These data appear to be consistent with a localization of the charge and radical site in the vicinity of the aminobenzyl group for most of the molecular ions formed from III. If ionization occurs by loss of an electron from the butyrophenyl ring in III, transfer of charge to the other ring apparently occurs rapidly, in keeping with the quasi-equilibrium theory.[13] Spiteller has objected to this theory, postulating that the bombarding electrons excite a particular site in the molecule before ionization.[14] It would appear to us that the cross section of the butyrylphenyl group for such a primary excitation[14] would not be greatly different in compounds I and III, in sharp contrast to the observed difference in their reactivities.

Previous correlative evidence[2-4] for the increase in reactivity upon ionization of the carbonyl group[15] is similar to the evidence for other functional groups, thus supporting the application of the localized charge concept in interpreting and predicting the mass spectra of other types of compounds.

as (M − C_2H_4 − C_2H_4), (M − C_2H_4 − C_3H_7), and (M − C_2H_4 − C_4H_7O), are of very low abundance and may be due in part to the loss of C_2H_4 from the center of the molecule. Also, abundances of the (M − C_2H_4) and (M − C_3H_7) ions of this compound do not exhibit the statistical factor of 2 expected in comparison to the compounds in which one C_3H_7CO group is replaced by H or NO_2.

(13) A. L. Wahrhaftig, "Mass Spectrometry," R. I. Reed, Ed., Academic Press Inc., New York, N. Y., 1965, p 137, and references cited therein.

(14) G. Spiteller and M. Spiteller-Friedmann, *Ann. Chem.*, **690**, 1 (1965).

(15) This is similar to its reactivity increase upon excitation to the n,π* state, which suggests similar transition states for the analogous unimolecular reactions induced by photon and electron impact.[4] This does not rule out, however, the possibility that some mass spectral decompositions arise from other excited states, such as those similar to intermediates in thermal reactions.[6] Note also that these effects were observed in odd-electron ions, whose behavior is known to differ from that of even-electron ions.[3,4]

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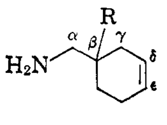
Received June 15, 1967

One-Step Synthesis of Bridged Aziridines

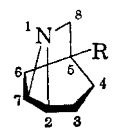
Sir:

Recently, the chemistry of aziridines,[1] the simplest nitrogen heterocycles, has received increasing interest in the field of synthetic organic chemistry because of their high reactivity and also in relation to nitrene chemistry.[2] We wish to report the first synthesis of 1-azatricyclo[3.2.1.$0^{2,7}$]octane derivatives which have been known only as hypothetical intermediates in alkaloid chemistry.[3]

This method consists of oxidation of δ,ε-unsaturated primary amines **1** to highly strained bridged aziridines **2** and represents a new method for aziridine synthesis.

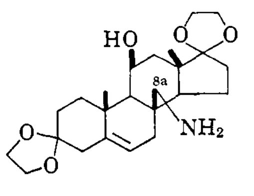


1a, R = CH_3
b, R = H



2

In connection with study on 8β-functionated steroids, N-chlorination of the amine **3** was attempted. Treatment of **3** with 1 equiv of N-chlorosuccinimide (NCS) in methylene chloride yielded, as a basic product, the aziridino compound **4a**[4] [90%; $C_{24}H_{35}O_5N$; mp 261–262°; $[\alpha]^{28}D$ −8.0° (ethanol)]. The structure of **4a** is assigned on the basis of the following evidence.



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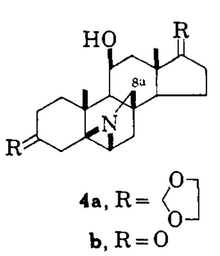
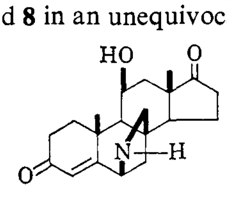


4a, R =
b, R = O

Compound **4a** has a lower pK_a value (7.17) than the 8.81 of **3**. No double bond absorption is observed in its infrared and Raman spectra. A sharp singlet for C-8a protons at τ 7.16 and a signal for a vinyl proton at 4.79 in **3** are absent in the nmr spectrum of **4a**, and an AB-type quartet (J = 11.4 cps) appeared at τ 6.38 and 7.40. Corroborative evidence for **4a** was obtained by transformation into the known compound **7** [$C_{22}H_{35}O_3N$; mp 215–219°; $[\alpha]^{23}D$ +127.8°; λ_{max} 241.0 mμ (ε 15,800); ν_{max} 3610, 3450 (-OH), 2800, 2770 (-N-$(CH_3)_2$), 1733 (C=O), 1667, 1617 cm^{-1} (Δ^4-3-keto)].

Cautious hydrolysis of **4a** with dilute hydrochloric acid gave the diketone **4b** [$C_{20}H_{29}O_3N$; mp 226–230° dec; $[\alpha]^{23.5}D$ +89.0°; λ_{max} 284.5 mμ (ε 110); ν_{max} 3640 (OH), 1736, 1710 cm^{-1} (C=O)], which on basic treatment was converted into the pyrrolidine **5** [$C_{20}H_{29}O_3N$; mp 270–280° dec; $[\alpha]^{24}D$ +129.3° (methanol); λ_{max} 240.7 (ε 14,000), 325 mμ (ε 176); ν_{max}^{Nujol} 3345 (OH), 1736 (C=O), 1674, 1616 cm^{-1} (Δ^4-3-keto)]. Quaternization with methyl iodide in the presence of potassium carbonate afforded the salt **6** [$C_{22}H_{34}O_3NI \cdot 0.5H_2O$; mp 272–277° dec; $[\alpha]^{24}D$ +93.6° (methanol); λ_{max} 221.7 mμ (ε 22,500); ν_{max}^{Nujol} 3350 (OH), 1738 (C=O), 1660, 1604 cm^{-1} (Δ^4-3-keto)], which was treated with zinc to give **7**. This compound was prepared from the corresponding 8β-cyano-11-oxo-Δ^5-steroid **8** in an unequivocal manner.[5]



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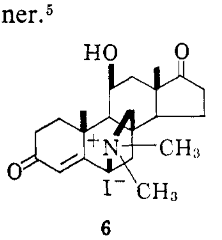

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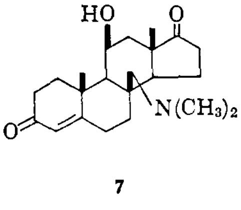

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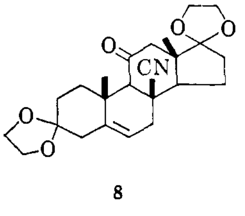

8

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(1) P. E. Fanta in "Heterocyclic Compounds with Three and Four Membered Rings," Part 1, A. Weissberger, Ed., Interscience Publishers, Inc., New York, N. Y., 1964, Chapter 2.

(2) L. Horner and A. Christmann, *Angew. Chem.*, **75**, 707, (1963); R. A. Abramovitch and B. A. Davis, *Chem. Rev.*, **64**, 149 (1964).

(3) G. Büchi, D. L. Coffen, K. Kocsis, P. E. Sonnet, and F. E. Ziegler, *J. Am. Chem. Soc.*, **88**, 3099 (1966); J. W. Huffman, T. Kamiya, and C. B. S. Rao, *J. Org. Chem.*, **32**, 700 (1967).

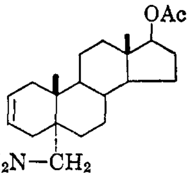
(4) Satisfactory elemental analyses have been obtained for all compounds with formulas cited. Unless otherwise stated, infrared spectra were measured in chloroform, ultraviolet spectra in 95% ethanol, and specific rotation in chloroform.

(5) The synthetic pathway will be described in detail in a full paper.

Table I

Compd	Bp, °C (mm)	pK_a	ν, cm^{-1}	Nmr (>N—CH$_2$), τ (J, cps)	Picrate mp, °C	Flavanate mp, °C	n_D (T, °C)
12	65–70 (0.03)		3024, 2987 1227, 1213	6.85, d (11.5) 7.72, d (11.5)	162–164	180 dec	1.5086 (24)
2a	25 (0.2)	8.50	3015, 2997 1219	7.26, d (11.5) 7.47, d (11.5)	158–160	187–189	1.4753 (23)
2b		8.34	3010, 1212		214–217 dec		

Lead tetraacetate in benzene was also found to be an excellent oxidant[6] and converted **3** into **4a** almost quantitatively. With yellow mercuric oxide in ethylene glycol, oxidation was partially successful to give a 21% yield of **4a**. Compound **9** on treatment with either NCS or lead tetraacetate afforded **10** ($C_{22}H_{33}O_2N$; mp 236–240° dec; $[\alpha]^{23}D$ +41.0°; ν_{max} 1725 cm^{-1}) in 71 and 80% yields, respectively.



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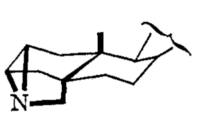
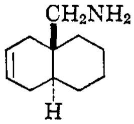


10

Oxidation of **11**, **1a**, and **1b** with NCS yielded fairly stable monochloramines which could not be smoothly changed by pyrolytic decomposition into the aziridines **12**, **2a**, and **2b**.[7] However, oxidation with lead tetraacetate and potassium carbonate gave good results. The bridged aziridines **12**, **2a**, and **2b** were obtained in 55–60% yields. These bridged aziridines are volatile oils and quite unstable.[8] They readily polymerize at room temperature and cannot be distilled without polymerization. On the other hand, the aziridine salts are stable.



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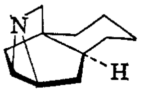

12

Physical properties are summarized in Table I. Infrared bands at around 3000 and 1220 cm^{-1}, characteristic of the aziridine ring,[9] an AB-type quartet patterns of the methylene group attached to the nitrogen atom in the nmr spectra, and lower pK_a values support the assigned structures. Chemical evidence will be presented in the forthcoming paper.

Acknowledgment. We wish to thank Mr. M. Yoshioka for participation in this work.

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(6) To our knowledge, aromatic primary amines are oxidized to diazo compounds (K. H. Pausacker and J. G. Scroggie, *J. Chem. Soc.*, 4003 (1954)) and aliphatic primary amines to the corresponding carbonitriles probably through aldimines (M. Lj. Mihailovic, A. Stojikovic, and V. Andrejevic, *Tetrahedron Letters*, 461 (1965)). Our result is quite striking when compared with these results.

(7) It is suspected that cyclization of **11**, **1a**, and **1b** may not be effected because of low rigidity of the molecules; that is, the functionated amidomethyl group cannot always be close to the double bond in the ground state, particularly in **1b**.

(8) The relatively low yields may be partly due to unstability and volatility.

(9) K. C. Tsou, K. Hoegerle, and H. C. F. Su, *J. Med. Chem.*, **6**, 435 (1963); J. B. Patrick, R. P. Williams, W. E. Meyer, W. Fulmor, D. B. Cosulich, R. W. Broschard, and J. S. Webb, *J. Am. Chem. Soc.*, **86**, 1889 (1964).

A New Method for Isoquinuclidine Synthesis. A Total Synthesis of Desethylibogamine

Sir:

The isoquinuclidine nucleus forms a part of alkaloids such as ibogaine[1] and dioscorine.[2] Most previous methods for preparing the nucleus comprise either internal condensation[3] of a *cis*-4-aminocyclohexanecarboxylic acid ester followed by reduction of the resulting lactam or the Diels–Alder reaction[4] of 1,2-dihydropyridine with a dienophile. Recently, Cava and his co-workers[5] developed a new method consisting of the Diels–Alder reaction of a methyleneurethan with cyclohexadiene.

Strained tricycloaziridine and its derivatives reported in a previous paper[6] are highly reactive and useful for the preparation of isoquinuclidines. We wish to report a new method for preparing isoquinuclidines and a total synthesis of desethylibogamine. When the bridged aziridines **1a–c** were treated with an acylating agent such as acyl halide or acid anhydride (RX) in an appropriate solvent such as ether, acetone, or pyridine, facile cleavage[7] of the aziridine ring occurred, giving in excellent yield a 4:1 mixture of the isomeric azabicyclo[2.2.2]- and -[3.2.1]octane compounds **2** and **3**. Both isomers can be readily differentiated by nmr spectra, since the signal of the bridgehead proton at C_1 and the methyl signal at the other bridgehead (C_4) of isoquinuclidines **2** (in the case of $R_1 = CH_3$; $R_2 = H$) appear at higher fields by 10–20 and 12 cps, respectively, than the signals of the azabicyclo[3.2.1]octane ring compound

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(1) For a review of the iboga-type alkaloids, see H-G. Boit, "Ergebnisse der Alkaloid Chemie bis 1960," Akademie-Verlag, Berlin, 1961, p 631.

(2) W. A. M. Davies, I. G. Morris, and A. R. Pinder, *Chem. Ind.* (London), **35**, 1410 (1961).

(3) J. W. Huffman, C. B. S. Rao, and T. Kamiya, *J. Org. Chem.*, **32**, 697 (1967); E. Ferber and H. Bruchner, *Ber.*, **75B**, 425 (1952); **76B**, 1019 (1953); L. H. Werner and S. Ricca, Jr., *J. Am. Chem. Soc.*, **80**, 2733 (1958); W. Schneider and R. Dillmann, *Ber.*, **96**, 2377 (1963).

(4) G. Büchi, D. L. Coffen, K. Kocsis, P. E. Sonnet, and F. E. Ziegler, *J. Am. Chem. Soc.*, **88**, 3099 (1966); O. Mumm and J. Diedrichsen, *Ann.*, **538**, 195 (1939); K. Schenker and J. Druey, *Helv. Chim. Acta*, **42**, 1960 (1959); **45**, 1344 (1962); M. Saunders and E. H. Gold, *J. Org. Chem.*, **27**, 1439 (1962); T. Agawa and S. I. Miller, *J. Am. Chem. Soc.*, **83**, 449 (1961).

(5) M. P. Cava, C. K. Wilkins, Jr., D. R. Dalton, and K. Bessho, *J. Org. Chem.*, **30**, 3772 (1965).

(6) W. Nagata, S. Hirai, K. Kawata, and T. Aoki, *J. Am. Chem. Soc.*, **89**, 5045 (1967).

(7) J. E. Dolfini and D. M. Dolfini, *Tetrahedron Letters*, 2053 (1965).