alcohol (control). The cages were well ventilated; after 10 minutes food and water were supplied to the flies. After 24 hours the percentage of mortality was counted. Four replications were made at each concentration. All the experiments were carried out at 35 ± 1° C.

Studies of the insecticidal properties reveal that the mortality of house-flies are highest in DDT (97%). Next to DDT we have the toxicity of tetrahydrocarbazole (I), 2-methyl tetrahydrocarbazole (II) and 3-methyl tetrahydrocarbazole (III) (*ca.* 84·3%). The toxicity of these tetrahydrocarbazole derivatives (I, II, III) are greater than those of the corresponding carbazole derivatives (IV, VI and VII). The toxicity of (I), (II) and (III) are more or less the same. But the presence of oxo group in 1-position of tetrahydrocarbazole derivatives diminishes their toxicity. Of the 1-oxo-tetrahydro-derivatives, the toxicity of 1-oxo-tetrahydrocarbazole (VIII) > 1-oxo-2-methyl-tetrahydrocarbazole (IX) > 1-oxo-3-methyl-tetrahydroacarbazole (X). Carbazole (IV), 1-methyl carbazole (V), 2-methyl carbazole (VI), 3-methyl carbazole (VII), glycozolidine (XII) and 1-oxo-3-methyl-tetrahydrocarbazole (X) have more or less the same degree of toxicity, but the toxicity of 2-methoxy-3-methyl-6-hydroxy carbazole (XIV) is much lower. Glycozoline (XI) and 3-methyl-6-hydroxy carbazole (XIII) have little or no toxicity.

The glycozolidine (XII) is toxic but glycozoline (XI) is not. Hence the introduction of another methoxy group in the 2-position of glycozolidine makes the resultant compound toxic. If the methoxy group at the 6-position of glycozolidine (XII) be converted to hydroxy group, the resultant compound becomes less toxic. Moreover, the toxicity of carbazole derivatives is highly enhanced by the presence of partially reduced nucleus.

The inhibitory effects of the ten synthetic carbazole compounds (I to X) were studied against ten microbes, *viz.*, (*a*) *Microsporum gypseum*, (*b*) *Candida albicans*, (*c*) *Epidermophyton floccusam*, (*d*) *Tricophyton rubrum*, (*e*) *Alternaria solani*, (*f*) *Aspergillus niger*, (*g*) *Helminthosporium sativum*, (*h*) *Curvularia lunata*, (*i*) *Escherichia coli* and (*j*) *Staphylococcus aureus* by agar diffusion method. The agar medium was at first inoculated with a 24 h. old culture of the test organism. Filter paper discs (6 mm dia) saturated with the solution of the carbazole derivatives (10 mg/ml) in ethanol were placed on the agar plate. The zones of inhibition around the discs were measured after an incubation period of 24 hours at 35° ± 1° C. The antimicrobial activity of the carbazole derivatives was measured from the zone of inhibition.

Though carbazole (IV) has no pronounced activity on microbes, the presence of methyl group in the 1-position of the carbazole nucleus enhances its activity. But the methyl group at the 2 or 3 positions of the carbazole nucleus does not enhance its activity to a marked extent, *i.e.*, (V) is active on the microbes but not (VI) and (VII). Tetrahydrocarbazoles (I, II and III) (particularly III), show pronounced activity. But the presence of oxo group in the 1-position of the 2-methyl and 3-methyl tetrahydrocarbazole derivatives decreases their activity in comparison to that of 2-methyl and 3-methyl tetrahydrocarbazole derivatives.

These investigations clearly show that tetrahydrocarbazoles (I, II, III and VIII) are not only toxic to house-flies, but also have ant fungal and antibacterial activities. Generally, insecticidal properties are enhanced due to the pressence of partially reduced heterocyclic moiety, but at the same time the fungicidal properties are reduced. But in the case of the above carbazole derivatives it is seen that due to the presence of partially reduced moiety both the insecticidal and antimicrobial properties are enhanced.

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D. N. CHOWDHURY.
S. K. BASAK.
B. P. DAS*.

* For correspondence.

1. Das, K. C., Chakraborty, D. P. and Bose, P. K., *Experientia*, 1965, **21**, 340.
2. Chakraborty, Debi P., Das, Kalachand, Das, Basudeb, P. and Chowdhury, Bijoy, K., *Trans. Bose Res. Inst.*, 1975, **38**, 1.
3. Barclay, B. M. and Campbell, N., *J. Chem. Soc.*, 1938, p. 8.
4. Kent, A. and Mc. Neil, D., *Ibid.*, 1938, p. 8.
5. Chakraborty, D. P., *Phytochem.*, 1969, **8**, 769.
6. — and Das, B. P., *Sci. and Cult.*, 1966, **32**, 181.
7. —, — and Basak, S. P., *The Plant Biochem. J.*, 1974, **1**, 73.

SYNTHESIS OF NEW ANTICOAGULANTS AS RODENTICIDES AND THEIR TOXICITY AGAINST BLACK RAT (*RATTUS RATTUS* LIN.)

Introduction

THE advent of anticoagulent rodenticides in 1950 marked a turning point in rodent control strategy as it offered three main advantages, such as bait being

readily acceptable to rats, preparation and use being less hazardous and non-development of bait shyness, a serious drawback in conventional poisons. The majority of the anticoagulants in use at the present time are either hydroxycoumarin derivatives or indandiones.

No work appears to have been done in India on the development of new rodenticides. However, an attempt was made to restructure some of the known anticoagulants with a view to improving their rodenticidal value. The present investigation describes the synthesis of three hydroxycoumarin compounds (anticoagulants) as rodenticides and the effect of their toxicity on black rat (*Rattus rattus*).

Experimental

NMR spectra were recorded on varian A–60D instrument using TMS as an internal reference. The chemical shifts are expressed in τ units while J values in Hz and are compatible with the assigned structures. The compounds were checked by IR on Perkin-Elmer 137 infracord. Melting points are uncorrected. The homogeneity of the compounds was checked by TLC on silica gel plates.

I. 3, 4-*Cyclohepteno*-6-n-*propyl*-7-*hydroxycoumarin* (*I, R*)

A mixture of 2-carbethoxycycloheptanone[1] (0·011 mol.), 2-4-dihydroxy-*n*-propylbenzene (0·01 mol.), phosphorus oxychloride (2 ml) and dry benzene (40 ml) was kept for 24 hours. The solvent was removed *in vacuo*, the residue was triturated with water, filtered and crystallised from benzene (yield—60%), M.P. 180°, IR (KBr) 3200 (*bh*, OH), 2930, 2850 (C–H stretching), 1680 (C = O, unsaturated lactone) 1620, 1605, 1570 (C=C, Ar), 1400, 1310, 1235, 1170, 1145 (O–H bending and C–O stretching), 1275, 1255 twisting and wagging C–H and 850 cm^{-1} (substituted benzene) NMR ($CDCL_3$ + TFA); 1·05 (bs, 1, OH), 2·77 (s, 1, H–5), 3·16 (S, 1, H–8), 7·00–7–70 (m,4, H–3′ and H–7′), 7·37 (t, J = 7·0 Hz, 2, CH_2, Ar), 8·0–8·80 (m, 8, CH_2, CH_3, H–4′, H–5′ and H–6′), 9·07 (t, J = 7·0, 3, CH_2–CH_3).

Anal. Found C, 75·2, H, 7·52, $C_{17}H_{20}O_3$ calculated C, 75, H, 7·35%.

II. 3,4-*Cyclohepteno*-6-n-*butyl*-7-*hydroxycoumarin* (*II,R*)

It was prepared by following the procedure described above for I,R and crystallised from alcohol, (yield 65%), M.P. 155°, IR (KBr) 3300, 2930, 2850, 1675, 1620, 1605, 1575, 1410, 1320, 1255, 1225, 1170, 1145, 1120, 1070 and 850 cm^{-1} NMR ($CDCI_2$ + TFA), 2·39 (bs, 1, OH), 2·80 (s, 1, H–5), 3·18 (s, 1, H–8), 6·90–7·50 (m, 6, CH_2, Ar, H–3′ and H–7′), 7·90–8·80 (m, 10, CH_2, —CH_2 CH_3) H–4′, H–5′ and H–6′) 9·1 (t, J = 7·0, 3, CH_2 CH_3).

Anal Found: C, 75·81; H, 8·0 $C_{18}H_{22}O_3$ requires: C, 75·52 ; H, 7·69 %.

III. 3, 4-*Cyclohepteno*-6-*isopentyl*-7-*hydroxycoumarin* (*III, R*)

A mixture of 2-carbethoxycycloheptanone (0·011 mol.), 2, 4-dihydroxy isopentylbenzene[2] (0·01 ml), POCI3 (2 ml) and dry benzene (40 ml) on keeping at room temperature for 24 hours and usual work up yielded III (60%). It was crystallised from alc. M.P. 185°, IR (KBr) 3350, 2950, 2900, 2850, 1670, 1610, 1260, 1180, 1165, 860 and 775 cm^{-1}, NMR ($CDCI_3$ + DMSO–d6), 2·70 (s, 1, H–5), 3·20 (s, 1, H–8) 6·90–7·50 (m, 6, $ArCH_2$, H–3′ and H–7′), 8·10–8·80 [m, 9, CH_2, C*H* $(CH_3)_2$, H–4′, H–5′ and H–6′], 0·9 [d, J = 6·06, CH $(CH_3)_2$].

Anal Found: C, 75·85, H, 8·12 $C_{19}H_{24}O_3$ requires C, 76 and H, 8·0%.

The black rats (*Rattus rattus*) were trapped and kept in individual cages. Rats were fed on wheat flour and water was given *ad libitum* for 3–4 days.

Preparation of bait

For the preparation of 100 g bait, 0·25 g of hydroxycoumarin compound was thoroughly mixed with 99·75 g of the base (94·74 g semolina, 3 g of powdered sugar and 2 g of groundnut oil). Similarly, the bait of each hydroxycoumarin compound was prepared at different concentrations, *viz.*, 0·25, 0·5, 1·0 and 2%.

Water and poison bait were replenished every day and the bait intake was observed daily. The data on the number of rats used in each experiment, average body weight, mortality per cent, time taken for death, consumption of bait intake per rat/day and consumption of posion/kg body weight are given in Table I. The conclusions were drawn on the mean results of 10 rats used in each experiment.

Results and Discussion

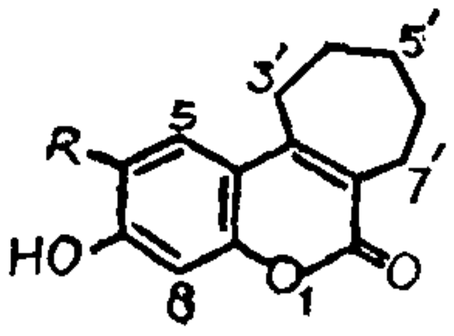
It is clear from Table I that all the hydroxy coumarin compounds, I, II and III at concentrations of 0·25, 0·5, 1·0 and 2% were found toxic against rats, but 100% mortality of rats was not achieved with any of the compounds. However, each compound at 2% concetration gave 50% mortality of the rats with the mortality occurring after an average of 20 days with an average bait intake of 5 gm each with I, II and III. This period of mortality seems to be longer than the known anticoagulants since only 50% mortality of rats was achieved after 20 days.

It has been observed in this investigation that the rats continue to consume the bait irrespective of the concentrations of the compound. In the case of I compound, at 0·25, 0·50, 1·0 and 2% concentration the poison/kg. body weight consumed in milligram was 5208, 6225, 7881 and 12772 respectively. Similar results were observed in II, and III compounds as shown in Table I. However, all the

TABLE I

Toxicity of hydroxycoumarin compounds against black rat (Rattus rattus)

No. of Rats used : 10



I, R = C_3H_7

II, R = C_4H_9

III, R = $(CH_2)_2CHMe_2$

Compound No.	Conc. of the compound in the bait (%)	Average body weight (gms)	Mortality %	Kill period Range Av.	Min.	Max.	Average bait intake gm/rat/day	Mg of poison/kg body wt. reqd. Av.
I, R	0·25	156	10	32	25	35	10	5208
,,	0·50	150	20	25	20	30	7	6225
,,	1·00	158	30	25	20	28	5	7881
,,	2·00	160	50	20	17	27	5	12772
II, R	0·25	140	20	30	26	32	9	4911
,,	0·50	185	20	30	25	30	8	6648
,,	1·00	180	40	25	20	30	5	8593
,,	2·00	175	50	20	18	25	5	11428
III, R	0·25	155	10	31	26	36	9	4734
,,	0·50	149	20	25	21	31	7	5989
,,	1·00	160	30	25	21	28	5	7968
,,	2·00	168	50	20	18	25	5	12227

compounds were found to be more or less identical in their toxicity.

In a study of the structure-activity relationship in this class of 7 hydroxycoumarin derivatives, it appears that the length of the side chain does not play a significant role in its toxicity, The structural changes in the other parts of the molecule to increase the toxicity are in progress.

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Hapur (U.P.),
November 19, 1977.

K. K. ARORA.
VEENA.*
O. P. MALIK.*

* Department of Chemistry, D.N. College, Meerut (U.P.).

1. Hesse, G. and Urbanek, F., *Chem. Ber.*, 1958, **91**, 2733.
2. Dohme, A.R.L., Cox, T. H. and Ellis Miller, *J. Am. Chem. Soc.*, 1926, **48**, 1688.

FORMATION CONSTANTS OF SOME BIVALENT METAL CHELATES OF 2-HYDROXY-1-NAPHTHALIDENE-2', 5'-DIMETHOXYANILINE

IN continuation of our earlier work on the determination of stability constants of various Schiff bases of 2-hydroxy-1-naphthaldehyde, a structurally similar ligand has been selected to study the behaviour of some divalent metal ions with this ligand.

In the present communication, the successive stability constants of the complexes of 2-hydroxy-1-naphthalidene-2', 5'-dimethoxyaniline with some bivalent metal ions have been determined potentiometrically following the Calvin-Bjerrum pH titration technique as adopted by Irving and Rossotti.[1]

Experimental

A Corning Model 12, precision research pH meter with a wide range glass electrode and a calomel reference electrode was used for the pH measurements. The smallest scale division on the expanded scale is 0·005 pH unit.

The ligand, 2-hydroxy-1-naphthalidene-2', 5'-dimethoxyaniline was synthesised and repeatedly crystallised to get an analytically pure sample (Observed m.p. 148 C). The chemicals used were of B.D.H. analytical grade. The medium of titration was a