Tetrahedron Letters,Vol.27,No.32,pp 3705-3708,1986 0040-4039/86 $3.00 + .00
Printed in Great Britain Pergamon Journals Ltd.

REMOTE INTRAMOLECULAR FUNCTIONALIZATION OF ARYLNITRENIUM IONS: SYNTHESIS OF AMINO-DIHYDROPHENANTHRIDINES AND BENZO[c]CHROMANS

Rudolph A. Abramovitch,* Melanie M. Cooper, Ramasubbu Jeyaraman, and Grzegorz Rusek
Department of Chemistry, Clemson University,
Clemson, SC 29634-1905, U. S. A.

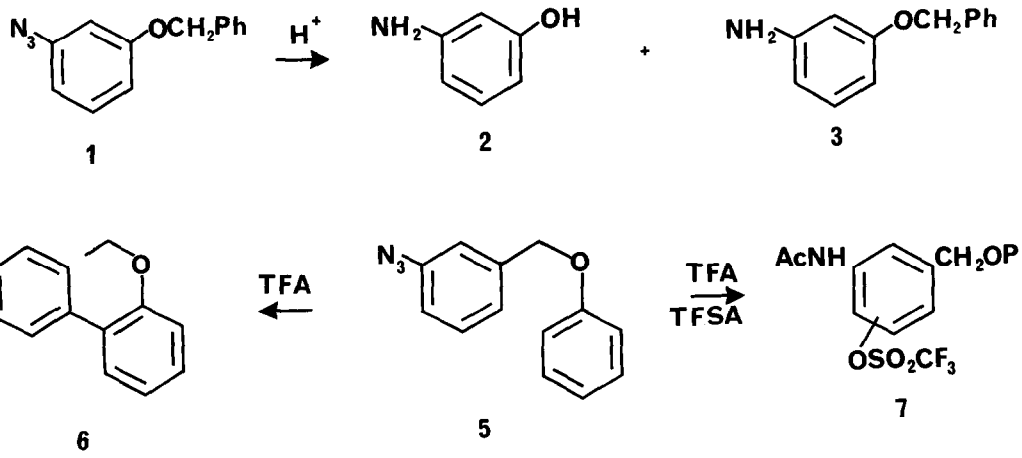
Abstract- 4-Aminobenzo[c]chroman (**6**) and 3-amino-5-acetyl-5,6-dihydrophenanthridine (**9**) are synthesized by intramolecular trapping of the delocalized nitrenium ions from 3-azidobenzyl phenyl ether and 3-azido-*N*-benzylacetanilide, respectively. On the other hand, no cyclization product is obtained from 3-azidophenyl benzyl ether, possibly owing to an *ortho*-effect exerted by the oxygen atom *ortho* to the developing π-aryl cation.[1]

A novel *ortho*-effect was observed in the intramolecular cyclization of aryloxenium ions to form C-C bonds.[1] It was found that if an oxygen atom was present at the position *meta* to the oxenium ion (*ortho* to the delocalized π-carbenium ion) no intramolecular cyclization to form 5- or 6-membered rings took place. Seven-membered ring formation took place in very low yield. On the other hand, if the *meta*-oxygen was replaced by methylene a six-membered ring formed readily. This was tentatively ascribed[1] to the imposition by the oxygen *ortho* to the π-aryl cation of a rotational conformation on the aryloxy or arylalkoxy group in which intramolecular attack by the cation is geometrically unlikely. This also appears to be the case with the corresponding arylnitrenium ion as suggested by the experiments described below.

We have shown[2] that six-membered rings can be prepared readily by intramolecular cyclizations at aromatic carbon by the acid-catalyzed decomposition of aryl azides, and that seven-membered rings can also be formed from the corresponding arylnitrenium ions.[3] We now report the synthesis of amino-dihydrophenanthridines and -benzo[c]chromans from the appropriate azides.

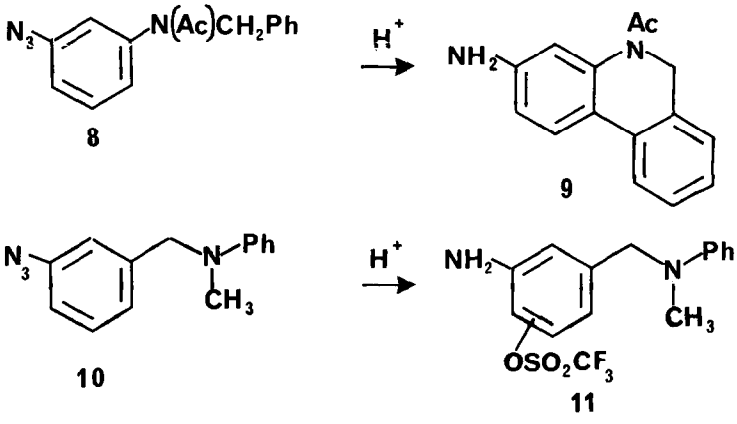
3-Azidophenyl benzyl ether (**1**),[4] bp 110-115°C/0.05 mm, (obtained in 94% yield from 3-benzyloxyaniline) was decomposed at 0°C in trifluoroacetic acid (TFA) with trifluoromethanesulfonic acid (TFSA) to give *m*-aminophenol (**2**) (71.4%) and 3-benzyloxyaniline (**3**) (28.5%). GC/MS analysis indicated that if any cyclization product (**4**) was formed it was present in less than 0.1% yield.

Quite different results were obtained when the relative positions of the oxygen and methylene functions in the side chain of 1 were inverted. Thus, 3-azidobenzyl phenyl ether (**5**)[4] (88.5% yield from the corresponding amine), mp 41-43°C, decomposed in TFA at room temperature for 20h to give 4-aminobenzo[c]-chroman (**6**) (44%), mp 120-121°C.[5] Removal of the oxygen ortho to the developing π-cation (**5** compared with **1**) once again seems to eliminate the ortho-effect preventing cyclization.[2] When the decomposition was carried out with TFSA in TFA no **6** was obtained. Instead, the arylnitrenium ion was trapped by trifluoromethanesulfonate to give an amine which, on acetylation (Ac_2O) gave 2- or (4-)trifluoromethylsulfonoxy-5-acetamidobenzyl phenyl ether (**7**)[4] (36%), mp 92.5-93.5°C.[6] The NMR spectral data suggest that the triflate has entered para rather that ortho to the amino group. Thus, triflate appears to be capable of forming hydrogen bonds with appropriate o-substituents,[7] and should do so with acetamido NH. Hydrogen-bonding by a nitro group ortho to CH_3CONH- leads to an appreciable downfield shift of the other ortho-hydrogen owing to the enforced Z-configuration of the carbonyl group.[8] This does not appear to occur with **7**. On the other hand, formation of a tight ion-pair would favor attack by triflate at the ortho-position. More work is needed to establish the orientation in this and other cases.



3-Azido-N-benzylacetanilide (**8**) (obtained in 87% yield from N-acetyl-N-benzyl-m-phenylenediamine, mp 105-106°C) decomposed in TFA containing TFSA at 0°C to give mainly 3-amino-5-acetyl-5,6-dihydrophenanthridine (**9**)[4](72%), mp

182-184°C, and traces of a second product. Thus, if the lone pair on ortho oxygen is responsible for the ortho-effect preventing intramolecular cyclization, conjugation of the nitrogen lone pair away from the benzene ring in the nitrenium ion from **8** would have countered that effect here. On the other hand, N-3-azidobenzyl-N-methylaniline (**10**), bp 105-110°C/10^{-5}mm decomposed with TFSA in TFA to give only a product (**11**) of trapping of the nitrenium ion by triflate (51.6%).[9] The presence of a fragment at m/e 210 in the mass spectrum of this compound suggests the formation of cyclized product by loss of CF_3SO_3 from $10^{+\cdot}$ and ring-closure and could indicate that the triflate group is ortho to $-CH_2N(Me)Ph$. Alternatively, hydrogen randomization in the cation via prismane and benzvalene structures (analogous to those which occur in benzene and the derived M - H ions[10]) would invalidate such a conclusion and, as with **7**, the orientation of the triflate group still remains to be determined. It seems likely that protonation of the amine group in **10** by the strong acid deactivates the aromatic nucleus sufficiently that triflate competes efficiently with the latter for the delocalized arylnitrenium ion so that no intramolecular cyclization is observed.



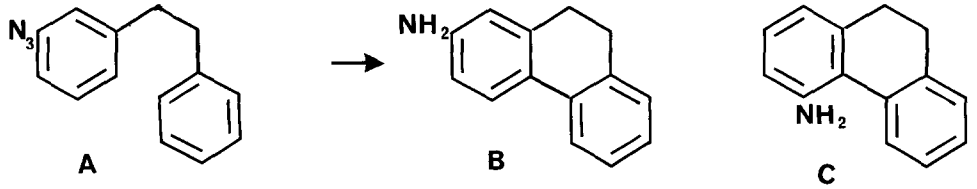
8 9 10 11

Acknowledgment. We thank the National Science Foundation (Grant CHE-8313525) for financial support of this work.

REFERENCES AND NOTES

1. Abramovitch, R. A.; Bartnik, R.; Cooper, M.; Dassanayake, N. L.; Hwang, H.-Y.; Inbasekaran, M. N.; Rusek, G. J. Org. Chem. 1982, 47, 4817. The suggestion that an oxygen atom ortho to the developing π-cation

exerted an "ortho-effect" was made to account for the observation that, in such cases, no intramolecular C-C bond formation took place, even when the substrate nucleus contained two activating methoxy groups, while intermolecular arylation of solvent (benzene or anisole) occurred readily. This was confirmed by replacing the ortho oxygen atom by a methylene group, which now led to intramolecular C-C bond formation in good yield. Similarly, compound **A** decomposed in the presence of TFA and TFSA at 0°C to give **B** (72.5%) and **C** (15.2%) (cf. **5** → **6** and **8** → **9**).[2]



A **B** **C**

2. Abramovitch, R. A.; Cooper, M.; Iyer, S.; Jeyaraman, R.; Rodrigues, J. A. R. J. Org. Chem. **1982**, 47, 4819.
3. Abramovitch, R. A.; Jeyaraman, R.; Yannakopoulou, K. J. Chem. Soc., Chem. Commun. **1985**, 1107.
4. All new compounds gave the expected microanalytical and spectral data.
5. **6**: IR (KBr) 3440, 3350 cm^{-1} (NH_2); NMR ($CDCl_3$) δ7.65-6.46 (m, 7H, ArH), 5.02 (s, 2H, CH_2), 3.48 (s, 2H, exchanges with D_2O, NH_2); mass spectrum m/e (rel. intensity) 197(100, $M^{+\cdot}$), 168(14.4), 98(9.3), 84(10.3).
6. **7**: IR (KBr) 3320(NH), 1660(C=O), 1405, 1150(OSO_2), 1205 cm^{-1}(CF_3); NMR ($CDCl_3$) δ7.62 (d, 1H, J = 3Hz, H_6), 7.45 (s, 1H, exchanges with D_2O, N**H**), 7.25 (d, 1H, J = 8Hz, H_3), 7.15 (s, 5H, $C_6\mathbf{H}_5$), 6.93 (dd, 1H, J = 8, 3Hz, H_4).
7. Kametani, T.; Takahashi, K.; Ogasawara, K. Synthesis **1972**, 473.
8. Appleton, J. M.; Andrews, B. D.; Rae, J. D.; Reichert, B. E. Aust. J. Chem. **1970**, 23, 1667. Baas, J. M. A. Recl. Trav. Chim. Pays-Bas **1972**, 91, 1287.
9. **11**: IR (film) 3490, 3400(NH_2), 1425, 1150(OSO_2), 1220 cm^{-1}(CF_3); NMR ($CDCl_3$) δ7.40-6.43 (m, 8H, Ar**H**), 4.50 (s, 2H, CH_2), 3.65 (br s, 2H, exchangeable, NH_2), 3.00 (s, 3H, CH_3); mass spectrum (rel. intensity) 360($M^{+\cdot}$, 100), 227(14), 210($C_{14}H_{14}N_2^+$, 18).
10. Williams, D. H.; Ronayne, J. Chem. Commun. **1967**, 1129. Jennings, K. Z. Naturforsch. **1967**, 22a, 454.

(Received in USA 28 February 1986)