This raises the further question of how to combine the data in case there are, as there needs must be, irregular omissions in the data. It is a general rule of statistics that if we have two independent and consistent[2] estimates Q_1 and Q_2 of a quantity with two standard deviations σ_1 and σ_2, the weighted mean $Q = pQ_1 + (1-p)Q_2$ will have the smallest value of σ_Q when $p = \sigma_2^2/(\sigma_1^2+\sigma_2^2)$ and $\sigma_Q^{-2} = \sigma_1^{-2} + \sigma_2^{-2}$. Hence, applied to the estimates of amount of growth $Y-X$ and $W-Z$, the best estimate would have the sampling error

$$G = \frac{\sigma^2_{W\text{-}Z}(Y-X) + \sigma^2_{Y\text{-}X}(W-Z)}{\sigma^2_{W\text{-}Z} + \sigma^2_{Y\text{-}X}}.$$

$$\frac{1}{\sigma_G^2} = \frac{n}{\sigma_x^2+\sigma_y^2-2r\sigma_x\sigma_y} + \frac{lm}{l\sigma_w^2+m\sigma_z^2}$$

If we use for illustration the assumption $\sigma_x=\sigma_y=\sigma_w=\sigma_z$, $l=m=tn$,

$$\sigma_G^2 = \frac{2\sigma_x^2(1-r)}{n}\cdot\frac{1}{1+(1-r)t},$$

and it is clear that if r is large so that $1-r$ is small, t must be considerable before an appreciable reduction is made in σ_G.

It is well known in statistics that the sampling error of a quantity involves the method of estimating the quantity. Thus if a universe is symmetrical, its center may be estimated from a sample drawn from the universe by the mean of the sample or by its median or by its mode or by the mean of the least and of the greatest element in the sample, but the standard deviations of the four estimates will be different. So in the above problem if we should undertake to form from X and Z at the earlier age and from Y and W at the later age the overall age means

$$\frac{nX+lZ}{n+l} \text{ and } \frac{nY+mW}{n+m}$$

and their difference

$$G = \frac{nY}{n+m} - \frac{nX}{n+l} + \frac{mW}{n+m} - \frac{lZ}{n+l}$$

we could get σ_G^2 as

$$\sigma_G^2 = \frac{n\sigma_y^2}{(n+m)^2} + \frac{n\sigma_x^2}{(n+l)^2} - \frac{2nr\sigma_x\sigma_y}{(n+m)(n+l)} + \frac{l\sigma_z^2}{(n+l)^2} + \frac{m\sigma_w^2}{(n+m)^2},$$

but this would be a bad way to estimate G if r were large and l and m were not large compared with n. Indeed, if we take the simple illustrative case as before, $\sigma_x=\sigma_y=\sigma_z=\sigma_w$, $l=m=tn$ we have

$$\sigma_G^2 = \frac{2\sigma_x^2(1-r)}{n(1+t)^2}\left[1+\frac{t}{1-r}\right]$$

This is greater than if we had omitted altogether the extra observations which were not common to both years unless $t \geqq (2r-1)/(1-r)$. If $r=.96$ we should have 23 times as many non-common as common observations before we should be as well off using general means to estimate growth.

This discussion will show, it is hoped, how important it is when establishing norms for increments of growth (*i.e.*, of *growth*) to maintain throughout the study a discipline on the part of the students and of the studied which will bring about the maximum continuity of the record.

OBITUARY

WILLIAM REES BREBNER ROBERTSON
1881–1941

W. R. B. ROBERTSON was born on May 31, 1881, and spent his early life on a farm at Manchester, Kansas. He died in Iowa City on March 15, 1941. He was one of C. E. McClung's eager students of cytology in the University of Kansas (A.B., 1906; A.M., 1907). He also studied with E. L. Mark, 1909–1912, in Harvard (Ph.D., 1915). He then spent the rest of his

for the observations to which the formulas are applied. Thus if the theoretical sampling error of some quantity Q for samples of n items be σ, and if we take a considerable number of samples of n items we may find that the standard deviation of the values of Q observed in the different samples is considerably more than the theoretical value σ. If we evaluate the amount of growth by subtracting averages taken for two groups at each of two ages and also evaluate it by averaging the amount of growth between those ages for a single group measured at both ages, doing this a considerable number of times for different single groups on the one hand and for different pairs of groups on the other, we may well find that the variations observed are not those given by theory and further that they are not in the same ratio as that given by theory. It often takes extended experience to correct for such differences between theory and observation, but in the absence of such experience we have to make our estimates according to the theory.

[2] The qualification that the estimates have to be consistent is usually omitted. There are cases to be found in the literature where inconsistent estimates have been combined by the rules which I believe to be appropriate only for consistent estimates. Thus W. S. Eichelberger and Arthur Newton, "The Orbit of Neptune's Satellite and the Pole of Neptune's Equator," Astronomical Papers of the American Ephemeris, Vol. 9, Pt. 3, 1926, pp. 275–337, discuss on p. 329 the value of the reciprocal of the mass of Neptune, finding from reduction of the visual observations 19176 ± 25 and from reduction of the photographic observations 19655 ± 36. The difference is 479, which is many times as much as would be consistent with the indicated errors, yet they obtain 19331 ± 21 by combining the observations as if they were consistent, even reducing the estimated error of the combination in accordance with the rule. With the high standard in the reduction of observations set for the American Ephemeris and Nautical Almanac by Simon Newcomb over many years, I have to be somewhat hesitant in suggesting the above criticism, yet I must say that I have never seen any theory of least squares which seems to me to validate the process by which the final result 19331 ± 21 is obtained from its immediate antecedents.

life in the University of Kansas, the University of Missouri, the Kansas Agricultural Experiment Station and the University of Iowa. He was a life member of the Kansas Academy of Science; fellow of the American Society of Zoologists; member of the American Society of Naturalists, the Genetics Society, Medical Association, Poultry Society, Eugenics Research Association, Phi Beta Kappa, Sigma Xi and others.

Robertson's early papers, 1915–17, dealt with chromosomal inequalities, deficiencies, shapes and homologies in relation to synapsis, taxonomy and genetics in seven species of the subfamily Tetriginae, as well as in a few species of the larger grasshoppers. During the period of 1920–27, he derived a valuable set of data, including many skins and feather samples, from the extensive breeding of turkeys to which he devoted himself with meticulous care and great zeal. He never published on the turkey data but left them in such form that they will be available, it is believed, for forthcoming contributions of importance to the understanding of inheritance in these birds.

In 1927, Robertson came to the Department of Zoology of the Kansas State College as guest collaborator. He remained for three years, devoting himself exclusively to the cytogenetics of *Paratettix texanus* Hancock and *Apotettix eurycephalus* Hancock. He published five papers in 1930 and 1931 covering the work of this period. These researches dealt with the chromosomal relations in partheno-produced (I think that he introduced this useful word) pigmy locusts, including gonomeric grouping, synapsis-like tendencies, types of parthenogenesis, hybrid vigor, split chromosomes, the origin of the rarely partheno-produced males and other cytogenetic features of partheno-production. Subsequent joint papers (1933, 1941) have reported on inheritance in *Corthippus longicornis* and his accurate concatenation of cytology with the gross genetics of x-ray induced aberrancies in *A. eurycephalus,* including an autosome-sex chromosome translocation.

Robertson was extremely sensitive by nature and, like most people of similar dispositions, he commonly misconstrued the intentions and actions of his family, friends and colleagues to a greater degree, perhaps, than he was himself misunderstood and ill-judged. Nevertheless, he was a staunch and loyal friend and beneficently devoted to the welfare and progress of his students, the work of several of whom he directed to doctorate theses. As a scientist he was extraordinarily painstaking, exacting and demanding of high standards in his own and students' researches. Consequently, he proceeded slowly and, when measured beside stream-lined researches, perhaps awkwardly, and thus in at least a few instances he was subjected to the facile and inconsiderate opprobrium of dilatoriness. Due to his peculiarly sensitive nature he was unable to meet such imputations with that saving complex of disdain, aplomb and sense of humor so essential to the peace of mind and welfare of the creative and critically experimental scientist such as he was. But let it be recorded to the enduring excellence of Robertson's scientific character that, although staggered by the forces of financial, spiritual and professional embarrassment, he never relented nor deviated from the high and exacting standards which he had irrevocably set for himself in the days of his apprenticeship with McClung and Mark. It was during one of the most distressing periods for him that the research which will perhaps eventually be considered of considerable significance was accomplished.

In 1930, Robertson went to the University of Iowa. There, with the sagacious, understanding and genial MacEwen, Bodine, Ingram, other staff members and graduate students as colleagues, his long perturbed, thwarted and lonesome spirit was restored to a degree of composure and hope such as he had scarcely experienced since those early days of happy participation in the beginnings of cytogenetics on Mt. Oread. These remaining eleven years of his life were happily devoted to teaching, graduate students, various researches, including further cytogenetics of x-rayed pigmy locusts and some larger grasshoppers. He also gave attention to human heredity and contributed a chapter dealing with the biological background of the family to Jung's "Modern Marriage."

ROBERT K. NABOURS

DEATHS AND MEMORIALS

PROFESSOR WILMER E. DAVIS, professor of plant physiology at the Kansas State College of Agriculture and Applied Science, died on January 17 at the age of seventy-five years.

DR. CHARLES DAVISON, professor emeritus of surgery at the University of Illinois College of Medicine, died on January 19 at the age of eighty-four years.

DR. HARRY CAPPS, assistant professor of psychology, Louisiana State University, soon to have been inducted into the Army, died by suicide on January 17. He was thirty-three years old.

DURING the recent celebration of the fiftieth anniversary of the founding of the School of Mines of the University of Minnesota, the Board of Regents honored its founder and first dean, the late William Remsen Appleby, by naming the School of Mines building "Appleby Hall." A plaque, unveiled at a ceremony in his honor on January 13, will be placed