# Reaction of 5*H*-Dibenz[*b*,*f*]azepine with *t*-Butyl Hypochlorite: An Aromatic Nitrenium Ion Intermediate?



Michael C. Cann* and David Lezinsky

Department of Chemistry, University of Scranton,
Scranton, PA 18510

Received November 16, 1987

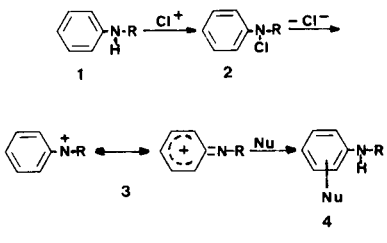
The reaction of 5*H*-dibenz[*b*,*f*]azepine with *t*-butyl hypochlorite and this same reaction in the presence of silver(I) were studied in an attempt to generate dibenz[*b*,*f*]azatropylium, an aromatic nitrenium ion. Analysis of the product mixture from this reaction mitigate against formation of this ion. An alternate mechanism is presented.

*J. Heterocyclic Chem.*, **25**, 863 (1988).

Nitrenium ions continue to attract the interest of many investigators for several reasons, including their potential as intermediates in many chemical reactions [1] especially the reactions of carcinogenic amino-, amide-, *N*-oxide and nitro-aromatics [2], and their synthetic application [3]. In order to increase our understanding of these intermediates, we investigated the potential for formation of an aromatic nitrenium ion.

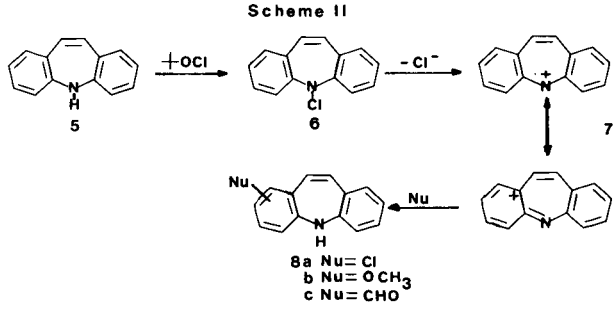
Gassman [4] demonstrated (Scheme I) that the *N*-chloroamines (**2**) generated from the reaction of aryl amines (**1**) with hypohalites, decompose by loss of chloride ion to yield aryl nitrenium ions (**3**). These delocalized nitrenium ions subsequently react with nucleophiles to yield ring substituted products (**4**). Addition of silver(I) promotes the loss of chloride ion and the formation of **3**.

Scheme I

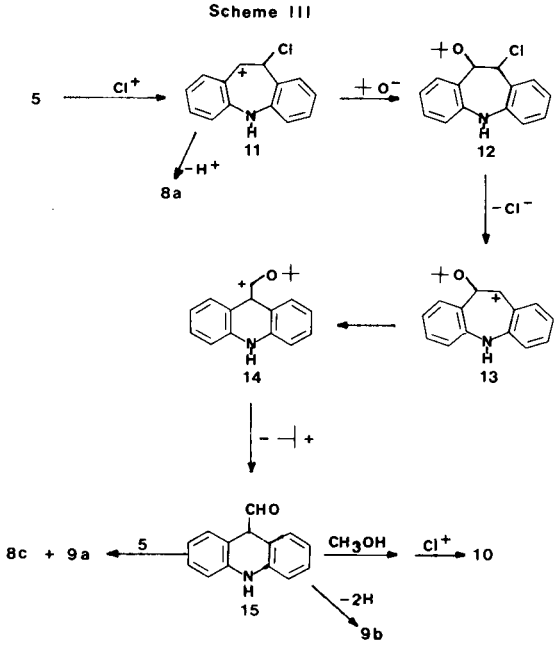


We envisioned a similar process for the formation of dibenz[*b*,*f*]azatropylium ion (**7**) (Scheme II). Reaction of 5*H*-dibenz[*b*,*f*]azepine (**5**) with *t*-butyl hypochlorite would produce the *N*-chloroamine (**6**), followed by loss of chloride ion resulting in the aromatic nitrenium ion (**7**). Nucleophilic attack on **7** would then yield ring substituted products (**8**).

Scheme II

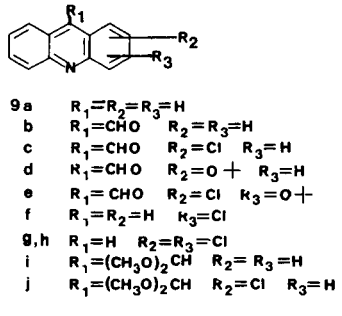


Scheme III



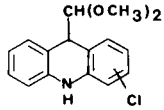
Results.

The reaction of equimolar amounts of **5** and *t*-butyl hypochlorite in methylene chloride at −78° results in a mixture of several compounds. Column chromatography enabled us to achieve a partial separation of products including unreacted **5** (47%) and acridine-9-aldehyde (**9b**) (24%). Attempts to further purify the remaining products



by column chromatography were unsuccessful. However, analysis of the entire reaction mixture by gc/ms confirmed the existence of **5** and **9b** and showed the presence of six additional products. Acridine (**9a**) (7%) was positively identified by comparison of the retention time and mass spectrum with an authentic sample. The remaining five products **8a** (1%), **8c** (5%), **9c** (4%), **9d** (10%) and **9e** (1%) were partially identified by their mass spectrum and are ring substitution products of **5** and **9a**.

The reaction of equimolar amounts of **5** with *t*-butyl hypochlorite in methylene chloride at −78° was repeated, and an equimolar amount of silver trifluoroacetate in methanol was added after fifteen minutes, while maintaining the temperature at −78°. Analysis of the product mixture by gc/ms indicated eleven products including **5** (7%), **9a** (37%) and **9b** (13%). The mass spectrum of the remaining eight products allowed for their partial structural identification as **8a** (1%), **8c** (23%), **9f** (7%), **9g** (3%), **9h** (1%), **9i** (4%), **9j** (1%) and **10** (2%).




**10**

Discussion.

The product mixture from this reaction is clearly more complicated than we expected, especially the ring contracted products **9**. However, the ring contraction of **5** is not without precedent. Reaction of **5** with Fremy's salt (potassium nitrosodisulphonate) gives **9b** in 37% yield [5]. Furthermore, we have found that reaction of **5** with silver(I) results in the quantitative formation of **9a** [6].

Although the products from the reaction of **5** with *t*-butyl hypochlorite can perhaps be rationalized by formation of the aromatic nitrenium **7**, and subsequent nucleophilic attack and/or ring contraction, in general we feel, the more direct route outlined in Scheme III is better suited to rationalize these products. Compound **8a** is formed by addition of positive chlorine to **5** followed by loss of a proton. Attack of the *t*-butoxide ion on **11**, followed by loss of chloride ion, ring contraction and ejection of a *t*-butyl carbonium ion yields, **15**. Aromatization of **15** yields **9b**, while formaldehyde transfer from **15** to **5** produces **8c** and **9a**. Electrophilic aromatic substitution by positive chlorine on **9b** yields **9c**. Compounds **9d** and **9e** are substitution products of **9b** and **9c**.

As stated previously, Gassman [4] found that addition of silver(I) in methanol promotes the loss of chloride from *N*-chloroaryl amines **2** resulting in the formation of arylnitrenium ions **3** which subsequently undergo nucleophilic attack by methanol (Scheme I). In view of Gassman's discovery, we chose to add silver(I) to the reaction of **5** with *t*-butyl hypochlorite. If the *N*-chloroamine **6** is indeed an intermediate in this reaction, then silver should facilitate the loss of chloride from **6** yielding the aromatic nitrenium ion **7** and subsequently **8a** and **8b**.

As can be seen from the product mixture, the major effect of the addition silver(I) on this reaction is an increase in the amount of **9a** from 7% in the absence of silver(I), to 37%. Since a major decrease in the amount of unreacted **5** (47% to 7%) also occurs with the addition of silver(I), we believe the silver(I) reacts directly with **5**, and not with **6** to produce **9a**. This conclusion is consistent with our previously mentioned observation of the quantitative conversion of **5** to **9a** upon reaction of 1 equivalent of **5** with 4 equivalents of silver(I) [6]. Thus, we are inclined to further discount reaction of **5** with *t*-butyl hypochlorite by the nitrenium ion mechanism (Scheme 2). Furthermore, if the addition of silver(I) in methanol did promote the conversion of **6** to **7**, we should observe significant amounts of methoxy substituted products **8b**. However, the only products where methanol appears to have been incorporated are the acetals **9i**, **9j**, and **10** which are formed from the aldehydes **9b**, **9c** and **15** by direct reaction with methanol. This further supports the mechanism outlined in Scheme III over the mechanism in Scheme II [7].

## EXPERIMENTAL

5*H*-Dibenz[*b*,*f*]azepine (**5**) and silver trifluoroacetate were purchased from Aldrich Chemical Co., Milwaukee, Wisconsin, *t*-butyl hypochlorite from Frinton Laboratories, Vineland, N. J. and were used without further purification. The gc/ms were obtained on a Hewlett Packard Model 5995C equipped with a 12 meter fused silica capillary column OV101.

Reaction of 5*H*-Dibenz[*b*,*f*]azepine (**5**) with *t*-Butyl Hypochlorite.

To a solution of **5** (0.58 g, 3.0 mmoles) in methylene chloride (40 ml) at −78°, was added dropwise a solution of *t*-butyl hypochlorite (0.36 g, 3.3 mmoles) in methylene chloride (10 ml) while maintaining the temperature at −78°. The reaction mixtures is stirred for 4 hours at −78°, allowed to warm to room temperature overnight and extracted with 10% sodium hydroxide (2 x 50 ml). The organic layer was dried over sodium sulfate (a small portion of this solution is retained for gc/ms analysis) and the solvent removed *in vacuo*. Chromatography (alumina, chloroform, methanol) afforded **5** (47%), **9b** (23%) and an inseparable (by column chromatography) mixture. Analysis of the entire reaction mixture by gc/ms confirms the formation of **5** and **9b** and reveals the presence of **9a** (7%) and four other products **8a** (1%), **8c** (23%), **9c** (4%), **9d** (10%) and **9e** (1%) whose structures were partially revealed by their mass spectrum. The yield of **9a** was determined by comparison of gc peak area with that of an internal standard of benzophenone. The yields of **8a**, **8c**, **9c**, **9d** and **9e** are estimates based solely on the relative peak areas of these compounds.

The following data was obtained from the mass spectrum, m/z (relative intensity) **5**, 193 (100, M+), 165 (14); **8a**, 229 (33), 227 (100, M+); 191 (17); **8c**, 221 (100, M+), 192 (100); **9a**, 179 (100, M+), 151 (10), 89 (10); **9b**, 207 (99, M+), 179 (100), 150 (12%); **9c**, 243 (33), 241 (100, M+), 213 (60), 206 (30%), 178 (49); **9d**, 279 (36, M+), 223 (100), 206 (10), 178 (9); **9e**, 315 (7), 313 (22, M+), 259 (33), 257 (100), 240 (10), 212 (10), 177 (8).

Reaction of 5*H*-Dibenz[*b*,*f*]azepine (**5**) with *t*-Butyl Hypochlorite and Silver Trifluoroacetate.

To a solution of **5** (0.58 g, 3.0 mmoles) in methylene chloride (40 ml) at

−78°, was added dropwise a solution of *t*-butyl hypochlorite (0.36 g, 3.3 mmoles) in methylene chloride (10 ml) while maintaining the temperature at −78°. After 15 minutes at −78° silver trifluoroacetate (0.66 g, 3.0 mmoles) in methanol (40 ml) was added dropwise, while maintaining the temperature at −78°. The solution was stirred at −78° for 4 hours, allowed to warm to room temperature overnight, and filtered. Analysis of the remaining solution by gc/ms afforded **5** (7%), **9a** (37%) and **9b** (10%) and allowed for the partial identification of **8a** (1%), **8c** (23%), **9f** (7%), **9g** (3%), **9h** (1%), **9i** (4%), **9j** (1%), and **10** (2%). The yields of **5**, **9a** and **9b** were determined by comparison of gc peak areas with that of an internal standard of benzophenone. The yields of **8a**, **8c**, **9f-i** and **10** are estimates based solely on the relative peak areas of these compounds.

The following data was obtained from the mass spectrum m/z (relative intensity), **9f**, 215 (33), 213 (100, M+), 178 (18); **9g**, 251 (11), 249 (67), 247 (100, M+), 212 (13), 177 (13); **9h**, 251 (13), 249 (68), 247 (100, M+), 212 (17), 177 (18); **9i**, 253 (56, M+), 222 (100), 207 (19), 179 (36), 75 (16); **9j**, 289 (14), 287 (40, M+), 256 (100), 241 (14), 213 (20), 178 (13), 75 (15); **10**, 291 (3), 289 (11, M+), 258 (10), 214 (83), 178 (9), 75 (100).

Acknowledgements.

Support of this work by the Petroleum Research Fund (PRF #8950-G1), administered by the American Chemical Society and the University of Scranton Faculty Research and Development Fund is gratefully acknowledged. The gc/ms used in this work was purchased with the aid of a CSIP grant from National Science Foundation to T. A. Dickneider who assisted in obtaining the gc/ms data.

## REFERENCES AND NOTES

[1] J. C. Fishbein and R. A. McClelland, *J. Am. Chem. Soc.*, **109**, 2824 (1987) and references therein.

[2] P. G. Gassman and J. E. Granrud, *J. Am. Chem. Soc.*, **106**, 1498; M. Demevnynck, N. Tohme, M. Lhomme, J. M. Mellor and J. Lhomme, *ibid.*, **108**, 3539 (1986); J. C. Parham and M. A. Templeton, J. D. Scribner, *J. Org. Chem.*, **41**, 3820 (1976); M. Novak and A. K. Roy, *ibid.*, **50**, 571 (1985); M. Pelecanov and M. Novak, *J. Am. Chem. Soc.*, **107**, 4499 (1985); J. C. Parham and M. A. Templeton, *Cancer Res.*, **40**, 1475 (1980).

[3] R. A. Abramovitch, R. Jeyaraman and K. Yannakopoulov, *J. Chem. Soc., Chem. Commun.*, 1107 (1985); R. A. Abramovitch, A. Hawi, J. A. R. Rodriques and T. R. Trombetta, *ibid.*, 283 (1986); H. Takeuchi, K. Koyama, M. Mitani, R. Ihara, T. Uno and Y. Okazaki, *J. Chem. Soc., Perkin Trans. 1*, 677 (1985); R. A. Abramovitch and R. Jeyaraman, "Azides and Nitrenes: Reactivity and Utility", E. F. V. Scriven, ed, Academic Press, 1984, pp 297-357; Y, Kikugawa and M. Kawase, *J. Am. Chem. Soc.*, **106**, 5728 (1984).

[4] P. G. Gassman, G. A. Campbell and R. C. Frederick, *J. Am. Chem. Soc.*, **94**, 3884 (1972); P. G. Gassman and G. A. Campbell, *ibid.*, **94**, 3891 (1972).

[5] K. E. Haque and G. R. Protor, *J. Chem. Soc., Chem. Commun.*, 1412 (1968); K. E. Haque, K. M. Hardie, and G. R. Proctor, *J. Chem. Soc., Perkin Trans. 1*, 539 (1972).

[6] M. C. Cann, *J. Org. Chem.*, in press. The nitrenium ion **7** is suggested as a possible intermediate in this reaction.

[7] Our observations do not rule out the possibility that **6** has decomposed prior to addition of the silver(I). However, the *N*-chloroarylamines investigated by Gassman [4] are stable at 0° and some decompose only slowly even at room temperature. Although **6** would decompose to the aromatic **7**, we felt that at −78° **6** should have a half-life on the order of hours.