desert, where they were overtaken by a dust storm. A slight indisposition following this exposure finally led to an attack of Nile fever which ended fatally in spite of the devoted energies of his friends and Dr. Nickerson, the British Surgeon of the Post. He was borne to the grave by British soldiers attended by their officers, amid the strains of martial music, and was laid to rest in the little cemetery on the edge of the desert near the grave of Mr. Cross, the late war correspondent in the Sudan campaign.

The death of this young man calls to mind another young American zoologist of great promise, Adam T. Bruce, whose death also occurred in Egypt, twelve years ago. As with Bruce, Harrington's scientific and academic career had just begun. Though born in Massachusetts—in Somerville, December 22, 1870, the son of John and Emma Harrington—he was virtually a Cleveland boy, and was graduated from the West High School in 1889. He received the degree of Bachelor of Arts in 1893 and later that of Master of Arts from Williams College. The years 1893–1898 were passed at Columbia University, with the exception of a year as assistant in the laboratory at Williamstown, in the capacity of graduate student, assistant and fellow. During this interval his summers were spent in study at Woods Hole, and as a member of the Zoological Expeditions sent out by Columbia University, to Puget Sound and Alaska. These were followed by the Senff Expeditions to Africa in 1898–1899, as already recorded. In 1898 he was appointed Instruc-

tor in the College for Women, Western Reserve University.

Harrington's most elaborate paper on 'The Calciferous Glands of the Earthworm, with Appendix on the Circulation' was in press at the time of his death, and had been accepted as a thesis for the degree of Doctor in Philosophy, which he had hoped soon to receive from Columbia University. An important paper on Amœba and its reaction to the stimulus of light waves of different intensities, written in collaboration with Mr. Leaming, was published during the past summer. The following briefer articles testify to his energy and enthusiasm as a field naturalist; 'Observations on the Plankton of Puget Sound' with the collaboration of his ever devoted friend, the late Professor Peck; 'Notes on the distribution and habits of some Puget Sound Invertebrates,' and on 'Nereids commensal with Hermit Crabs.'

All who knew Harrington will agree that his character, courage and earnestness in the pursuit of knowledge, which led to the sacrifice of his life are well worthy of permanent record. His sympathetic and generous mind, his capacity for friendship, his industry and zeal are endowments which any young man would be fortunate to possess. He has left an honorable name in zoology, more lasting than the simple cross which now casts its shadow on his grave.

F. H. H.

SCIENTIFIC BOOKS.

The University Geological Survey of Kansas. Special report of coal. By ERASMUS HAWORTH, assisted by W. R. CRANE, Vol. III., Topeka. J. S. Parks, State Printer. 1898. 347 pp. 70 pl. 55 Figs.

Part I. of this volume, by Professor Haworth, is a general description of the Kansas Coal Measures, which the author divides into Upper and Lower, embracing seven formations with twenty-five subordinate divisions. Some of the latter will be subdivided in turn when further studies have been made. The total thickness is not far from 3,000 feet.

The Lower Coal Measures include the Cherokee and Marmaton formations. The Cherokee, 400 to 500 feet thick, consists mostly of shales but contains some irregular limestones and some sandstone beds of economic interest. The coal beds are important, being those mined at Pittsburg, Fort Scott and Columbus, and are available in an area of about 12,000 square miles. The Cherokee covers a wide space in Indian Territory, extends into Iowa to form part of the Des Moines formation, and Professor Haworth is inclined to think that the important coal fields of Arkansas may belong to the same horizon.

The Marmaton consists of alternating limestones and shales. The lower and middle limestones, Oswego and Pawnee, are persistent, but the intervening Labette shales are irregular in distribution. The upper limestone, the Altament, is thin and not persistent, so that the Pleasanton shales, divided at some localities by the limestone, are unbroken over a large area. The lower division of the Oswego limestone is the well-known Fort Scott cement rock A few coal beds occur in the Marmaton, but thus far they seem to be unimportant.

The remaining five formations belong to the Upper Coal Measures as grouped by Professor Haworth.

The Pottawatomie consists of three limestones, Erie, Iola and Garnett, separated by the Thayer and Lane shales. The Erie limestones, having a maximum thickness of 225 feet, are usually triple with intervening shales, which thicken southwardly at the expense of the limestones until the latter become insignificant. The upper limestone is cherty and all are very fossiliferous. The Thayer shales have an extreme thickness of 200 feet but thin northward, so that the Iola limestone, which thickens in that direction to 200 feet, is at length practically continuous with the upper Erie. The Lane shales and Garnett limestones are somewhat irregular in their variations, but the latter, owing to erosion of the overlying shales, is exposed over a great area. This formation contains no coal of economic importance.