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Note

Investigation of the gas–liquid chromatographic separation of phencyclidine and some heterocyclic analogues by combined gas–liquid chromatography–mass spectrometry

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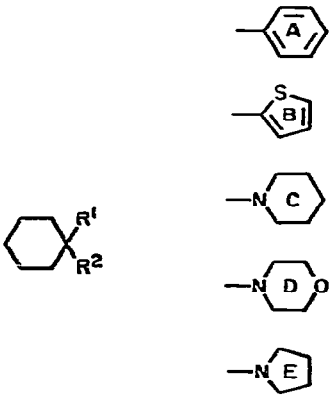
The widespread abuse of phencyclidine and an increasing number of its analogues[1,2] creates the need for rapid unambiguous identification. Two recent papers give gas chromatographic (GC) data for the separation of some analogues[3,4]. The two papers overlap on the description of five of these, namely: phencyclidine (I), 1-[1-(2-thienyl)cyclohexyl]piperidine (II), 1-(1-phenylcyclohexyl)morpholine (III), 1-[1-(2-thienyl)cyclohexyl]morpholine (IV), and 1-(1-phenylcyclohexyl)pyrrolidine (V). To complete the series, this paper will also include 1-[1-(2-thienyl)cyclohexyl]pyrrolidine (VI) (Fig. 1).



	R^1	R^2
I	A	C
II	B	C
III	A	D
IV	B	D
V	A	E
VI	B	E

Fig. 1. Structures of phencyclidine and its analogues.

Both Bailey *et al.*[3] and Cone *et al.*[4] give comparable data for OV-17 and SE-30 but results differ for OV-225. It is interesting to note that the systems that seem to separate best the thienyl analogues from the phenyl ones (OV-7 and SE-30 (ref. 3); SE-30, OV-225 and Silar 5 CP (ref. 4), give relatively short, equal retention times for all three thiophenes. On systems where the thienyl analogues have long retention times [OV-17 and OV-225 (ref. 3); OV-17 (ref. 4)], they are distinguishable from one another but hardly from their phenyl counterparts. It was mentioned by Bailey *et al.*[3] that some of their results are indicative of decomposition.

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This paper will attempt to demonstrate using GC–mass spectrometric (MS) techniques that the short retention times observed for the thiophene analogues on some phases were in fact due to on-column decomposition. No such decomposition was obtained on these phases until it was induced by contaminating the phases prior to their use.

EXPERIMENTAL

A Hewlett-Packard 5985-A GC–MS data system was used. Columns were of glass, 4–8 ft. × 2 mm I.D. Injection port temperature was 250°C, and the detector and interface temperatures were 275°C. The carrier gas was helium with a flow-rate of 30 ml/min. Retention times were determined using a mixture of the bases of all six compounds dissolved in methanol. Source of samples were as previously described[3]. Silyl 8 is a trade name of Pierce (Rockford, IL, U.S.A.).

RESULTS AND DISCUSSION

Results of the aforementioned papers were reproduced, except where the reported retentions times of the thiophene analogues were much shorter than their phenyl counterpart. It can be seen (Table I) that the phenyl analogues and their thienyl counterparts (I *vs.* II, III *vs.* IV, V *vs.* VI) exhibit little difference in chromatographic behaviour. Both the SE-30 and the OV-101 were found to give some separation, however the resolution of paired analogues was incomplete (Fig. 2). Analysis of the mass spectra of the emerging peaks revealed them to be almost identical with those published by Bailey *et al.*[3]. No evidence of decomposition could be found.

TABLE I

RETENTION TIMES OF PHENCYCLIDINE AND ANALOGUES

Conditions: A, 3% SE-30 on 80–100-mesh Chromosorb W, 150°C, 4 ft.; B, 5% OV-101 on 100–120-mesh Chromosorb W, 150°C, 6 ft.; C, 3% OV-7 on 80–100-mesh Chromosorb W, 150 °C, 4 ft.; D, 3% OV-7 (acid treated) on 80–100-mesh Chromosorb W, 150°C, 4 ft.; E, 3% OV-17 on 100–120-mesh Gas-Chrom Q, 160°C, 6 ft.; F, 2% OV-25 on 80–100-mesh Chromosorb W, 150°C, 8 ft.; G, 3% OV-225 on 100–120-mesh Chromosorb W, 140°C, 4 ft.; H, 3% Silar 10C on 100–120-mesh Gas-Chrom Q, 150°C, 4 ft.

Compound	*Retention time (min)*							
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
I	5.3	10.7	12.5	18.3	14.9	9.7	12.9	3.6
II	5.1	10.2	12.5	18.3	14.9	9.7	12.9	3.6
III	6.8	13.3	18.3	26.3	23.6	15.6	28.9	14.6
IV	6.4	12.6	17.6	25.7	23.6	15.6	28.9	14.6
V	3.8	7.6	8.7	12.6	10.5	7.0	9.8	3.0
VI	3.6	7.0	8.2	11.9	10.3	7.0	9.8	3.0
VII	—	—	—	2.3	—	—	—	—

Much shorter retention times for II, IV and VI, could be produced by injecting small quantities (10–15 μl) of dilute aqueous hydrochloric acid onto a 3% OV-7 column prior to its use. This had the effect of producing a new early eluting peak with

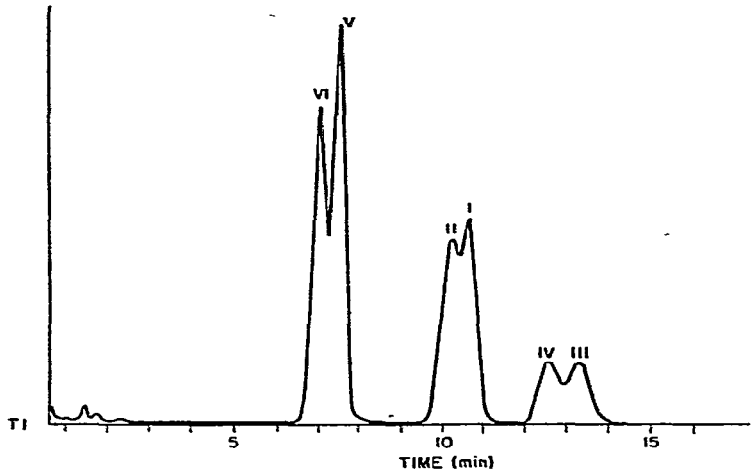

Fig. 2. Separation of phencyclidine and its analogues on 5% OV-101 at 150°C.

the same retention time (2.3 min) for all three thienyl analogues (Table I). Analysis of the mass spectra of the compounds giving rise to this peak (Fig. 3), suggested that this new compound is 1-(2-thienyl) cyclohexene (VII), formed by acid catalysed loss

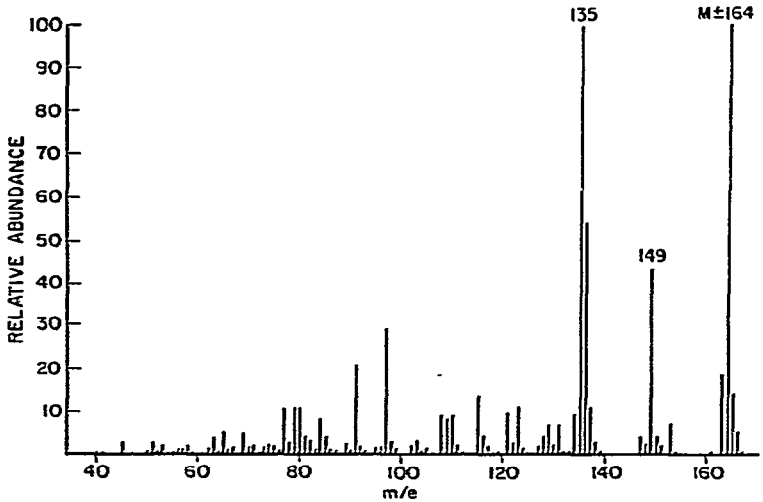

Fig. 3. Electron impact spectra of the decomposition product of compounds II, IV and VI.

of the R^2 ring substituent (Fig. 4). The five major peaks (*m/e* 79, 135, 136, 149, 164) of the spectrum, are also found to be amongst the predominant peaks below *m/e* 165

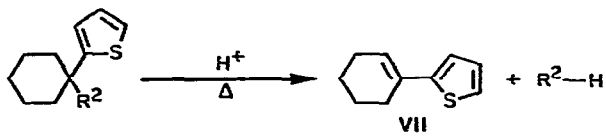

Fig. 4. Decomposition scheme of thienyl analogues on acid-treated OV-7.

in the spectra of the three thiophene analogs published by Bailey *et al.*[3]. The peaks at *m/e* 97 along with those at M—15 (*m/e* 149) and M—28 (*m/e* 136) are characteristic of thiophene and cyclohexene derivatives, respectively[5]. The small ion at *m/e* 153 is likely due to an impurity as it is the base peak in a scan of the area immediately following the GC peak corresponding to VII. At 150°C decomposition was not complete since vestiges of the thienyl analogues could still be seen. However if the temperature of the column is raised to 200°C, decomposition of the thiophenes becomes virtually complete. It would seem that injector temperature is not the source of the decomposition as it was maintained at 250°C at all times and only a raise in column temperature afforded increased decomposition, thus indicating that the column change generated by treatment with the hydrochloric acid was responsible for the decomposition relative to the results obtained prior to acid treatment (Table I). It is also noteworthy that the retention times of the phenyl and the undecomposed thienyl analogues were noticeably lengthened. The original performance of the column was restored by treatment with Silyl 8.

It is now obvious that the data previously reported[3,4] that gave short retention times for the thienyl analogues in relation to their phenyl counterpart, cannot be used for identification purposes. However deliberate selective decomposition of the thienyl compounds could be carried out to facilitate their differentiation from their phenyl analogues.

It is therefore recommended that columns that have been used with acid salts of organic compounds should be treated with Silyl B before the analysis of phencyclidine and its analogues is attempted.

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