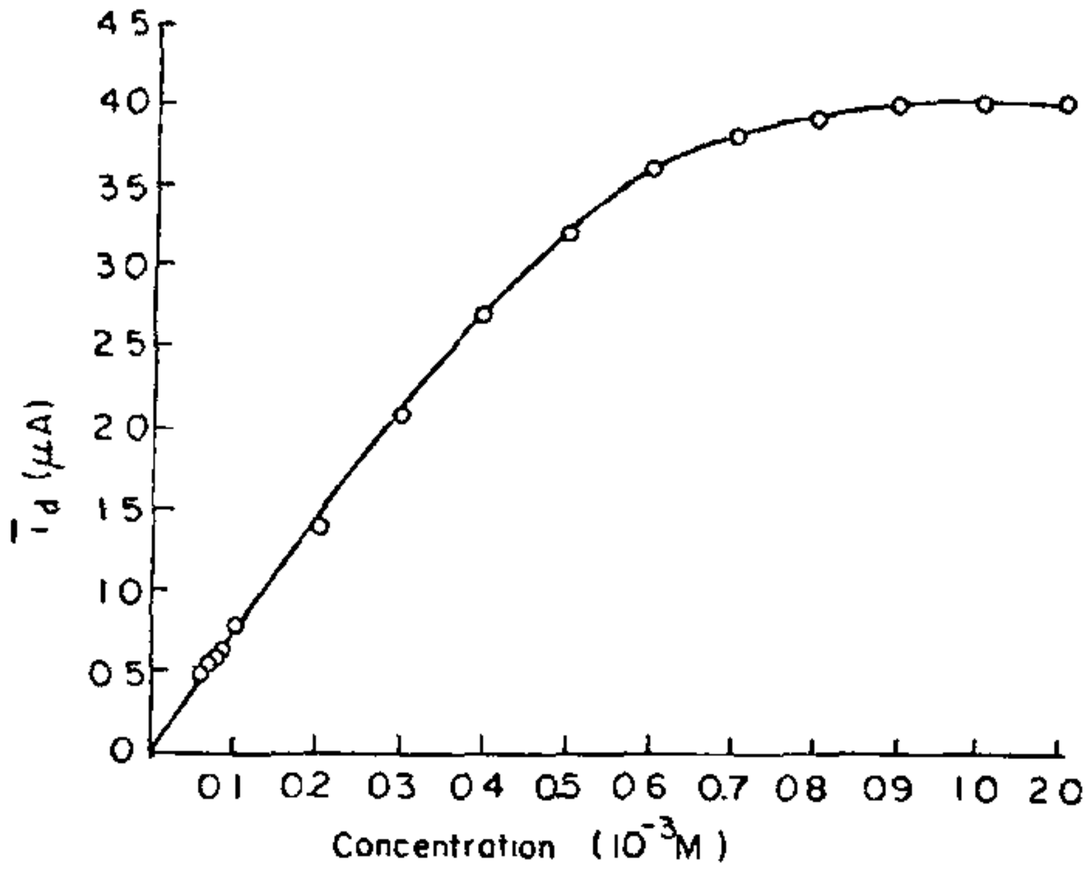

Figure 4. Concentration dependence of limiting current of waves of Ephedrine hydrochloride (pH 6.2).

very similar to those of stem extract and ephedrine; the slopes range from −0.20, −0.20 and −0.23 at −1.50 V to 0.34, 0.32 and 0.34 at −1.72 V for sida stem, root and ephedrine hydrochloride respectively.

To find the concentration of ephedrine in the sida stems and roots, polarograms for different concentration (0.001–0.1 mol m^{-3}) of ephedrine hydrochloride (pH 6.2) have been recorded. The calibration curve (i_d *vs* concentration plot, figure 4) has the slope of 0.8 μA $mmol^{-1}$. The concentration of ephedrine in air-dried stems and roots are therefore, 1.86% and 1.64% respectively.

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1. Zuman, P., *Coll. Czech. Chem. Comm.*, 1953, **18**, 36.
2. Zuman, P., *Coll. Czech. Chem. Comm.*, 1954, **19**, 1140.
3. Šantavý, F. and Reichstein, T., *Helv. Chim. Acta.*, 1950, **33**, 1606.
4. Chopra, R. N., *Indigenous Drugs of India*, U. N. Dhar and Sons Pvt. Ltd. Calcutta, 1958, p. 160.
5. Nadkarni, A. K., *Indian Materia Medica*, Popular Book Depot, Bombay, 1954, p. 1137.
6. Chopra, Nayar and Chopra, *Glossary of Indian medicinal plants*, CSIR, New Delhi 1956, p. 227.
7. Ghosh, S. and Dutt, A., *J. Indian Chem. Soc.*, 1930, 825.
8. Mairanovskii, S. G., *Catalytic and kinetic waves in polarography*, Plenum Press, New York. 1968, p. 252.

GROWTH EQUATION OF *SAPROLEGNIA*

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BACTERIAL cultures in an unlimited nutritive medium normally grow at a rate proportional to the number of bacteria at that time. In some cases, this ideal growth relationship is not obeyed. Although attempts[1,2] have been made to establish the relationship between growth parameter and time, these equations do not represent the entire region of growth. Srivastava and Avasthi[3], using the data of Wilson[4] for the growth of *Salmonella pullorium*, suggested a new equation for the growth which represents the growth with time in the entire region. However, the validity of the equation[3] has yet to be tested for fungal growth.

In this communication studies on the fungal growth of *Saprolegnia luxurians* (Bhargava & Srivastava) Seymor under three different light intensities are reported with a view (i) to studying the effect of light conditions on fungal growth and (ii) to work out the relationship between growth parameter and time.

The procedure followed for measurements of fungal growth was similar to the one adopted by Lee and Scott[5]. Single zoospores were used for inoculum and mycelial dry weights (in mg) were taken. SPS agar medium* defined earlier[6] was used.

A 60 W Philips Argenta lamp emitting 400 ft-C intensity of light at a distance 60 cm was used for white light. A 30 W Philips germicidal lamp (1220 Å) was used for ultra violet. UV of the inoculated culture was irradiated at night under dark conditions for 2 min and

* Ingredients of SPS–Agar medium (g/L)
1. Chelation agent: EDTA (0.5); 2. Buffer for pH 7.0: K_2HPO_4 (0.18), KH_2PO_4 (0.15); 3. Inorganic nutrients: $MgCl_2$ $6H_2O$ (1.02), $CaCl_2$ $6H_2O$ (0.02), $MnCl_2$ $4H_2O$ (0.05), $ZnCl_2$ (0.05), $FeCl_3$ $6H_2O$ (0.0014); 4. Organic nutrients: Methionine glucose (5.06), Sodium glutamate (mono) (2.02); 5. Ingredients of the above steps were dissolved in 972 ml of distilled water and then pH of the solution adjusted to 7 with KOH pellets, 6. Agar (20); 7. Autoclave the medium at 15 lbs. for 30 min.

the irradiated cultures were then incubated inside a light tight chamber (uv + dark). A perfect light tight chamber was used for darkening. Growth studies were carried out in three experimental sets and the average growth data recorded. The maximum variation of the growth data from the average values was not more than $\pm 1.5\%$. The temperature was kept constant thermostatically at $22 \pm 0.5°C$ in each of the three sets. The change in the growth was noted after every 24 hr upto ten days.

Figure 1 shows the growth data obtained under the three different intensities of light plotted against time. Fungal growth depended on light conditions and it decreases from light to (UV + dark) through dark. The dependence of growth on time under all the three conditions follows a similar trend. The curve starts from the origin, bends upward, then becomes linear and finally approaches stationary state (figure 1).

To work out the relationship between the growth and the time, let us divide the total growth curves (figure 1) into two parts: (i) the first portion represents the exponential and straight line part and (ii) the second portion represents the decline phase and the stationary state. The straight line part of the curve extrapolates to an intercept t_0 on the time axis. It is of interest to note that under three different intensities of light, t_0 is almost the same (table 1).

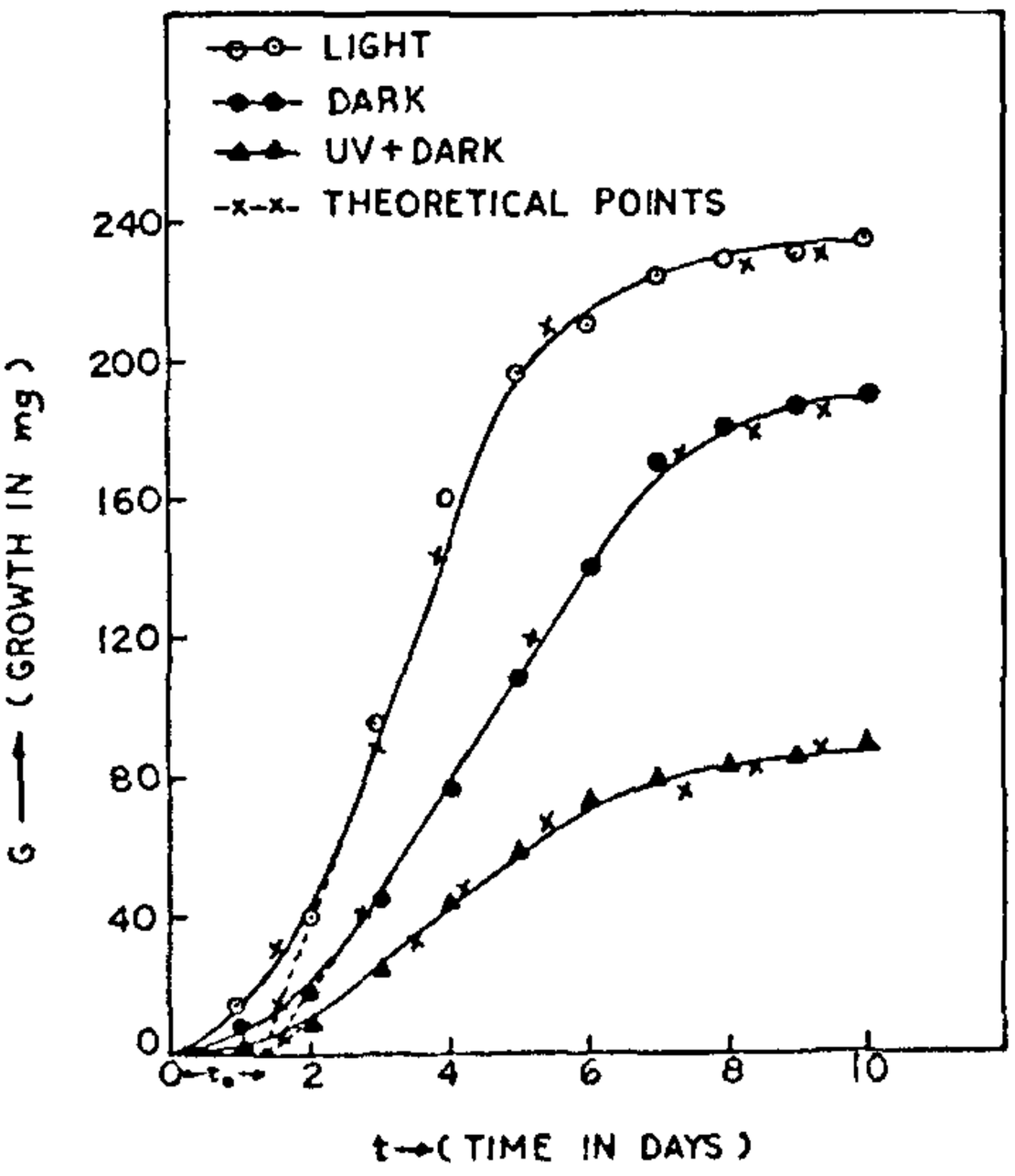

Figure 1. Dependence of growth of *S. luxurians* on time.

Table 1 *Values of various coefficients for S. luxurians*

Condition of growth	L (mg day^{-1}) From figure 1	L (mg day^{-1}) From figure 2	L_1 (mg day^{-2})	t_0 (day)
Light	54.0	54.5	−3.1	1.3
Dark	36.5	40.5	−1.9	1.4
UV + dark	16.0	16.8	−0.5	1.4

To describe the growth of the first portion, representing the exponential and straight line parts, one can write the following general equation[7],

$$G = L[t - t_0\{1 - \exp(-t/t_0)\}], \qquad (1)$$

where G stands for the growth parameter estimated (in mg), t represents the time (in days), and L is a coefficient. It is seen that when the term (t/t_0) assumes such a high values that $\exp(-t/t_0)$ becomes negligible in comparison to unity, equation (1) reduces to

$$G = L(t - t_0), \qquad (2)$$

which is an equation of a straight line part of the curve with slope L. The values of L, thus calculated, are recorded in table 1. For the rest of the curves, the following general equation can be written[7],

$$G = L(t - t_0) + L_1(t - t_0)^2 + \ldots, \qquad (3)$$

where L_1 and L are the constants. Our data on *S. luxurians* fit into the second order. This can be tested as follows[7]: Equation (3) can be written as,

$$\left(\frac{G}{t - t_0}\right) = L + L_1(t - t_0). \qquad (4)$$

The values of $G/(t - t_0)$, obtained from G and $(t - t_0)$ at various points in nonlinear and stationary state region, are plotted against $(t - t_0)$ in figure 2. As expected from (4) the plots yield a straight line of slope L_1 and intercepts equal to L on the y-axis. L_1 values thus calculated are recorded in table 1 and it is obvious that L calculated from slopes in figure 1 and extrapolated intercepts on y-axis in figure 2 are in good agreement, confirming the validity of the method for working out the form of relationship between the growth parameter and the time.

From the foregoing discussion it can be concluded that the growth developed under light, dark and UV + dark conditions for the entire region can be represented by the following equation, in accordance with

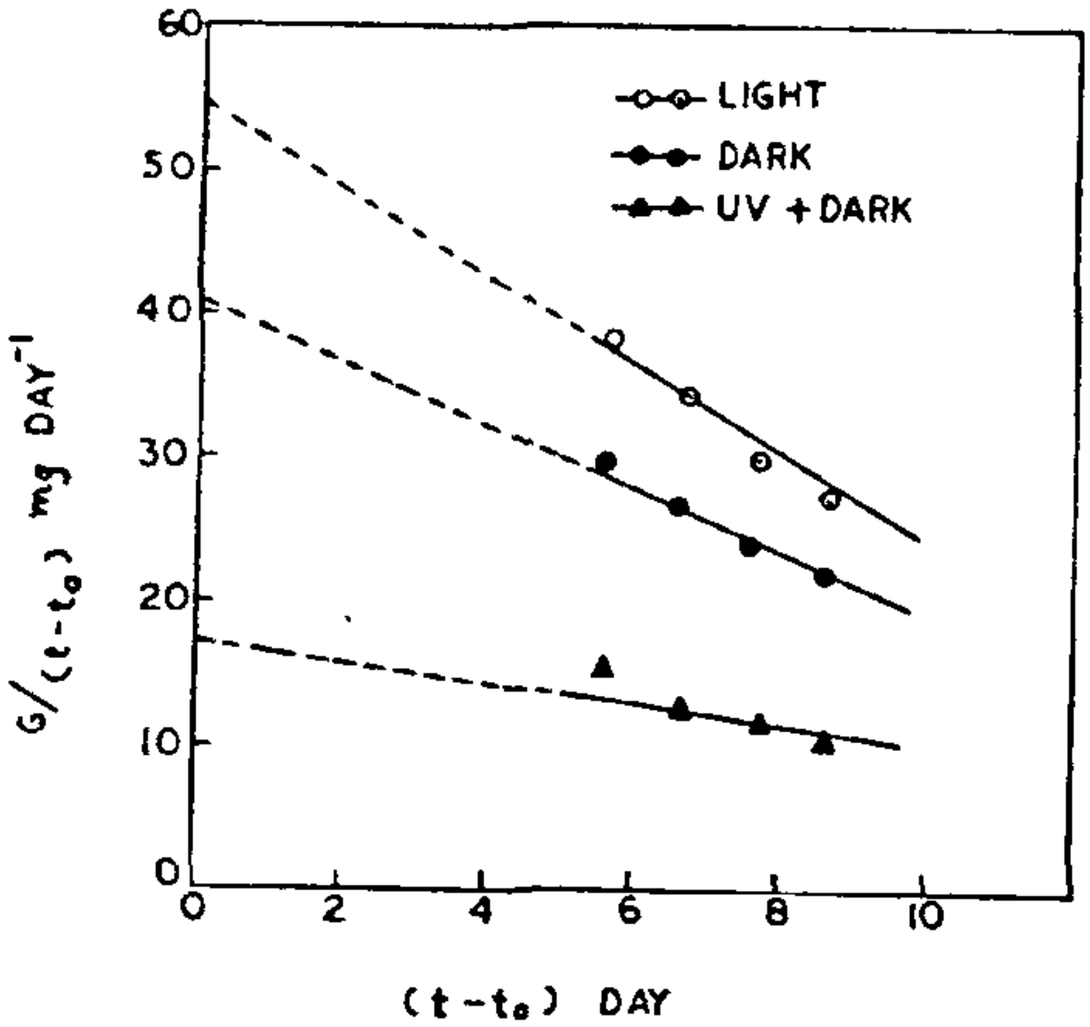

Figure 2. Test of equation (4).

the one proposed earlier[3] for microbial growth,

$$G = L[t - t_0\{1 - \exp(-t/t_0)\}] + L_1(t - t_0)^2. \quad (5)$$

The fact that (5) does represent the growth data in the present case was confirmed in the usual manner[3]. Using the values of t_0 and the values of coefficients L and L_1 the curve predicted by (5) has been traced by giving hypothetical values to t and calculating the corresponding values of G. Since the theoretical points fall on the experimental curves (figure 1), it can be concluded that the growth data of *S. luxurians* are adequately represented by (5) in the present case.

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1. Bray, H. G. and White, K., *Kinetics and thermodynamics in Biochemistry*, J. A. Churchill Ltd., London, 1966.
2. Iamanna, C. and Mallette, M. F., *Basic bacteriology and its biological and chemical background*, The Williams & Wilkins, Baltimore, 1961.
3. Srivastava, R. C. and Avasthi, P. K., *Z. Natuurforsch.*, 1971, **B26**, 804.
4. Wilson, C. S., *J. Bacteriol.*, 1922, **7**, 405.
5. Lee Jr., P. C. and Scott, W. W., *Virg. Polytech. Inst. Bull.*, 1967, **2**, 1.
6. Scott, W. W., Powell, J. R. and Seymor, R. L., *Virg. J. Sci.*, 1963, **14**, 42.
7. Phillips, E. G., *Analysis*, Cambridge University Press, 1948.

COMPLEXES OF DITHIOCARBAZIC ACID WITH SOME OXOCATIONS

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SOME new complexes of dithiocarbazic acid $H_2N.NH.CSSH$ with VO(IV), ZrO(IV) and UO_2(VI) of the general composition $MO_n(dtcz)_2.2H_2O$ ($n = 1$ with V and Zr and $n = 2$ with U) have been synthesised and characterised by analytical, magnetic, electronic and infrared spectral studies. The ligand and the complexes have been prepared according to literature methods[1,2]. The magnetic moments at 293°K indicate that the UO_2(VI) and ZrO(IV) complexes are diamagnetic, whereas the magnetic moment of VO(IV) complex is 1.44 B.M., which is much lower than the spin-only moment for a d^1 system (1.73 B.M.). It is likely that the present VO(IV) complex has polynuclear structure[3].

The IR spectra of the free ligand and the corresponding complexes clearly indicate that the $\nu(NH_2)$ bands in ligand occurring at 3310, 3260 and 3200 cm^{-1} are shifted to lower frequencies in all the complexes. The bands in the 1050–940 cm^{-1} region in the spectra of dithiocarbazate can be assigned to the asymmetric and symmetric modes of the CSS– group[4]. The low values of these bands reveal the linkage of metal ions via thiocarboxylate sulphur.

In conclusion, it can be said that the ligand is bidentate ligand, coordination taking place through amino nitrogen and thiocarboxylate sulphur.

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1. Audrich, L. F., Scott, E. S. and Kippus, P. S., *J. Org. Chem.*, 1953, **19**, 733.
2. Kapur, V., *Synthesis and spectroscopy of transition metal complexes involving biologically important ligands*, Ph D. Thesis, Meerut University, 1980.