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145. **Masaaki Horiguchi** : Gas Chromatographic Separation of Quinolizidine and Unsaturated Quinolizidines.

(*Central Research Laboratories, Sankyo Co., Ltd.*[*1])

Gas liquid chromatography was applied successfully to the separation of a mixture of five quinolizidine derivatives, the reduction products of quinolizinium bromide with sodium borohydride in water. Separation of a mixture of the reduction products and 1,9*a*-dehydroquinolizidine (Ⅳ) was reexamined using the same kinds of columns.

Of these various liquid phases, DEGS was found the most effective for the complete separation in both the cases.

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Many gas chromatographic investigations of aromatic nitrogen compounds such as pyridine, pyrimidine, quinoline, and their derivatives have been reported. However, the gas chromatographic studies on quinolizidine and unsaturated quinolizidines have not been reported.

Powell and Whiting[1] have applied gas chromatography to the analysis of double bond isomers of octalin, and discussed quantitative analysis of the five different binary mixtures.

Recently Janák, *et al.*[2] have reported the gas chromatographic separation of saturated and unsaturated 1,3-dimethylpiperidines which were prepared by reducing the quaternary pyridinium salt.

The principal purpose of the present study was to separate gas chromatographically a mixture of quinolizidine and the unsaturated quinolizidines, which were formed during the reduction of quinolizinium bromide with sodium borohydride in water[3] as shown in Chart 1. Seven kinds of column packings with a variety of polarities were examined for the purpose. They were i) 30% Carbowax 6000 on 40～60 mesh Chromosorb-W (CW-6000), ii) 20% polydiethyleneglycol succinate on 60～80 mesh Chromosorb-W (DEGS), iii) 10% XE-60 on 60～80 mesh Chromosorb-W (XE-60), iv) 10% dioctyl phthalate on 60～80 mesh Chromosorb-W (DOP), v) 10% silicone oil D.C.-710 on 60～80 mesh Chromosorb-W (DC-710), vi) 20% silicone high vacuum grease on 40～60 mesh Chromosorb-W (SHVG), and vii) 10% Apiezon L grease on 60～80 mesh Chromosorb-W (Apiezon L).

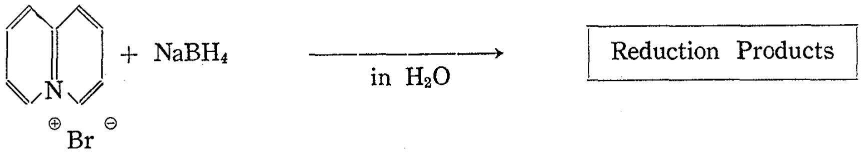


Chart 1.

Among these DEGS column was the most effective for the separation of the reduction products to give five peaks. Each component was collected by repeating the injection of 30～50 μl. of the reduction mixture.

[*1] Hiro-machi, Shinagawa-ku, Tokyo (堀口正明).

1) J.W. Powell, M.C. Whiting : Tetrahedron, **12**, 163 (1961).

2) J. Janák, M. Holik, M. Ferles : Collection Czechoslov. Chem. Commun., **31**, 1273 (1966).

3) T. Miyadera, Y. Kishida : Tetrahedron Letters, No. 14, 905 (1965).

The structures of these separated substances were determined by infrared absorption (IR), ultraviolet (UV), and nuclear magnetic resonance (NMR) spectra, pKa values and catalytic hydrogenation.3) The results proved that all of the five components were pure substances for the structures as shown in Chart 2.

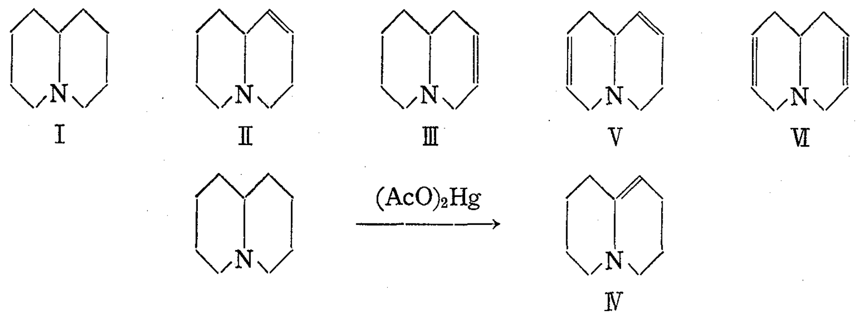
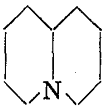
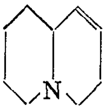
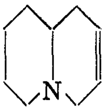
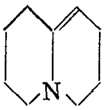
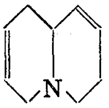
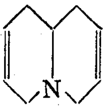


Chart 2. Reduction Products

From the gas chromatographical interest, 1,9*a*-dehydroquinolizidine (Ⅳ) having an enamine structure was prepared by dehydrogenation of quinolizidine with mercuric acetate, according to the procedure described by Leonard, *et al.*,4) shown in Chart 2. The enamine (Ⅳ) and the separated quinolizidines (I, Ⅱ, Ⅲ, V, Ⅵ) were mixed in an arbitrary ratio and reexamined for the effectiveness of the seven columns mentioned above. Observed retention times are shown in Table I and the gas chromatogram on DEGS column is shown in Fig. 1.

Table I. Retention Times (min.) of Six Quinolizidines

Compound		Column						
		Apiezon L	SHVG	DC-710	DOP	XE-60	DEGS	CW-6000
I		7.90	9.50	5.10	9.00	4.50	4.00	6.85
Ⅱ		7.75	9.45	5.90	10.20	5.60	5.70	9.50
Ⅲ		9.65	10.65	7.05	12.95	7.35	7.90	12.50
Ⅳ		12.10	14.35	9.65	16.50	8.85	9.05	16.10
V		8.90	10.75	7.15	13.30	8.30	10.45	15.55
Ⅵ		11.60	13.40	9.25	18.75	11.60	15.35	22.05
Column Temp. (°C)		125	125	125	120	110	120	125
Carrier gas flow rate (ml./min.)		40	40	40	35	40	40	40

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4) N. J. Leonard, A. S. Hay, R. W. Fulmer, V. W. Gash: J. Am. Chem. Soc., **77**, 439 (1955).

The results indicate that the liquid phases other than DEGS were insufficient for the complete separation of the six quinolizidines, since some of the substances have identical or nearly the same retention times.

In the case of DEGS column, introduction of one or two double bonds in the quinolizidine ring made the retention time longer, following the increasing number of the double bond. However, the order of the retention times varied with the kind of the columns. For example, on a polar liquid phase, CW-6000, a faster elution was observed for the diene (V) than the enamine (Ⅳ).

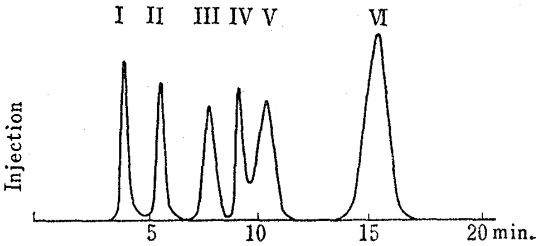

Fig. 1. 20% DEGS on 60~80 mesh Chromosorb-W

Column Temp. 120°C, Helium flow rate 40ml./min.,
Injection Temp. 260°C, Detector Temp. 150°C,
Cell current 200mA.

It is apparent that the migration of a double bond in the ring did not occur, since the pure unsaturated quinolizidines showed only single peak and the retention times and the relative intensities of the mixtures were reproducible.

As the polarities of the liquid phases decrease, the enamine (Ⅳ) showed a tendency to have a longer retention time than the symmetrical diene (Ⅵ). In addition, the decrease of the polarities of the liquid phase (*e.g.* SHVG and Apiezon L) resulted in a shorter retention time for the saturated amine (I) than that for the monoene (Ⅱ). In contrast with DEGS, the gas chromatogram on the nonpolar Apiezon L column eluted faster the diene (V) than the monoenes (Ⅲ, Ⅳ).

Experimental

A Yanagimoto Model GCG-3 gas chromatograph equipped with a thermal conductivity detector was used in this investigation. The column was a stainless steel tube of 5 mm. i.d. and 2 m. long filled with a solid support of acid-washed chromosorb-W, coated with a liquid phase.

Helium was used for carrier gas.

A mixture of the reduction products distilled under reduced pressure was submitted to gas chromatography.

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