LETTERS TO THE EDITOR

A General Test for Finding whether Two Random Samples are Consubstantial*

The usual method of testing whether two random samples are consubstantial is to test whether the two samples differ significantly in their means; see *e.g.*, R. A. Fisher's "Statistical Methods for Research Workers". This test is accurate only in the case of samples drawn from a normally distributed population. A more general test was given by the writer some time ago.[2] This test too is not entirely free from a defect. However, the following test is quite as general and appears to be flawless. We will consider the simpler case of two equal samples.

Suppose the two samples, containing n individuals each, had been drawn from the same population. In this case each of the $2n$ individuals could have been drawn either in the first sample or in the second. Assuming for the time being that no two out of these $2n$ individuals are alike, it is clear that the pair of samples obtained by us is only one out of ${}_{2n}C_n/2$ different pairs of samples in which these very individuals could have been drawn. We will now classify these different possible samples in the following manner:

Let the individuals arranged in the order of increasing magnitude be a_1, a_2, ... a_{2n-1}, a_{2n} and let $a_{\overline{n}}$ be the median value of this sample.[1] We shall call an individual less than $a_{\overline{n}}$ an "inferior individual". In general, in each pair of samples one will have more inferior individuals than the other. We shall term this sample the "inferior sample". (If the two samples have the same number of inferior individuals it is immaterial which of them is classed as an inferior sample).

We now divide the different pairs of samples into groups, such that the inferior samples in each group have the same number of inferior individuals. If we give a number to a group equal to the number of inferior individuals in one of its inferior samples, it is clear that the greater the number of a group the smaller is the frequency of pairs of samples in that group.

Assuming the total frequency of the pairs of samples in all these groups to be unity, the frequency of the pairs of samples in groups numbered m, $m+1$, $m+2$, ... and n is

$$f = 2\sum_{r=m}^{n} ({}_nC_r)^2/({}_{2n}C_n) \quad .. \quad .. \quad .. \quad \text{I}$$

By rejecting these groups as not belonging to our population the chance of our going wrong is f.

We thus deduce the following test:

Using some limit P for random chance we solve equation I for m after putting $f = \text{P}$. Let m_1 be the value.

If the number of inferior individuals in the inferior of our two samples is m_1 or more

* This word was used by Karl Pearson to mean "from the same population".

we say that on the limit P for random chance the two samples were not drawn from the same population.

It should be noted that this test is accurate when all the $2n$ individuals are different. It will, however, be shown in a fuller paper under preparation that even when two or more of the drawn individuals are alike, this test is true to a high degree of approximation in the long run.

We will now apply this test to the following case:—

N. A. F. Moos[2] showed that the observed value of P_0 in the year T during the period 1867–1904 can be "best" represented by $P_0 = -645 \cdot 10^{-5} \quad -68 \cdot 10^{-7} t$, where $t = T - 1865$. In other words, this implied a trend in the same direction.

To test the reality of the trend, the observed values of P_0 were divided into two groups from 1867–1885 in one group and the rest in the other.

The median of the 38 values $= -660 \times 10^{-5}$.

In the second sample (from 1867–85), which is the inferior sample, there are only 10 values less than the median.

Using 5 per cent. as our limit for random chance, *i.e.*, putting f, in equation I, equal to 0·05 and $n = 19$, we solve the equation for m. The value of $m = 14$.

Since the number of inferior individuals in the inferior sample is less than 14, we deduce that the two samples could have reasonably been obtained from the same population. That is to say, on the 5 per cent. limit for random chance the observed trend is not significant.

In conclusion it is hoped that the fuller paper, which is under preparation, will be sent for publication elsewhere before long.

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1 S. R. Savur, *Proc. Ind. Acad. Sci.*, (A.), 1937, pp. 569.

2 N. A. F. Moos, *Bombay Magnetic Observations*, 1846–1905, Part I. See page 5.

Constitution of Butrin

BUTRIN, the glycoside of the flavanone, butin, was isolated by Lal and Dutt[1] from the flowers of *Butea frondosa*. When hydrolysed with dilute sulphuric acid, it gives rise to a molecule of butin and two molecules of glucose. On treatment with excess of ethyl iodide and potassium carbonate, it was reported by Lal[2] to produce a diethyl ether. Assuming that under the conditions of the experiment only phenolic hydroxyl groups are attacked by ethyl iodide, he concluded that butrin was a bioside. In view of certain peculiar features exhibited by butrin its constitution interested us in connection with a general study of the constitution of anthoxanthin glycosides. On treatment with diazomethane, butrin yielded only a monomethyl ether and the latter on hydrolysis gave rise to a monomethyl derivative of butein. Hence the glycoside seems to be not a bioside but a diglucoside of butin, having the two sugar nuclei in two different positions. Experiments aimed at definitely establishing the positions of the glucose groups are under progress. Details will be published elsewhere.

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1 Lal and Dutt, *J. I. C. S.*, 1935, **12**, 262.

2 Lal, *J. C. S.*, 1937, 1562.

Magnetic Susceptibilities of Some Halides

THE magnetic susceptibilities of a number of fluorides, chlorides, bromides and iodides have been studied by various investigators.[1,2,3] However, several halides have still to be studied. A detailed investigation of some of these substances, has been started in this laboratory. Such an information not only fills the existing gap in our knowledge but also reveals interesting properties.

Mr. Chowdhery has already measured[4] the susceptibilities of some fluorides using Gouy's