

acolytes, the shrines and the divinity thereto attached. It is interesting to note that the people would talk about an important *ti* "in exactly the same kind of way that an Englishman talks about a benefice."

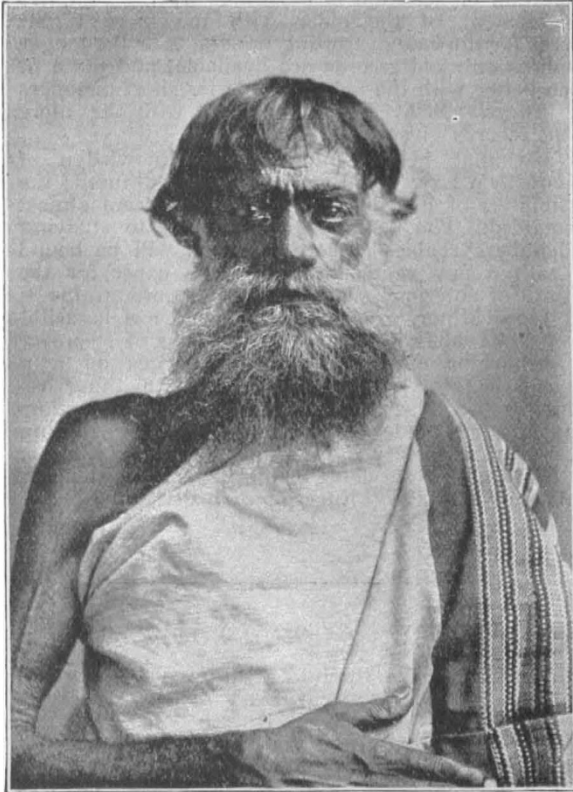


FIG. 2.—Toda man. From "The Todas."

The European cleric and the Toda *palol* thus meet after a journey commenced at what widely separated points. Thanks to Dr. Rivers's energy and care we have a complete and scientific account of one of the most significant phenomena in the history of that varied organism, religion.

The author is of opinion that the division of the people into *Teivaliol* and *Tariharol* is due to the coalescence of two tribes, coming to the hills at different times. There are marked dialectical differences between them. The Toda language as a whole is very difficult. The philologist will find it well worth study, and the data are both extensive and rendered more valuable in a way because the collector was himself ignorant of any other Dravidian tongue, and had therefore no expert prejudices. The secret and sacred languages are rather conspicuous in the life of the Todas.

The book—Dr. Rivers' first book, if I mistake not, in this subject—is a monument of industry and care, not without insight and the results of comparative study, and is an invaluable record of which Cambridge and the new anthropology may be proud.

A. E. CRAWLEY.

A LAW OF RECORD TIMES IN RACING.

A REMARKABLE article on "An Approximate Law of Fatigue in the Speeds of Racing Animals," by Mr. A. E. Kennelly, appears in the Proceedings of the American Academy (vol. xlii., p. 275) for December, 1906. We cannot help speculating as to the causes which led the author to choose such a

subject for investigation. To the man of science, even to the omnivorous statistician, the subject sounds so unpromising—one may almost say undignified or improper; the sort of subject with which no civil servant, no permanent official, should ever deal, even in secret. Once the investigation was commenced, it was naturally extended from one series of records to another; but what accident prompted the commencement? Mr. Kennelly is provokingly silent on the point. He opens, it is true, by telling us that "Olympia and Epsom Downs are known to fame by the races they have witnessed. Olympian races, recently revived, are of international interest. . . . A reduction of either of the records [for the 100 yards or the mile] by even one per cent. would be a matter of world-wide importance, and the hero of the new record would be famous among the inhabitants of the temperate zones." Yet we find it hard to believe that the investigation was undertaken simply as a definite matter of urgent public importance, even though the results, as it turns out, may have the gravest social consequences. They may lead to the advertising of mathematical tables and squared paper in the sporting press. They may even influence the teaching of mathematics in our public schools, our universities, and other haunts of ancient peace.

Put briefly and in its simplest possible form, the approximate law relating distances with record times which Mr. Kennelly has discovered is as follows:—For all pairs of distances in the same proportion the record times are in constant ratio, and this ratio is independent of the animal and of the mode of progression. The observed ratios fluctuate, as one might expect, but the fluctuation seems to be of a casual kind over a very wide range of distances, and the ratios for different animals or modes of progress show little more divergence than the ratios for the same animal and the same mode of progress. Thus, taking merely a few instances in the ratio 2:1, we have:—

HORSES TROTTING.

Distance (miles)	Time (seconds)	Ratio of times
1	118.5	—
2	257.0	2.16
4	598.0	2.33
5	750.75	—
10	1575.0	2.10
20	3505.0	2.22
Average ratio		2.202

MEN SWIMMING.

Distance (yards)	Time (seconds)	Ratio of times
25	12.2	—
50	24.6	2.02
100	58.0	2.36
200	140.0	2.42
400	297.0	2.12
800	628.0	2.12
Average ratio		2.208

The law has been tested and found to hold good for horses running, trotting, and pacing, and for men walking, running, rowing, swimming, and skating. It does not hold, on the other hand, for bicycling—a not unnatural result, when the importance of the machine as well as the rider is considered.¹

If T denote the record time and L the distance, the law may evidently be put in the form

$$T = A \cdot L^a \quad (1)$$

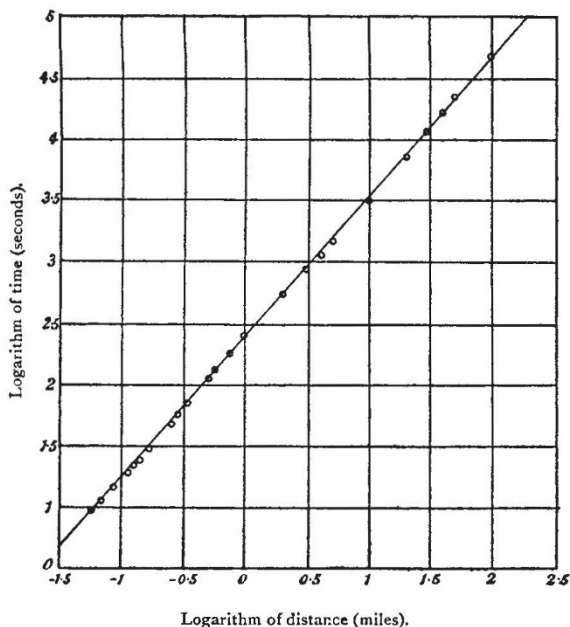
¹ Cf. the work of M. Pouny (Paris Academy of Sciences, and NATURE, vol. liv., 1896), and R. E. Crompton (NATURE, vol. lxi., 1899).

where n is a constant and A varies with the animal and the mode of progress. That is, in terms of logarithms,

$$\log T = \log A + n \cdot \log L \quad \dots \quad (2)$$

Hence, if T and L are plotted on logarithmic paper, or their logarithms plotted on ordinary scale paper, the points obtained will lie more or less closely round a straight line. If a line be run as near as may be through the points, its slope will give the value of n . This is the procedure adopted by Mr. Kennelly, and he finds an average value of n equal to $9/8$, corresponding to a ratio of the times for double distances 2.181. To illustrate the closeness of the logarithmic law from data that are readily accessible in England, we have plotted a diagram from the table of running records in "Whitaker's Almanack" (p. 415), taking, like Mr. Kennelly, the lowest record, whether amateur or professional, in each case. We must refer the reader to the original paper for numerous diagrams, on a somewhat larger scale, illustrating the records in the other cases.

The author concludes, we think correctly, that a



Men running: logarithmic graph of record time and distance, 100 yards to 100 miles.

record is more likely to be lowered if it correspond to a point lying above the time-distance line than if it correspond to a point lying below it, and hence the graph may be of service to the athlete. He also argues that, as a consequence of the law, an athlete should adopt such a speed in running that he can just maintain it constant to the end of the course and is then completely exhausted. But the energy of the individual is not exhausted suddenly in this way, and, although the conclusion may concur with practice, we do not think that it follows from the given law of record speeds. We agree with the author that more information is wanted on this head. It seems doubtful, in fact, if the observed rule should be termed a "law of fatigue" at all; it is not a law of the variation of speed, with time or distance, for the same individual running his fastest continuously, nor even of the average speeds of the same runner over different

distances when he knew in advance the distance to be run. It is a law relating times to distances when the best possible runner is selected for each particular distance. This involves the adaptation of the individual as well as fatigue. How much it involves adaptation or selection is illustrated by the complete disagreement of the older with the more recent records for the case of trotting horses. For the longer distances only old records are available, and these fit much better with the older records for short distances (cf. *Encycl. Brit.*, xii., 205) than with the more recent records given by Mr. Kennelly.

We cannot help hoping that a knowledge of "Kennelly's Law" will soon be widely diffused; the possibilities of its educational influence seem almost unbounded. The bookmakers will take to studying "Chambers' Tables"; betting books will be bound up with a few pages of logarithmic paper for the purpose of entering, shall we say, "recordograms"; and Jones Minor, callous to the beauties of logarithmic graphs when illustrated by the laws of steam or the behaviour of purely symbolic barges on non-existent canals, may awaken into something resembling life when racing records are in question. Schoolmasters need not hesitate for fear of corrupting youth; the necessary data can be taken from either of those most respectable publications, "Whitaker's Almanac" and the "Encyclopædia Britannica."

G. U. Y.

PROF. H. W. BAKHUIS-ROOZEBOOM.

CHEMISTS have received with great sorrow the news of the death of Prof. H. W. Bakhuis-Roozeboom on February 8. Roozeboom was struck down in full activity, and science might have hoped to have been enriched by his work for years to come. At the beginning of February, however, he was attacked by influenza; apparent recovery was followed by pneumonia, which in three days proved fatal. He leaves a widow and five children.

Hendrik Willem Bakhuis-Roozeboom was born on October 24, 1854, at Alkmaar, a little town some twenty miles north of Haarlem, noted in history for the first successful resistance made against the Spaniards in the struggle for Dutch independence. He was educated in his native town at one of the higher burgher schools where so excellent an education on modern lines is given. Even during his school career his unusual ability gave promise of a notable future. After leaving school he assisted his chemistry master, Dr. Boeke, for some time in making a number of soil analyses in connection with the plan which is still under discussion of draining the neighbouring Zuider Zee. Not thinking at first of an academic career, he accepted a position in the butter factory of Dr. Mouton at the Hague, and it was the circumstance of the factory being burnt down in 1878 which decided his future. Hearing of the fire, a brother-in-law of Dr. Boeke, van Bemmelen, professor of chemistry at Leyden, offered Roozeboom the post of assistant. This he decided to accept, and while thus occupied he carried on his studies in the University of Leyden, and graduated in 1884. He remained at Leyden as docent, and later as lecturer, supplementing his small university stipend by teaching in the girls' higher burgher school and by translating English books into Dutch, until on the removal of van 't Hoff to Berlin in 1896 he succeeded him as professor of general chemistry in the Uni-