residue crystallized on standing to give methyl 2,4,6-d_3-cinnamate [Xa, 12 mg, mp 33–35°, mol wt (mass spec) 165, d_1 = 3%, d_2 = 14%, d_3 = 83%]. The isotopic purity was calculated from the M − OCH_3 ion.

2′,4′,6′-d_3-Benzalacetophenone (XIa). 2,4,6-d_3-Benzaldehyde (40 mg), acetophenone (40 mg), and absolute ethanol (3 ml) were mixed and 10% aqueous sodium hydroxide then added until the solution became cloudy. The mixture was shaken for 30 min, and the solid which separated from solution was then isolated by filtration. Recrystallization of the crude product from aqueous methanol gave 2′,4′,6′-d_3-benzalacetophenone [XIa, 65 mg, mp 55–57°, mol wt (mass spec) 211].

2,4,6,2′,4′,6′-d_6-Dibenzalacetone (XIIa). 2,4,6-d_3-Benzaldehyde (40 mg), acetone (10 mg), and absolute ethanol (3 ml) were mixed, and 10% aqueous sodium hydroxide (2 ml) was added. The mixture was shaken for 30 min and the solid product then isolated by filtration. The crude material was recrystallized from absolute ethanol giving 2,4,6,2′,4′,6′-d_6-dibenzalacetone [XIIa, mp 109–112°, mol wt (mass spec) 240, d_3 = 1%, d_4 = 6%, d_5 = 25%, d_6 = 68% as calculated from the isotopic purity of the precursor benzaldehyde].

2,3,4,5,6-d_5-Benzalacetophenone (XIb). 2,3,4,5,6-d_5-Acetophenone (XVI, d_3 = 1.5%, d_4 = 16.5%, d_5 = 82%) was prepared by a standard Friedel–Crafts reaction between d_6-benzene and acetic anhydride in the presence of aluminum chloride. This material (XVI) was then condensed with benzaldehyde as described previously to give XIb.

d_6-Benzaldehyde (XVIII). d_8-Toluene (2 ml) was heated gently under reflux and a rapid stream of chlorine passed into the solution in the presence of sunlight. When the temperature of the liquid had reached 208°, the reaction was stopped, and the resulting d_6-benzal chloride was hydrolyzed with aqueous 25% calcium hydroxide solution. The product was isolated *via* ether extraction and distilled to give d_6-benzaldehyde [XVIII, 1.0 g, mol wt (mass spec) 112, d_5 = 3%, d_6 = 97%]. The mass spectrum of the material showed it to be quite pure.

d_6-Benzalacetophenone (XIc). This material was prepared by condensation of d_6-benzaldehyde (XVIII) with acetophenone in the presence of 10% aqueous sodium hydroxide as previously described.

2,3,4,5,6-d_5-Benzaldehyde (XX). The chlorination of d_8-toluene (2 ml) was carried out as described for the preparation of d_6-benzaldehyde (XVIII), except it was continued until the temperature of the liquid had reached 232°. The resulting trichloride (XIX) was then hydrolyzed with 25% aqueous calcium hydroxide, and the d_5-benzoic acid was filtered off and dried. This material was then reduced to the alcohol with lithium aluminum hydride and the alcohol then oxidized to the corresponding aldehyde by refluxing in sunlight with N-chlorosuccinimide (1.3 g), pyridine (1.3 ml), and carbon tetrachloride (20 ml).[15] The mixture was acidified with dilute hydrochloric acid, and the organic layer was removed and washed well with water, 2 *N* sodium hydroxide (10 ml), and finally again with water (three 10-ml portions). The carbon tetrachloride solution was dried and evaporated and the residue purified by distillation to give 2,3,4,5,6-d_5-benzaldehyde [XX, 250 mg, mol wt (mass spec) 111, d_4 = 3%, d_5 = 97%].

2′,3′,4′,5′,6′-d_5-Benzalacetophenone (XId). This material was prepared by condensing d_5-benzaldehyde (XX) with acetophenone in the presence of 10% aqueous sodium hydroxide as previously outlined.

α-d_1-Benzalacetophenone (XIe). Benzaldehyde (40 mg) and 1′,1′,1′-d_3-acetophenone (XXI)[16] were condensed in the presence of 10% aqueous sodium deuteroxide (1 ml) and deuteriomethanol (3 ml), and the product was obtained as detailed previously.

Acknowledgment. J. R. gratefully acknowledges the receipt of a Science Research Council postgraduate award.

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Unusual Mass Spectral Fragmentation of 21-Oxoaspidoalbidine-Type Alkaloids[1]

Keith S. Brown, Jr., Wolfango E. Sanchez L., Antonio de A. Figueiredo, and Joaquim M. Ferreira Filho

Contribution from the Centro de Pesquisas de Produtos Naturais, Faculdade de Farmácia e Bioquímica, Rio de Janeiro ZC-82, Brazil. *Received May 27, 1966*

Abstract: The mass spectra of indole alkaloids of the 21-oxoaspidoalbidine type show an unusual fragmentation pattern, giving an ion at *m/e* 160 as (usually) the base peak. Using the known alkaloid dichotamine and two new alkaloids of this group isolated from *Aspidosperma exalatum*, with deuterations and high-resolution mass spectral measurements, a rationale for this unprecedented fragmentation was developed. The first step, loss of CO_2, prohibits the normal aspidospermine-type fragmentation and leads instead to ion fragments including C-20 and one or both aliphatic carbons of the dihydroindole ring. All major peaks in the spectra are assigned tentative origins and structures on the bases of their established molecular formulas and their shifts in deuterated materials.

In recent years, there has been reported an increasing number of aspidospermine-type indole alkaloids, having the ethyl side chain oxidized at terminal C-21 and cyclized onto C-19 to form a hemiazaacetal lactone (I).[2–4] Early in the work on these compounds,[5] the unusual fact was noted that the alkaloids did not undergo the normal aspidospermine-type skeletal fragmentation in the mass spectrometer, but rather gave a prominent fragment of mass 160 (almost always as the base peak) with further important fragments at *m/e* 132, 136, 161, and 174. Other prominent fragmenta-

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(2) K. S. Brown, Jr., H. Budzikiewicz, and C. Djerassi, *Tetrahedron Letters*, 1731 (1963).

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(4) B. Gilbert, "The Alkaloids," Vol. VIII, R. H. Manske, Ed., Academic Press Inc., New York, N. Y., 1965, pp 451–452.

(5) K. S. Brown and P. Yates, unpublished observations. We are deeply indebted to Dr. Peter Yates of the University of Toronto for discussions on this subject and for copies of the mass spectra of cimicine (Ic) and cimicidine (Id).[3]

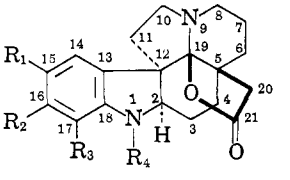
tions included only losses of CO_2 ($M^+ - 44$), the acyl group on the indole nitrogen when present, and ethyl from an N-propionyl group when present. This abnormal fragmentation pattern, giving a number of low molecular weight peaks common to all the alkaloids (I) and thus surely derived from the aliphatic portion of the molecules, provoked our curiosity.

We have isolated from *Aspidosperma exalatum* Monachino two new alkaloids of this series, Ie and Ig.[4] The structure of the latter, 21-oxo-O-methylaspidoalbine,[6] was suggested by its ultraviolet spectrum (nearly identical with that of O-methylaspidoalbine, IIb[6]), infrared absorption ($\nu_{max}^{CHCl_3}$ 1745, 1637 cm^{-1}; ν_{max}^{KBr} 1770, 1755, 1644 cm^{-1}), mass spectrum (M^+ 456; calcd for $C_{25}H_{32}N_2O_6$, 456; $M^+ - 44$, $M^+ - 57$ prominent), and nmr spectrum (1 aromatic proton at δ 6.97; 3 aromatic methoxyls at δ 3.90, 3.83, and 3.81; 3-proton triplet of methyl of N-propionyl at δ 1.15).[7] Hydrolysis gave a depropionyl compound If which could be repropionylated to original Ig and was identical by mixture melting point and infrared spectrum with the same material obtained by similar hydrolysis of the known 21-oxo-O-methyl-N-depropionyl-N-acetylaspidoalbine (Ih).[6] Reduction of the deacylated compound If with $LiAlH_4$ gave the known O-methyl-N-desacylaspidoalbinol (III)[6,8] identical by thin layer chromatography, infrared spectrum, and color reactions with the authentic poorly crystalline material.

New alkaloid Ie (21-oxoaspidoalbine) showed in the infrared spectrum a hydrogen-bonded amide (ν_{max}^{KBr} 1630, 1570 cm^{-1}) and a five-membered lactone (ν_{max}^{KBr} 1770 cm^{-1}). The ultraviolet spectrum was essentially identical with that of aspidoalbine[6] (IIa); the mass spectrum was very close to that of Ig, but displaced downward by 14 mass units in the upper regions; the nmr spectrum showed one aromatic proton (δ 6.75), a cryptophenol (strongly hydrogen bonded) (δ 10.97), two aromatic methoxyls (δ 3.90 and 3.82), and the methyl of the N-propionyl group (δ 1.15, triplet). Methylation of Ie with dimethyl sulfate gave a fair yield of Ig (plus another product whose structure will be the subject of a future communication), identical with natural material by infrared spectrum and mixture melting point.

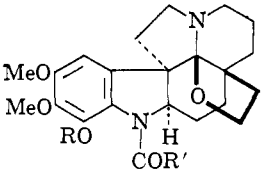
The mass spectral fragmentation of I was then studied with the aid of high-resolution mass spectrometry. This method[9] showed that the peaks at 132, 136, 160, 161, and 174 in the mass spectrum of the chosen derivative (the desacyl compound If) contained no oxygen. The latter fragment thus included all of the aliphatic portion of the molecule ($C_{12}H_{16}N$), with the exception of the CO_2 of the lactone but *including the two aliphatic carbons of the dihydroindole ring*—a most surprising and unexpected result evidently unprecedented in mass spectral fragmentations of indole alkaloids. The composition of $C_{11}H_{14}N$ for the 160 base peak was also confirmed by separate high-resolution measurements on Ie as well as If. It was therefore assumed that the peaks at 132, 136, 160, 161, and 174 were formed by initial loss of CO_2 from the molecular ion to produce ion a (prominent in all spectra, $M^+ - 44$).[5] Following this, the aliphatic portion of the molecule must either separate as such with transfer of one hydrogen (giving *m/e* 174), or separate with loss or leaving behind of one carbon atom and transfer of one (*m/e* 161) or two (*m/e* 160) hydrogen atoms, or undergo more extensive fragmentation with or without hydrogen transfer to give *m/e* 132 ($C_9H_{10}N$) or *m/e* 136 ($C_9H_{14}N$).

The nature of the carbon atom difference between 160–161 and 174 as well as of the hydrogen transfers was clarified by base-catalyzed dideuteration of the 20-position (α to the lactone) of Ig and Ib (dichotamine[2]) and measurement of the mass spectra of the resulting compounds. This revealed the interesting fact that the deuterium-bearing C-20 is retained in all of the above peaks and indeed in essentially all of the fragmentation products, but that a part of one deuterium is transferred away from the positively charged fragments 160, 161, and 174 (about 40–60% in Ig-d_4, 30% in Ib-d_2). The fragment at 136 evidently retains all of its deuterium content and may be tentatively formulated as resulting from a near-normal (or at least precedented) cleavage, possibly with transferral of carbons 3 and 4 from C-5 to C-19 (giving ion b) and also producing the usual indolic fragment (ion group c) which could be detected weakly in the spectra of Ic–g (in Ia,b it would appear at 160 and thus be impossible to distinguish).



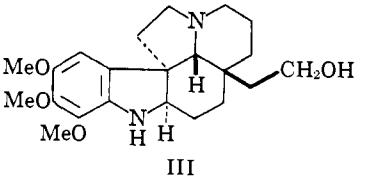
I

	R_1	R_2	R_3	R_4
a,	H	H	OMe	H
b,	H	H	OMe	CHO
c,	H	H	OH	COEt
d,	H	OMe	OH	COEt
e,	OMe	OMe	OH	COEt
f,	OMe	OMe	OMe	H
g,	OMe	OMe	OMe	COEt
h,	OMe	OMe	OMe	COMe

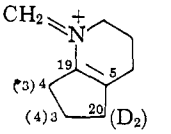


II

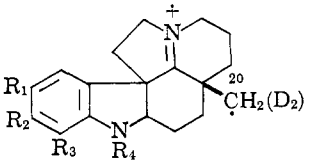
a, R = H, R′ = Et
b, R = Me, R′ = Et
c, R = Me, R′ = Me



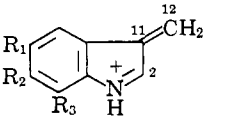
III



b
m/e 136



a
m/e 296, 324, 338, 356, 368, 398, 412



c
m/e 146, 160, 176, 206, 220

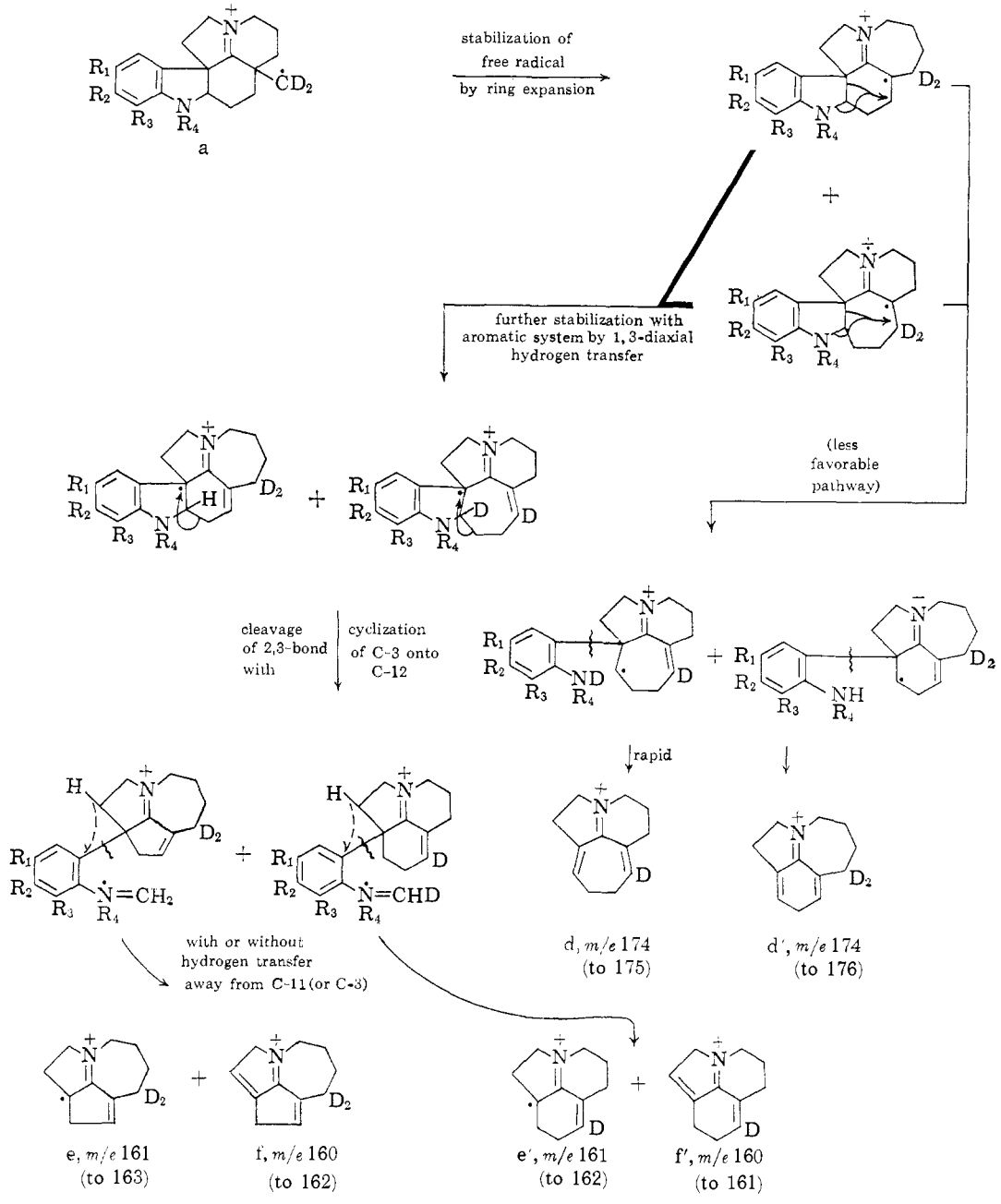
(6) See C. Djerassi, L. D. Antonaccio, H. Budzikiewicz, J. M. Wilson, and B. Gilbert, *Tetrahedron Letters*, 1001 (1962).

(7) We are grateful to Dr. Lois Durham and Mr. T. Burkoth of Stanford University, Calif., for the nmr measurements reported herewith.

(8) K. S. Brown, Jr., and C. Djerassi, *J. Am. Chem. Soc.*, **86**, 2451 (1964).

(9) All low- and high-resolution mass spectra (except for those of Ic and Id[3]) were performed at Stanford University on Atlas CH-4, CEC 21-103C, and AEI MS-9 instruments with direct inlet system. We are grateful to H. Budzikiewicz, R. Ross, and A. M. Duffield for performing these measurements as well as calculations for the high-resolution peaks.

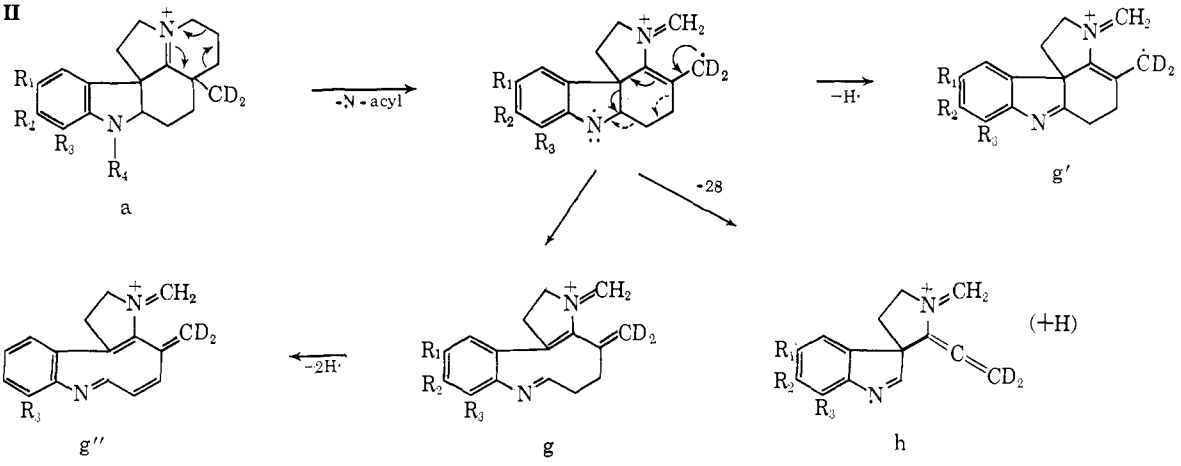
Scheme I



It therefore becomes necessary to postulate that, in relation to the peak at *m/e* 174, the peaks at *m/e* 160–161 lack a carbon atom other than C-20; we find the most attractive possibility for this carbon atom to be C-2, in view of the expected facilitation of cleavage of the 2–3 bond due to the presence of the indole nitrogen. It must also be postulated that part of the hydrogen transferred during the fragmentation of the aliphatic portion of the molecule comes from C-20, but that one or more alternate sources are also available.

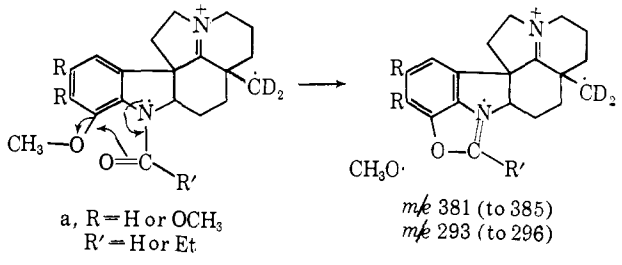
From this point on, rationalization of the *detailed* pathway of the fragmentation becomes speculative, in view of the number of possible pathways and structures which one may write. However, the fact that the *m/e* 160 peak is almost always the strongest peak in the spectra of various I implies that there must be operating a fragmentation pathway highly favorable at every step. As it is still controversial whether, in the mass spectral environment, an elegantly stabilized and strain-free cation of the sort one feels constrained to write in proposing detailed mechanisms for normal organic reactions in the liquid phase has any preference whatsoever over the many less elegant or more strained species one could write, we will not attempt a final definition of a "highly favorable" pathway. However, it is possible to write a pathway of fragmentation for the *m/e* 160, 161, and 174 peaks, involving successive stabilizations of the free radical on C-20 of ion a, and only unstrained and highly stabilized cationic or radical-cationic structures for the final three mass peaks (see Scheme I). This scheme, which seems well in accord with established fragmentations in simpler systems as well as with conventional concepts of free-radical and carbonium ion chemistry, is the least and the most that we can offer; however, at least one other

Scheme II

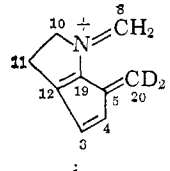


more simplistic formulation is mentioned below, in connection with the fragmentation of II, and could operate also for I.

Scheme III



There may be projected on paper other interesting fragmentation pathways for ion a, and some of these can be tentatively verified in the mass spectra of the various derivatives. For example, retro-Diels–Alder type disintegration of ring E (Scheme II) gives a loss of 28 mass units from a and an intermediate which can easily lose one or two further hydrogens (g′ or g″), be



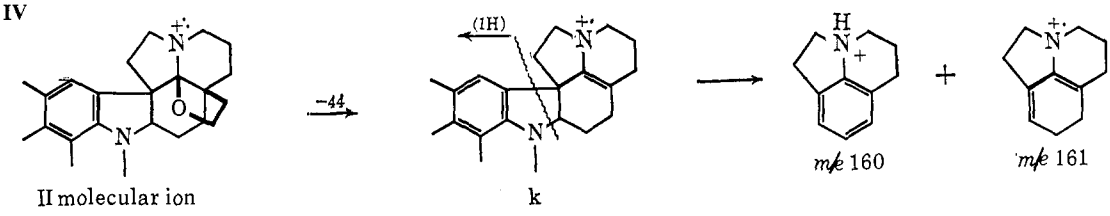
j

stabilized by electron redistribution (g), or undergo further fragmentation of ring C with loss of another 28 mass units (h). All derivatives show in the mass spectra prominent fragments corresponding to loss of CO_2 and N-acyl if present, plus 28–30 and 55–56 mass units not including C-20 or either of its hydrogens. The ion at *m/e* 132, furthermore, which includes C-20 and both of its hydrogens, may arise by a fragmentation of ring E concomitant with that of Scheme I, resulting in a final structure lacking 28 mass units from f or f′ and perhaps represented by j (with transfer of hydrogen from C-4).

There also exist in the spectra peaks corresponding to loss from ion a (with or without N-acyl still present) of a further CH_3 other than C-20 and not deriving wholly from an aromatic methoxyl (as these peaks occur in the spectrum of cimicine (Ic) which has no such group); we cannot guess the nature of this probably multiple fragmentation. The spectrum of only Ig shows a strong peak (*m/e* 381, to 385 when deuterated) which corresponds to loss of CO_2 and probably one methoxyl, possibly that on C-17 with participation of the N-acyl group (Scheme III). No other member of the series shows this strong peak, and Ig is characterized from them only by the presence of both an N-acyl group and a methoxyl on C-17, along with two other methoxyls on C-15 and C-16. The peak may be seen in the spectrum of dichotamine (Ib) but is only barely above the background, not of the considerable intensity with which it appears in the spectrum of Ig; this, however, would tend to support the mechanism of Scheme III.

All of this fragmentation information is summarized, with relative intensities of peaks and measurements of exact masses in the case of high-resolution work, in Table I. Figure 1 dramatizes the very different fragmentation pattern of alkaloids of type I in relation to the nonoxidized hemiazaacetals II. It is of considerable interest that the latter also consistently show low-intensity fragments at *m/e* 160–161 (usually totalling about 30% of the primary fragmentation product at *m/e* 138; see Table II)[6,10] presumably arising directly from the intermediate ion k, produced by loss of the ethylene oxide bridge (see Scheme IV);[6] however,

Scheme IV



II molecular ion k

without high-resolution measurements or deuterations on II we cannot indicate a more detailed mechanism than that represented. It thus seems likely that aspidosperma-type alkaloids which have a normal cyclic fragmentation of the aliphatic portion of the molecule

(10) See H. Budzikiewicz, C. Djerassi, and D. H. Williams, "Structure Elucidation of Natural Products by Mass Spectrometry," Vol. I, Holden-Day, San Francisco, Calif., 1964, p 115.

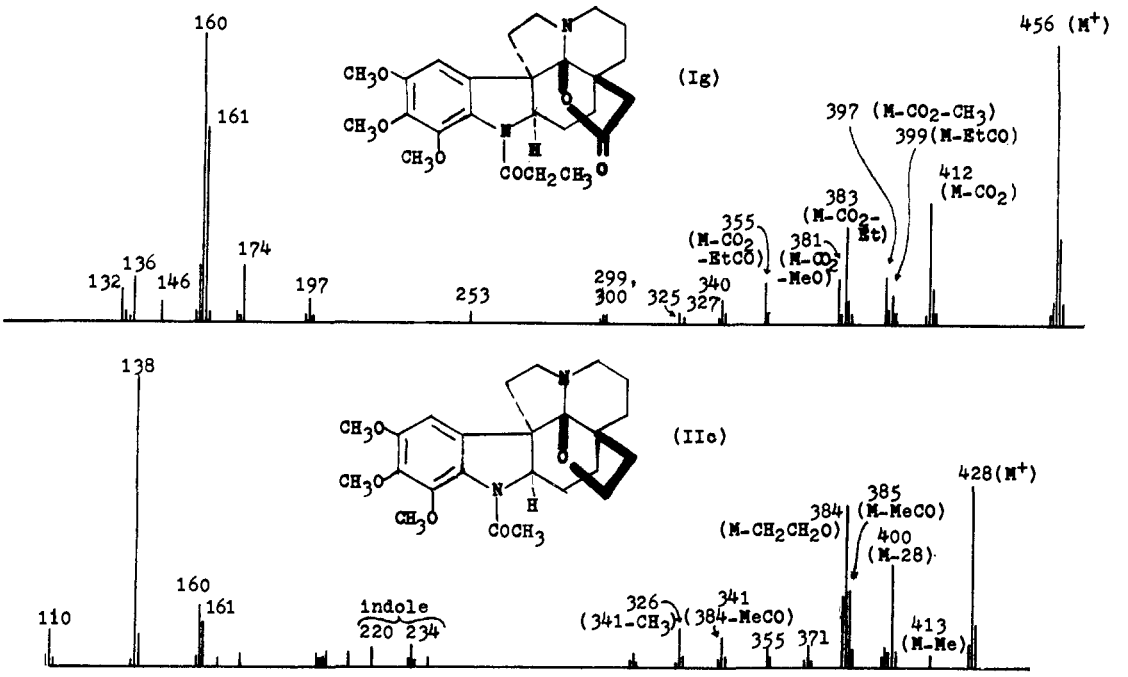


Figure 1. Mass spectral fragmentation of Ig and IIc.

blocked (by the presence of the tetrasubstituted double bonds in a and k) can favorably undergo fragmentation of the dihydroindole ring, even to breaking of a bond to aromatic carbon. We hope that more careful analysis of the spectra of other compounds which can produce such blocked fragmentation intermediates

Table I. Mass Spectral Fragmentations of Various I (base peak 160 (100), *m/e*, and intensity)

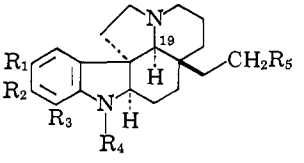
Compound Aromatic substituents	Ia OCH_3, NH	Ib OCH_3, NCHO	Ib-20-d_2[a] OCH_3, NCHO	Ic OH, NCOEt	Id OH, OCH_3, NCOEt	Ie[b] OH, $2OCH_3$, NCOEt	If[b] $3OCH_3$, NH	Ig $3OCH_3$, NCOEt	Ig-20-d_2[c] $3OCH_3$, $NCOCD_2CH_3$
M^+	340 (11)	368 (7)	370 (9) 371 (10)	382 (21)	412 (19)	442[h]	400 (237)[d]	456 (70)	460 (74)
M − CO_2 (a)	296 (8)	324 (41)	326 (35) 327 (38)	338 (74)	368 (34)	398 (212)[d,i]	356 (24)	412 (45)	416 (48)
M − CO_2 − CH_3	281 (4)	309 (6)	311 (3) 312 (7)	323 (5)	353 (4)	383 (28)	341 (30)[i]	397 (19)	401 (19)
M − RCO	*e*	339 (1) 340 (1)	342 (4) 343 (7)	325 (4)	355 (4)	385 (30)	*e*	399 (11)	401 (11)
M − RCO − CO_2	*e*	295 (4) 296 (3)	298 (6) 299 (6)	281 (16)	311 (30)	341 (38)	*e*	355 (21)	357 (22)
M − Et − CO_2	*e*	*e*	*e*	309 (20)	339 (18)	369 (51)	*e*	383 (41)	385 (44)
M − RCO − CO_2 − CH_3	*e*	280 (3) 281 (2)	282 (4) 283 (5)	266 (4)	296 (4)	326 (19)	*e*	340 (14)	342 (18)
M − CO_2 − OCH_3	*g*	293 (1)	296 (2)	*g*	*g*	*g*	*g*	381 (20)	385 (23)
Ring E fragmentation + N-acyl loss (g, g′, g″?)	267 (3) 268 (3)	267 (2) 268 (1)	269 (2) 270 (2)	253 (6)	283 (4)	312 (3)	326 (2) 327 (2)	325 (8)	327 (8)
Rings CE fragmentation + N-acyl loss (ion h?)	239 (3) 240 (3)	240 (9)	242 (7) 243 (7)	225 (8) 226 (12)	256 (6)	286 (23)	299 (3) 300 (2)	300 (8)	302 (11)
Ion group c	*f*	*f*	*f*	146 (13)	176 (6)	206 (9)	220 (3)	220 (9)	220 (11)
Ion d + d′ (?)	174 (12)	174 (14)	176 (8) 177 (5)	174 (10)	174 (24)	174 (17)	174 (18)[k]	174 (21)	175 (19) 176 (22)
Ion e + e′ (?)	161 (75)	161 (27)	162 (10) 163 (33)	161 (38)	161 (14)	161 (60)	161 (54)[l]	161 (70)	163 (63)
Ion f + f′ (?) intensity 100	160	160	161 (30) 162 (90)	160	160	160.1132[m]	160.1122[m]	160	162 (100) 161 (74)
Ion b (?)	136 (11)	136 (35)	138 (23) 139 (22)	136 (26)	136 (5)	136 (30)	136 (8)[n]	136 (17)	138 (22)
Ion j (?)	132 (13)	132 (11)	134 (7)	*g*	*g*	132 (11)	132 (12)[o]	132 (11)	134 (15)

[a] Containing also part of one more deuterium atom, position unknown (possibly in ring E?). [b] On which high-resolution measurements were made. [c] Containing also d_2 on the α-carbon of the N-propionyl group. [d] Note that this peak is stronger than the ion at *m/e* 160. [e] Does not apply. [f] Confusion with a peak of the same mass from a separate fragmentation. [g] Not present. [h] Not measured. [i] 398.2211 (calcd for $C_{23}H_{30}N_2O_4$, 398.2205). [j] 341.1868 (calcd for $C_{20}H_{25}N_2O_3$, 341.1865). [k] 174.1284 (calcd for $C_{12}H_{16}N$, 174.1283). [l] 161.1201 (calcd for $C_{11}H_{15}N$, 161.1204). [m] Calcd for $C_{11}H_{14}N$, 160.1126. [n] 136.1124 (calcd for $C_9H_{14}N$, 136.1126). [o] 132.0448 (calcd for $C_9H_{10}N$, 132.0449).

Table II. Abnormal Mass Spectral Fragmentations of Various II (base peak 138, intensity 100)

Aromatic	C-15	H	H	H	H	H	OCH_3	OCH_3
substituent	C-16	H	H	H	H	OCH_3	OCH_3	OCH_3
	C-17	H	H	OH	OCH_3	OH	OH	OCH_3
	N-1	H	$COCH_3$	$COCH_3$	$COCH_3$	$COCH_3$	$COCH_3$	$COCH_3$
Fragmentation of dihydroindole								
Relative intensity of *m/e* 161		4	3	7	8	11	10	15
of *m/e* 160		17	12	22	20	22	19	21

(such as type IV, which loses the 19 α-hydrogen readily in the mass spectrum)[2,8] will reveal other examples of this unprecedented pathway.



IV

Experimental Section[11]

Isolation of the Alkaloids from Aspidosperma Exalatum.[12] The total ethanol extract (1200 g) from about 7.5 kg of ground bark was agitated vigorously 7 hr with 1200 ml of 10% aqueous HOAc, then cooled at 0° 16 hr and filtered. The filtrate (pH 4) was extracted successively with three 500-ml portions of hexane (fraction A, discarded), four 500-ml portions of benzene (B, 3.5 g), and five 500-ml portions of $CHCl_3$ (C, 27.8 g). The latter fraction was chromatographed on 1500 g of silica gel (E. Merck), adding in benzene and passing first benzene–ethyl acetate mixtures and then EtOAc–MeOH, collecting 120 fractions of 500 ml each. Fractions 45–51 (EtOAc–MeOH 1:3) gave upon crystallization from methanol 294 mg of 21-oxo-O-methylaspidoalbine (Ig), mp 184–185° (a further 546 mg of slightly less pure material was obtained from the mother liquor), $[\alpha]^{31}D$ +96° ($CHCl_3$), λ_{max}^{EtOH} 220, 258, 290 mμ (log ε 4.92, 4.13, 3.70), ν_{max}^{KBr} 1770, 1755, 1644, 875 cm^{-1}; for nmr, see Discussion; for mass spectrum see Table I.

Fractions 52–62 (1.7 g) were rechromatographed on 50 g of basic alumina III, adding in benzene; elution with benzene–EtOAc 2:1 gave 172 mg of crystalline Ig; further elution with EtOAc and EtOAc–MeOH 10:1 gave 301 mg of 21-oxoaspidoalbine (Ie), mp 210–215°. After four recrystallizations from acetone–hexane there was obtained 203 mg, mp 208–209°, λ_{max}^{MeOH} 225, 265 mμ (log ε 4.27, 3.98), ν_{max}^{KBr} 3500, 1770, 1630, 1570 cm^{-1}; for nmr, see Discussion; for mass spectrum, see Table I.

Methylation of 21-Oxoaspidoalbine (Ie) to 21-Oxo-O-methylaspidoalbine (Ig). A solution of 39 mg of pure Ie in 5 ml of dry acetone was treated (reflux, 3.5 hr) with stirring with 200 mg of anhydrous K_2CO_3 and 0.20 ml of dimethyl sulfate. Addition of 5 ml of 10% aqueous NH_3 and extraction with $CHCl_3$ gave 28 mg, purified on 1 g of basic alumina III, adding in benzene. Elution with $CHCl_3$–MeOH 1:1 gave pure Ig, which upon crystallization from methanol yielded 10 mg, mp 180–184°, mmp 180–185°, infrared spectrum superimposable upon that of authentic material (Ig).

21-Oxo-O-methyl-N-desacylaspidoalbine (If). Hydrolysis of 22 mg of 21-oxo-O-methyl-N-depropionyl-N-acetylaspidoalbine (Ih)[6] with 1 ml of concentrated HCl and 2 ml of H_2O at reflux, 1 hr under N_2, with work-up proceeding with aqueous NH_3 and $CHCl_3$, gave 20 mg of product showing no N-acyl absorption in the infrared spectrum. Crystallization from acetone–hexane gave 9 mg, mp 199–200°, $\nu_{max}^{CHCl_3}$ 3400, 1750, 890 cm^{-1}.

Hydrolysis of 25 mg of natural 21-oxo-O-methylaspidoalbine (Ig) under identical conditions gave 20 mg, crystallized from acetone–hexane to yield 11 mg, mp 198–200°, mixture melting point with the above material 198–200°, infrared spectra of the two superimposable.

Acylation of 16 mg of the desacyl compound If with 2 ml of propionic anhydride and 2 ml of pyridine, 44 hr at room temperature, gave 15 mg, which upon crystallization from acetone–hexane yielded 8 mg, mp 178–181°, mixture melting point with natural Ig 177–181°; infrared spectra of the two materials were superimposable.

O-Methyl-N-desacylaspidoalbinol (III).[8,10] Reduction of 20 mg of 21-oxo-O-methyl-N-desacylaspidoalbine (If) with 30 mg of $LiAlH_4$ in 10 ml of ether for 2 hr, followed by recovery with a saturated aqueous solution of Na_2SO_4 (reflux and filtration), gave 20 mg, purified on 5 g of neutral alumina III in benzene. Elution with benzene–EtOAc 1:1 gave a single homogeneous compound, identical with authentic III[8] by thin layer chromatography (R_f and color reaction with $CeSO_4$, including a mixture of the two materials) and infrared spectrum, poorly crystalline as is III.

Deuterations. α-Deuterations of lactones were unreported when we began these experiments; we chose relatively mild basic conditions and achieved good results.

21-Oxo-O-methylaspidoalbine (Ig) (20 mg) was treated with 4 ml of MeOD, 1 ml of D_2O, and 50 mg of Na_2CO_3 at reflux 8 hr. The solvent was evaporated under reduced pressure and the product (15 mg) recuperated with D_2O and $CHCl_3$. Crystallization from acetone–hexane gave 5 mg, mp 178–182°, ν_{max}^{KBr} 2080 cm^{-1} with considerable changes from the spectrum of starting material in the 1400 cm^{-1} region. For the mass spectrum, refer to Table I.

Identical treatment of 15 mg of dichlotamine (Ib), followed by evaporation and repeat treatment for 8 hr with MeOD–D_2O, gave 15 mg which upon crystallization from ether–hexane yielded 9 mg, mp 170–260°, partially deformylated by infrared spectrum and thin layer chromatography. Reacylation of the total mixture with 5 ml of formylating solution (Ac_2O–HCOOH 1:1 preheated at 70° for 1 hr) for 4 days in the dark, with recuperation by aqueous NH_3 and $CHCl_3$, gave 15 mg which upon crystallization from acetone–hexane yielded 9 mg, mp 257–260°, ν_{max}^{KBr} 2080 cm^{-1}, no 1400 cm^{-1}; for mass spectrum, refer to Table I.

(11) Melting points (uncorrected) were determined on a Kofler block. Infrared spectra are on a Perkin-Elmer Model 137 Infracord; ultraviolet spectra on a Perkin-Elmer Model 202 Ultracord.

(12) This species was localized in "caatinga" (open woodland) by a large waterfall on a tributary of the upper Cuieiras River near Manaus, Amazonas, by Dr. W. Rodrigues of the Instituto Nacional de Pesquisas da Amazonia. We are grateful to Dr. Benjamin Gilbert for its collection.