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Studies on the Syntheses of Heterocyclic Compounds. CCXLV.[1] The Mass Spectra of Cryptaustoline Type Alkaloids

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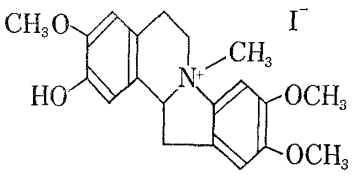
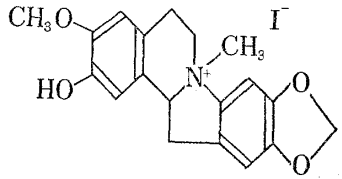
The mass spectra of several kinds of cryptaustoline type compounds, namely, dibenzopyrrocoline derivatives, were investigated and the characteristic fragmentation patterns were revealed.

In a previous paper[3] it has been reported that cyclization of 1-(2-bromo-4,5-dimethoxybenzyl)- and 1-(2-chloro-4,5-methylenedioxybenzyl)-7-benzyloxy-1,2,3,4-tetrahydro-6-methoxyisoquinoline with sodamide in liquid ammonia afforded the dibenzoindolizine derivatives, whose methylation with methyl iodide, followed by hydrolysis with acid, gave the corresponding methochlorides. Treatment of these compounds with potassium iodide or hydriodic acid gave the iodides of (±)-cryptaustoline (I)[4] and (±)-cryptowoline (II),[4] respectively.

The purpose of the present investigation was to study the fragmentation pattern of dibenzopyrrocoline derivatives by mass spectrometry, ten kinds of these compounds being investigated. We hereby wish to report these results, which seem to be important and convenient for mass spectral identification of these compounds because of the characteristic fragmentation patterns.



I



II

Chart 1

Since both alkaloids (I) and (II) are phenolic quarternary ammonium salts having very low vapor pressure, their molecular ion peaks (M^+) have not been observed, the ions of $[M-142\ (MeI)]^+$ being appeared as the second molecular ion peaks, respectively, and the same behaviors were observed from the other related quarternary bases (III), (V) and (VI). Furthermore, Hofmann degradation type fragmentation which was observed in case of quarternary indole alkaloids by Hesse and Renner,[5] could not be shown in our samples. This fact is presumably due to facile pyrolysis under the conditions of mass spectral determination, by the result of which the expulsion of methyl iodide seemed to occur prior to the electron impact to give a tertiary base. This presumption supports the facts that Robinson and Sugasawa[6] have

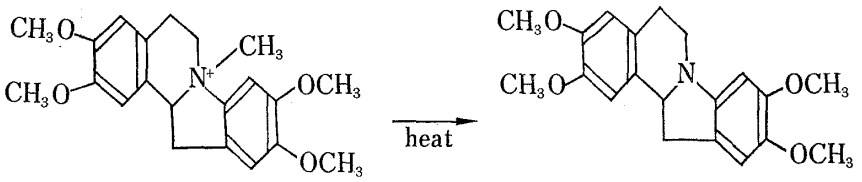
1) Part CCXLIV: *Chem. Pharm. Bull.* (Tokyo), **16**, 1285 (1968).
2) Location: *No. 85, Kita-4-bancho, Sendai.*
3) T. Kametani and K. Ogasawara, *J. Chem. Soc.* (*C*), **1967**, 2208.
4) J. Ewing, G.K. Hughes, E. Ritchie, and W.C. Taylor, *Nature*, **169**, 618 (1952); *Austral. J. Chem.*, **6**, 78 (1953).
5) M. Hesse and U. Renner, *Helv. Chim. Acta*, **49**, 1875 (1966).
6) R. Robinson and S. Sugasawa, *J. Chem. Soc.*, **1932**, 789.

TABLE I. Principal Fragmentation Ions (m/e) of Various Cryptaustoline Type Compounds[a)]

Compounds	M^+	M^+_{sec}	$M^+_{sec}-1$	$M^+_{sec}-2$	$(M^+_{sec}-2)-X$[c)]	$(M_{sec}-1)^{2+}$	d	e	f	g	h
I	none	327(13.4)	326(27)	325(100)		162.5(27)	310(92)	296(10)	294(5)	282(13)	266(20)
II	none	311(17)	310(35)	309(100)		154.5(20)	294(73)	280(8.6)	278(5)	266(37)	250(5)
III	none	341(9.2)	340(27)	339(100)	324(68) X=CH_3	169.5(26.5)	309(5.3)	269(8)	294(7)	281(13)	266(5)
V	none	417(10)	416(29)	415(100)	324(16.8) X=CH_2Ph		309(12.6)	296(60)	294(20)	281(21)	265(12.6)
VI[b)]	none	401	400	399	308 X=CH_2Ph		293	280	278	265	250
IV	341(13.4)		340(25)	339(100)	324(67) X=CH_3	169.5(18.5)	309(3.5)	296(7)	294(4)	281(12)	266(5)
VII	339(100)				324(65) (M^+–CH_3)	169.5(33)	309(4)	296(7)	294(3)	281(12)	266(5)
VIII	417(10)		416(30)	415(100)	342(8) X=CH_2Ph		309(6.4)	296(6.3)	294(17)	281(18)	266(11)
IX	401		400	399	308 X=CH_2Ph		293	280	278	265	250
X[b)]	463(6.7)		462(37)	461(100)	370(300) X=CH_2Ph		264(5)	252(75)	250(20)	236(18)	220(8)
					279(80) X=2×CH_2Ph						

a) In the above Table the relative intensity (%) is stated as numerals in ( ) when M^+ (or M^+_{sec})−2 is calculated as 100%, and all samples were determined by direct insertion method. Furthermore, the metastable ions are observed; b→d, b→c, c→f, c→e c→d.
b) In case of VI and IX the relative intensity could not be calculated because of scaling out.
c) This ion means the ion (c).

obtained the corresponding tertiary base by heating O–methylcryptaustoline under reduced pressure, and that the fragmentation patterns of tertiary bases (IV), (VIII) and (IX) were completely identical with their corresponding quarternary bases (III), (I) and (II) respectively. Accordingly, the process of fragmentation upon bombardment with electron would be thought to begin from the ion at M^+–142.[7]



III IV

Chart 2

After the appearance of the ion (M^+_{sec}), the ions of M^+_{sec} −1 and M^+_{sec} −2 are observed successively, the latter of which corresponds to the ion as its base peak. This fact shows that the ion of M^+_{sec} −2 would be comparatively stable. In this case the relative intensities of the successive fragmentations from the ion (M^+_{sec} −2) are not so strong. That is, if the abundance of base peak (M^+_{sec} −2) is estimated as 100%, the relative intensities of the ions appeared at less than M^+_{sec} −2 are calculated as 5—70% (Table I).

Thus, it is of interest that these fragmentation patterns of our samples are different from those of 1–benzyl–[8] and 2–benzylisoquinoline alkaloids.[9] Furthermore, it is of particular interest that the fragmentation from the ion (M^+_{sec} −2) is closely similar to that of 2–methoxytropone[10] as is shown in Chart 3.

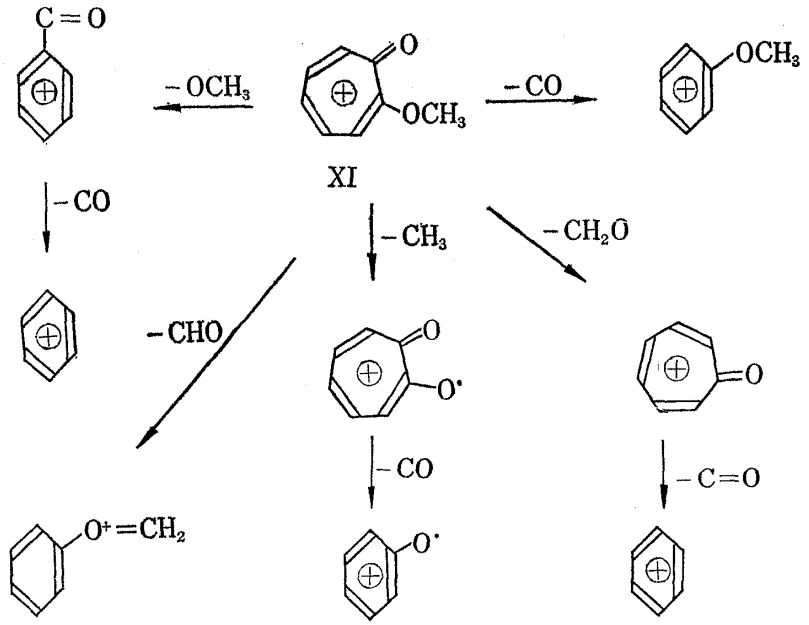


Chart 3

7) This ion [M −142 (MeI)]$^+$ is stood for M^+_{sec} as below.
8) H. Budzikiewicz, C. Djerassi, and D.H. Williams, "Structure Elucidation of Natural Products by Mass Spectrometry," Vol. I, Holden–Day, Inc., San Fransisco, p. 173.
9) T. Kametani and K. Ohkubo, *Chem. Pharm. Bull.* (Tokyo), **15**, 608 (1967).
10) Y. Kitahara, S. Sasaki, and I. Murata, "Physical Methods in Organic Chemistry," Vol. 6, Kyoritsu Publishing Co. Ltd., Tokyo, 1965, p. 81.

Regarding the fragmentation ion peak less than M^{+}_{sec} (or M^{+})—2 in case of the compounds (I) and (II), the formation of 2–methoxytropone derivative is not clear, but the same process as the cleavage if 2–methoxytropone (XI) shown in Chart 3 seem to proceed from the ion (b) through the route (A) (Chart 4).

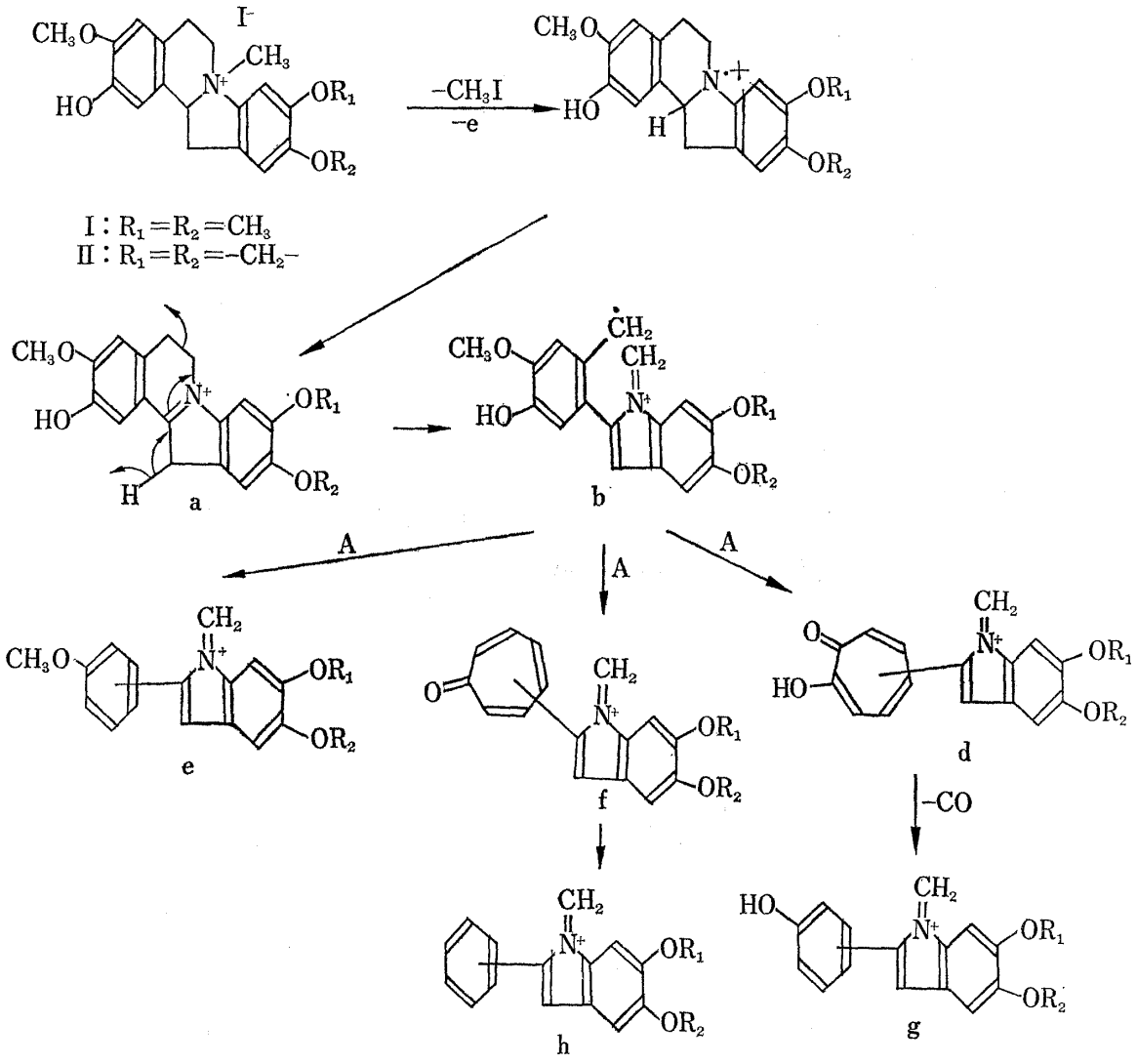


Chart 4

On the other hand, in case of the compounds (III–X) having the other radicals except hydrogen as R_1, loss of R_1 radical is first occurred to give 2–methoxytropone derivative (c) through the route (B), from which the following fragmentation shown in Chart 4 seems to be held. In this case it is beyond doubt that the first repulsion of R_1 radical is supported by the existense of the corresponding metastable ions. Furthermore, conversion of only A ring to methoxytropone is well explained by comparison of the fragmentation ion peak of X with the similar pattern of the other compounds. With regards to the process of M^{+}_{sec} (or M^{+}) —2, the fragmentation pattern of the dehydrogenated derivative (VII) is superimposable on that of the ion peak less than M^{+} —2 of IV, and therefore the cleavage of ion (a) to the ion (b) seems to be reasonable.

Finally the mass spectra of O–methyl–(III), O–benzyl–cryptaustoline (IV), O–benzyl–cryptowoline (V), and three tertiary bases (VIII, IX and X) were also investigated, but they were found to have nearly similar fragmentation pattern each other as was shown in Table I.

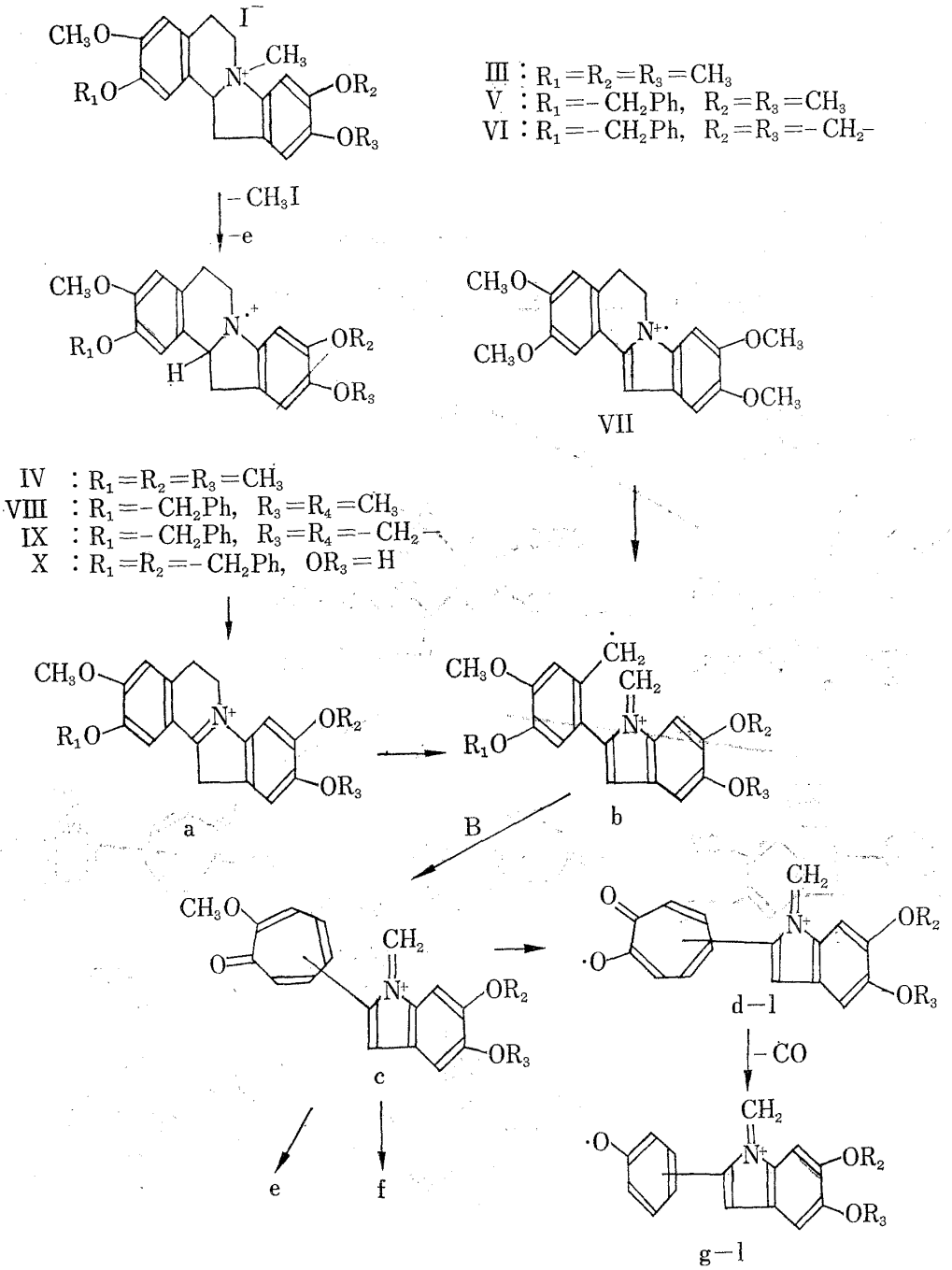


Chart 5

Therefore, the above results would be useful for mass spectral elucidation of dibenzopyrrocoline derivatives such as cryptaustoline type alkaloids.

Experimental

The mass spectra of all the samples prepared by our procedure through benzyne reaction[3] were measured by Hitachi RMU-6D mass spectrometer, using an all-glass inlet system heated to >300°. The ionizing energy was maintaind 70 eV and the ionizing current at 80 μA.