

away on the banks of gullies emptying into the stream, showed the presence of ciliates many of which were indistinguishable from forms found in the stream (*Colpoda*, *Holophrya*, *Oxytricha*, *Halteria*). Ciliate protozoa indistinguishable from forms found in the stream were also obtained from within dried mud originally excavated from the bottom of the stream and cast on adjoining fields (*Oxytricha*, *Halteria*).

Singh<sup>1</sup> observes that "the satisfactory edible bacteria in estimating protozoal numbers [in the soil] belong to strains of small cocci or non-sporing rods". Following this suggestion, it was found that soil ciliate protozoa from the above situations developed only slowly in artificial culture—in one to two weeks—if the sole food supply was the natural soil bacteria. If, however, the culture was inoculated with micrococci isolated from the stream, a massive development occurred within three to five days.

From these observations it is suggested that there is a free exchange between soil ciliate protozoa and those of inland waters, and that any distinction drawn between them is apparent and not real; in short, that water ciliates are identical with those of the soil, one habitat being the source of the other.

ERNEST GRAY

Botany School, Cambridge.

Jan. 28.

<sup>1</sup> Singh, B. N., *Ann. Appl. Biol.*, 33, No. 1, 117 (1946).

### Separation of Polar from Non-Polar Molecules

AFTER an interruption due to the War, I have re-commenced experiments aiming at the separation of molecules having a permanent dipole moment from non-polar molecules in liquid mixtures by the aid of a non-uniform electric field.

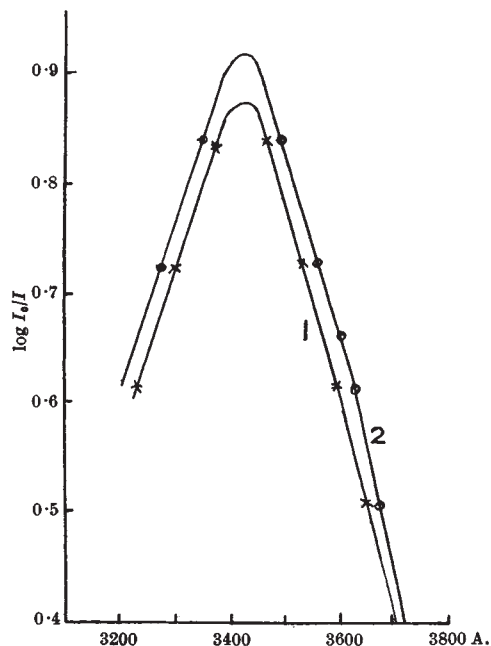
The ratio of the polar and non-polar molecules ( $N_p/N_n$ ) will undergo a change to the value  $(N_p/N_n)_r$  at a point  $r$  with the electric field strength  $E_r$  given by the expression:

$$\left(\frac{N_p}{N_n}\right)_r = \left(\frac{N_p}{N_n}\right)_0 \exp \frac{\mu E_r \cos \theta + \frac{1}{2} E_r^2 (\alpha_p - \alpha_n)}{kT}$$

where  $\mu$  is the permanent dipole moment,  $E_r$  the intensity of the electric field at the point concerned,  $\cos \theta$  the mean cosine of the orientation angle,  $\alpha_p$  and  $\alpha_n$  the polarizabilities of the polar and non-polar molecules respectively, and  $k$  the Boltzmann constant.

In evaluating this formula, which does not take into account a possible interaction between polar and non-polar molecules, the complete Langevin function for the calculation of the values of  $\cos \theta$  has been used. Plotting the ratio  $(N_p/N_n)_r$  against the logarithm of the field intensity and making  $(N_p/N_n)_0 = 1$  shows that up to  $10^5$  volt./cm. no appreciable deviation from the value 1 is to be expected. But from that value on a very rapid increase occurs, reaching several per cent at  $10^6$  volt./cm. At still higher fields, which of course cannot be reached due to the sparking potential, the ratio would increase rapidly to very great values.

In the apparatus used the liquid mixture is placed in a radial field produced in a metallic cylinder of 2 cm. diameter coaxial with a thin tungsten wire of 0.020 mm. diameter, which passes through a glass capillary of 0.1 mm. diameter. The tungsten wire protrudes 1–2 mm. beyond the end of the capillary. On applying potentials up to 10,000 volts, which are below the sparking potential of the cell, an electric



field of the magnitude of  $10^6$  volts./cm. is established close to the thin wire. The liquid around it up to a distance of 0.1 mm. is continuously collected at a very slow rate and its refractive index is compared with that of the original solution by means of a liquid-interferometer.

Using benzene–nitrobenzene mixtures, and plotting the observed interferometric deviation against the potential applied, it is found that an enrichment of nitrobenzene up to 0.7 per cent takes place in the solution for 6,000 volts applied. With *p*-nitroaniline solution in benzene and potentials up to 10,000 volts, a change of the concentration up to 12 per cent has been observed. The accompanying graph shows the ultra-violet absorption of the *p*-nitroaniline solution collected from the vicinity of the tungsten wire (Curve 2) and the absorption curve of the original solution (Curve 1). The position of the maximum is not altered, but the extinction is increased, showing an enrichment of the solution for the polar molecules of *p*-nitroaniline.

In a second apparatus the mixture was allowed to pass through a metallic net, with the horizontal wires forming the negative pole and the vertical ones the positive. They were insulated from each other so that potentials of up to 1,000 volts could be safely used. The net was wound about a glass rod and then placed in a glass tube. The dimensions were such that there were 42,000 intersection points, forming the non-uniform field, in a volume of 100 ml. After passing through the net, the liquid proves to be poorer in polar molecules compared with the liquid remaining in the tube. This shows that the net acted as a dipole filter.

At present work is in progress to amplify the changes in concentration by application of the method of counter-streams. A fuller report of this work is being prepared.

G. KARAGOUNIS

Physico-Chemical Laboratory,  
University of Athens,  
and  
Physico-Chemical Laboratory,  
University, Zurich.  
Jan. 9.