

LETTERS TO THE EDITOR

	PAGE		PAGE
Tests of Significance by Analysis of Covariance in Multivariate Populations. BY P. V. KRISHNA IYER	297	Biological Assay of the Overall Potency of the Growth Factors associated with Yeast Autolysates and Liver Extracts. BY (MISS) VIOLET DE SOUZA AND M. SREENIVASAYA	302
Radiative Equilibrium of the Atmosphere and the Thermal Structure of the Troposphere. BY R. ANANTHAKRISHNAN ..	298	Stability of Vitamin C in Drumstick Leaf. BY T. B. PANSE AND A. SREENIVASAN ..	303
Tamarind Seed Pectin. BY T. P. GOSE AND S. KRISHNA	299	Photoperiod in Relation to Flowering in Sugarcane. BY N. D. YUSUF AND N. L. DUTT	304
A New Method for Measuring the Time of Setting of Gel-Forming Systems. BY G. S. HATTIANGDI AND S. S. DHARMATTI	300	Two New Records and a New Species of the Genus Trichuris from Domestic Ruminants. BY M. M. SARWAR ..	306
Catalytic Dehydrogenation of Butene to Butadiene. BY J. C. GHOSH, C. D. SRINIVASAN AND A. N. ROY	301	The Sparing Action of α -Tocopherol on Carotene. BY S. DATTATREYA RAO, V. MAHADEVAN AND Y. B. RANGNEKAR	307
		The Isopod Parasite <i>Nerocila sundica</i> on West Coast Food Fishes. BY K. CHIDAMBARAM AND M. DEVIDAS MENON ..	308

TESTS OF SIGNIFICANCE BY ANALYSIS OF COVARIANCE IN MULTIVARIATE POPULATIONS

THE statistical significance of two multivariate samples can be judged by any one of the three methods mentioned below:—

1. Hotelling's T².
2. Discriminant function.
3. D²-Statistic.

Prof. Fisher¹ after indicating the relations between these three tests has extended them to the examination of collinearity and coplanarity of samples and to testing the significance of the deviations in directions. Following Prof. Fisher, Roy² has obtained the distribution of the *p*-statistics for any number of samples. In this note I propose to show the relation between the T²-test and the analysis of covariance.

Taking first the case of two samples it is known that

$$1 + \frac{T^2}{N-1} = \frac{|e_{ij}|}{|a_{ij}|},$$

where $|a_{ij}|$ and $|e_{ij}|$ are the generalized variance within the samples and the two samples together. Using Yule and Kendall's³ notation it has been shown (Krishna Iyer⁴) that

$$\frac{|a_{ij}|}{|e_{ij}|} = \frac{S^2_1 S^2_{2 \cdot 1} \dots S^2_{n \cdot 12 \dots n-1}}{S'^2_1 S'^2_{2 \cdot 1} \dots S'^2_{n \cdot 12 \dots n-1}},$$

where S² and S'² are the residual variances on the basis of size of samples within and the two samples together after fitting the regression equations. The degrees of freedom for S²_{r·12...r-1} and S'²_{r·12...r-1} and n₁-1 n₂-r-1 and n₁+n₂-r respectively; n₁ and n₂ being the sizes of the samples.

If there are more than two samples, then also

$$\frac{|a_{ij}|}{|e_{ij}|} = \frac{S^2_1 S^2_{2 \cdot 1} \dots S^2_{n \cdot 12 \dots n-1}}{S'^2_1 S'^2_{2 \cdot 1} \dots S'^2_{n \cdot 12 \dots n-1}} = W.$$

But the distribution of $\frac{|a_{ij}|}{|e_{ij}|}$ is very complicated when the number of samples is more than three. For three samples the distribution is given by

$$\frac{\Gamma \frac{N-1}{2} \Gamma \frac{N-2}{2} \Gamma \frac{N-n-4}{2}}{\Gamma \frac{N-n-1}{2} \Gamma \frac{N-n-2}{2} \Gamma n} W^{\frac{N-n-4}{2}} (1-W)^{n-1} F \left[\frac{n-1}{2}, n, n, (1-W) \right],$$

where F as usual denotes a hypergeometric series; N and n are the size of the three samples together, and the number of variates involved in the samples. For more than three samples also the distribution can be obtained by using the methods given by Wilks.⁵ But the expressions are very complicated and hence probably it would be easier to test the significance by taking the ratios S²_{r·12...r-1}/S'²_{r·12...r-1} for different values of r.

Imperial Agricultural Research Institute, New Delhi, P. V. KRISHNA IYER. July 3, 1945.

1. Fisher, R. A., "The statistical utilization of multiple measurements", *Ann. Evol.*, 1938, 8, 376-386.
 2. Roy, S. N., "Analysis of variance for multivariate normal populations. The sampling distribution of the requisite *p*-statistics on the null and non-null hypothesis," *Sankhya*, 1942, 6, 35-50.
 3. Yule, U. G., and Kendall, M. G., *An Introduction to the Theory of Statistics*, G. Griffin & Co., Ltd., London, 1940, 259-284.
 4. Krishna Iyer, P. V., "A note on Hotelling's T²," *Curr. Sci.*, 1945, 14 173-175. Wilks, S. S., "Certain generalizations in the analysis of variance," *Biom.*, 1932, 24, 471-94.