(I) $R = R_1 = R_2 = H$

(II) $R = R_1 = R_2 = CH_2C_6H_5$

(III) $R = R_1 = CH_2C_6H_5$, $R_2 = H$

(IV) $R = R_1 = CH_2C_6H_5$, $R_2 = CH_3$

(V) $R = R_1 = H$, $R_2 = CH_3$

Benzylation of 7, 2′, 4′-trihydroxy isoflavone[2] (I), m.p. 284° (d), with benzyl chloride gave the corresponding tribenzyloxy compound (II), m.p. 167° which on selective debenzylation at 2′-position using dioxan/HCl afforded 7, 4′-dibenzyloxy-2′-hydroxy isoflavone (III), in good yields, m.p. 175°. Methylation of (III) with dimethyl sulphate in acetone-K_2CO_3 yielded 7,4′-dibenzyloxy-2′,-methoxy isoflavone (IV), m.p. 133° which on debenzylation with pd/C yielded the required theralin (V) as light yellow needles, m.p. 276° (m.p. of natural theralin, 274–75°[1]). I.R. and U.V. spectra of the synthetic sample are in agreement with those reported for the natural sample.

Details of this work will the published elsewhere.

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PAPER CHROMATOGRAPHIC SEPARATION OF POTASSIUM, RUBIDIUM AND CAESIUM IN *n*-AMYL ALCOHOL-HYDROCHLORIC ACID-ETHANOL MIXTURE

THE solvent mixture (HCl-MtOH-BuOH-ketone) reported by Miller and Magee[1] for the paper chromatographic separation of K^+, Rb^+ and Cs^+ gives somewhat blurred bands. Phenolic solvents reported by Steel[2] and Magee and Headridge[3], though give sharp separations yet, attack the paper which

becomes fragile and difficult to handle. Mixture of two of the straight chain aliphatic alcohols, or mixture of an alcohol and an acid has been successfully used for the paper chromatographic separation of Li^+, Na^+, K^+ and NH_4^+ ions[4-7]. Investigations were therefore undertaken for finding out the possibility of separation of K^+, Rb^+ and Cs^+ using a mixture of straight chain aliphatic alcohol and a mineral acid.

Experimental

Extra pure *n*-amyl alcohol, freshly distilled absolute alcohol and concentrated hydrochloric acid were used for the preparation of the solvent. Sodium lead cobaltous hexanitrate reagent[3] (fresh) was used as the spraying agent.

Development of chromatogram.— One end of 4 × 56·5 cm long strip of Whatman filter paper No. 4 was tailored to 2 cm width. On this tapered end, leaving about 8 cm margin, the requisite volume of the desired solution (0·1%) was applied as a narrow elongated spot (about 2·5 cm × 0·5 cm) and dried. The chromatograms were then developed by decending development till the solvent front moved to the other end of the paper strip. The developed chromatograms were dried in air, hanged upside down and sprayed first with ethanol and then with freshly prepared sodium lead-cobaltous hexanitrate reagent. After about five minutes, the excess of the reagent was washed out with ice-cold distilled water and the position of the bands (Brown for K^+ and Rb^+ and yellowish-brown for Cs^-) on the chromatogram was noted (Table I). R values of K^+, Rb^+ and Cs^+ in 1 : 2 : 1 AHE solvent determined at 20° ± 1° C are given in Table II.

Results and Discussion

In the paper chromatographic separation of K^+, Rb^+ and Cs^+, usually Cs^+ moves faster than the other two and therefore its separation from Rb^+ is comparatively easy. Hence the separation of K^+ and Rb^+ was first tried.

It will be seen from Table I that the best separation of K^+ and Rb^+ could be obtained by the solvent mixture No. 8, although No. 7 also gave clear separation of K^+ and Rb^+ bands with smaller band distance between the two. The R_f values of all the three alkali metal ions, *viz.*, K^+, Rb^+ and Cs^+ were therefore determined using solvent No. 8. It will be seen from Table II that the chromatogram of individual alkali metal gives higher R_f values than that of their values obtained from the chromatogram of the mixture of the three alkali metal ions in equal proportion.

Further studies on the separation of K^+, Rb^+, Cs^+ using 1 : 2 : 1 :: AHE solvent mixture, on 4 cm

TABLE I

Effect of different solvent mixtures on the paper chromatographic separation of potassium and rubidium
(Load: 0·02 ml of solution containing 20 μg of each potassium and rubidium)

Sl. No.	Solvent mixture per cent by volume of			Time for develop-ment* hrs.	Position and width of		Space between bands	Remarks
	n-AmOH (A)	HCl (H)	EtOH (E)		K band cm	Rb band cm		
1.	..	40	60	20	7·0– 9·2	9·4–10·8	0·2	Partition of the bands observed
2.	60	40	..	27	8·0–12·0	..	Nil	
3.	..	50	50	16	13·0–15·5	16·0–18·2	0·5	Diffused bands; space between the bands not clear
4.	50	50	..	25	16·0–17·5	17·5–19·0	Nil	Partition of the bands observed
5.	30	50	20	18	16·5–18·0	18·5–21·0	0·5	Diffused bands; in between space not clear
6.	20	50	30	20	17·5–18·5	19·5–21·0	1·0	Bands slightly blurred
7.	20	40	40	25	9·5–11·0	12·0–13·5	1·0	Clear separation
8.	25	50	25	20	16·5–18·5	20·0–22·0	1·5	Clear separation
9.	30	40	30	26	8·4–10·7	11·2–13·2	0·5	
10.	40	40	20	26	7·8– 9·5	10·2–12·0	0·4	
11.	30	30	40	25	4·5– 5·5	6·0– 7·0	0·5	Diffused bands
12.	35	30	35	25	3·0– 5·0	..	Nil	No separation

* Time required to reach the solvent front upto the other end of the paper strip, *i.e.*, 48 cm.

TABLE II

R_f values of the K, Rb and Cs and their separation in 1:2:1 AHE solvent

Expt. No.	Ion/ions loaded microgram	Width of the bands in cm			R_f values for		
		K	Rb	Cs	K	Rb	Cs
1.	30, K	18·3–20·7 (19·5)	..	..	0·410	..	..
2.	30, Rb	..	20·5–22·5 (21·5)	..	..	0·453	..
3.	30, Cs	..	..	24·5–26·0 (25·2)	..	..	0·531
4.	Mixture of K, Rb and Cs 50 μg of each	17·5–19·5 (18·5)	20·5–22·4 (21·5)	24·5–26·2 (25·4)	0·385	0·448	0·529
5.	do.	18·2–19·7 (18·9)	21·0–22·4 (21·7)	23·8–25·1 (24·5)	0·394	0·452	0·511

wide paper chromatogram, have revealed that (*i*) the minimum limits for the separation of K⁺ and Rb⁺ or Rb⁺ and Cs⁺ from their respective mixture is 20 μmg of any of the alkali from 500 μg of the others, and (*ii*) the maximum amount of the alkali metal ions that can be resolved under the

said conditions is 600 μg mixture containing 200 μg of each of K^+, Rb^+ and Cs^+.

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ON FISHER'S FUNDAMENTAL THEOREM OF NATURAL SELECTION WITH NON-OVERLAPPING GENERATIONS

THE Fundamental Theorem of Natural Selection first given by Fisher[1] broadly appears in two forms (Turner[2]). According to one form, the change in the average fitness of a population is equal to the genotypic variance in fitness. The other form, which includes the effect of a mating system, states that for random mating population, with two-allele system, the rate of increase in average fitness at any time is equal to its additive genetic variance at that time. Thus in the absence of dominance these two forms are identical. However, the interpretation of the dominance in a two-allele system is essentially that of an interaction between the two alleles, the three fitness values attached to the three genotypes forming an arithmetic series in the absence of dominance. Now it may happen that the three fitness values may form a geometric series so that on the logarithmic scale there would be no dominance although on the arithmetic scale some partial dominance will be exhibited resulting in two different forms of the theorem. The purpose of this communication is therefore to show that in situations where the dominance is due to scale effects, the two forms of the theorem would still be identical, although the variance due to dominance deviations on the arithmetic scale is not zero.

Let the relative fitness of the three genotypes *AA*, *Aa* and *aa* be respectively w_2, w_1 and w_0 in a random mating population with gene frequencies *p* for *A* and *q* for *a* with $p + q = 1$. The average fitness of such a population, denoted by $\bar{w}$ can be expressed as

$$\bar{w} = p w_2 + q w_0 - pq (w_2 - 2 w_1 + w_0) \tag{1}$$

where $(w_2 - 2 w_1 + w_0)$ expresses the degree of dominance on the arithmetic scale. After the operation of natural selection the increase in average fitness denoted by $\Delta \bar{w}$ is

$$\Delta \bar{w} = \sigma_w^2 / \bar{w} \tag{2}$$

where σ_w^2 is genotypic variance of the fitness values. Now the genotypic variance is the sum of additive and dominance variances which can be expressed respectively as

$$\sigma_A^2 = 2pq [\bar{w} (w_2 - 2 w_1 + w_0) + (w_1^2 - w_2 w_0)] \tag{3}$$

$$\sigma_D^2 = p^2 q^2 (w_2 - 2 w_1 + w_0)^2. \tag{4}$$

An alternative expression for the change in the average fitness can then be shown to be equal to

$$\Delta \bar{w} = \frac{\sigma_A^2}{\bar{w}} \left[1 + \frac{pq (w_2 - 2 w_1 + w_0)}{2 (\bar{w} + \theta)} \right] \tag{5}$$

where

$$\theta = (w_1^2 - w_2 w_0)/(w_2 - 2 w_1 + w_0). \tag{6}$$

Taking into account the round of random mating in addition to the effect of natural selection, the change in the average fitness of the population, denoted by $\Delta \bar{w}^*$ is, according to the derivations of Li[3] and using (1), given by

$$\Delta \bar{w}^* = \frac{\sigma_A^2}{2\bar{w}} \left[1 + \left(\frac{p w_2 + q w_0}{\bar{w}} \right) \right]$$
$$= \frac{\sigma_A^2}{\bar{w}} \left[1 + \frac{pq (w_2 - 2 w_1 + w_0)}{2w} \right]. \tag{7}$$

Comparing the two expressions (5) and (7), it is clear that even if $(w_2 - 2 w_1 + w_0)$ is not zero, the two $\Delta \bar{w}$ and $\Delta \bar{w}^*$ are identical provided $w_1^2 = w_2 w_0$. This would mean that, on the geometric scale, there is no dominance.

It is apparent therefore that while the behaviour of the average fitness under natural selection without involving the effects of mating system is more rigorous, the change in average fitness, taking into account the random mating, is very much dependent on the scale on which the fitness values are measured. This also points out to the limitation of the concept of the additive genetic variance in that it involves the linearity assumption. On the other hand, the genotypic variance is a quantity free from any such assumption and therefore the Fundamental Theorem of Natural Selection employing it, *viz.*, in the form of (2) is much more general