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SYNTHESIS OF NOVEL CYCLIC SULFILIMINES, 2-AZATHIABENZENE DERIVATIVES(1)

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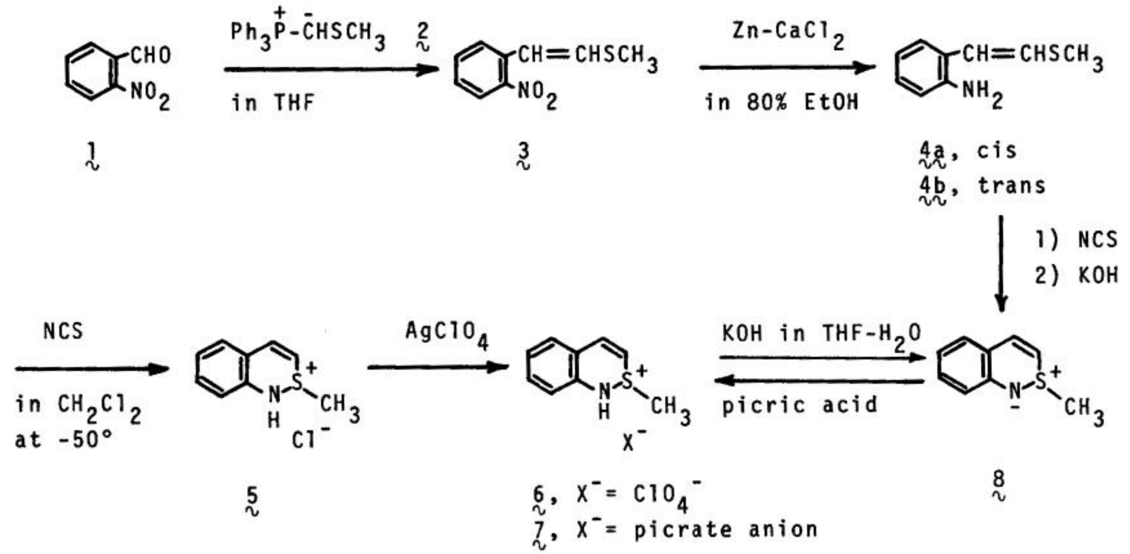
Summary: The synthesis and some properties of novel cyclic sulfilimines, 2-methyl-1-aza-2-thianaphthalene and 9-methyl-10-aza-9-thiaphenanthrene are described.

There have been many reports on the chemistry of sulfilimines, in particular, open-chain ones.(2) However, the chemistry of cyclic sulfilimines is not reported so much except the sulfilimines with N-sulfonyl or N-acyl group,(2) or two nitrogen atoms(3) in the rings. In connection with our interest in the aromaticities of cyclic sulfilimines, so-called "azathiabenzenes", in which sulfur-nitrogen bond forms part of a cyclic conjugated ring system containing six π-electrons, we succeeded in the first synthesis of novel cyclic sulfilimines, azathianaphthalene and azathiaphenanthrene.

The synthesis of the 1-aza-2-thianaphthalene derivative (8) was accomplished in the following manner. o-Nitrobenzaldehyde (1) was allowed to react with triphenylphosphonium methylthiomethylide (2)(4) in THF under nitrogen atmosphere with reflux to afford o-nitrostyryl methyl sulfide (3)(5) as a 1:1 mixture of cis and trans products, which were not able to be separated. Subsequently, this mixture was submitted to the reduction with zinc powder and calcium chloride in 80 % EtOH to give cis-(4a) and trans-o-aminostyryl methyl sulfides (4b) which were easily separated by column chromatography on silica gel using ether-$CHCl_3$-pet. ether (1:1:10) as an eluent. cis-Olefin (4a) was treated with equivalent amount of N-chlorosuccinimide (NCS) in CH_2Cl_2 at -50°, and then dry ether was added to precipitate 2-methyl-1-aza-2-thiochromenium chloride (5) which was treated with silver perchlorate in CH_2Cl_2 to give the corresponding perchlorate (6) with colorless needles (from hexane-CH_2Cl_2), mp 165-168° in 41 % yield: IR (KBr) ν max cm^{-1} 3270 (NH), 1100 (ClO_4^-); NMR (DMSO-d_6) δ 2.79 (3H, s, CH_3), 6.70 (1H, d, J=9 Hz, C_3-H), 7.00-7.70 (4H, m, ArH), 7.80 (1H, d, J=9 Hz, C_4-H). Treatment of 6 with KOH in THF-H_2O at room temperature yielded the expected 2-methyl-1-aza-2-thianaphthalene (8) with yellow prisms (from hexane-CH_2Cl_2), mp 129° (decomp.) in 57 % yield, which was moderately stable at room temperature: IR (KBr) ν max cm^{-1} 1600, 1255, 950, 920; NMR ($CDCl_3$) δ 2.20 (3H, s, CH_3), 5.70

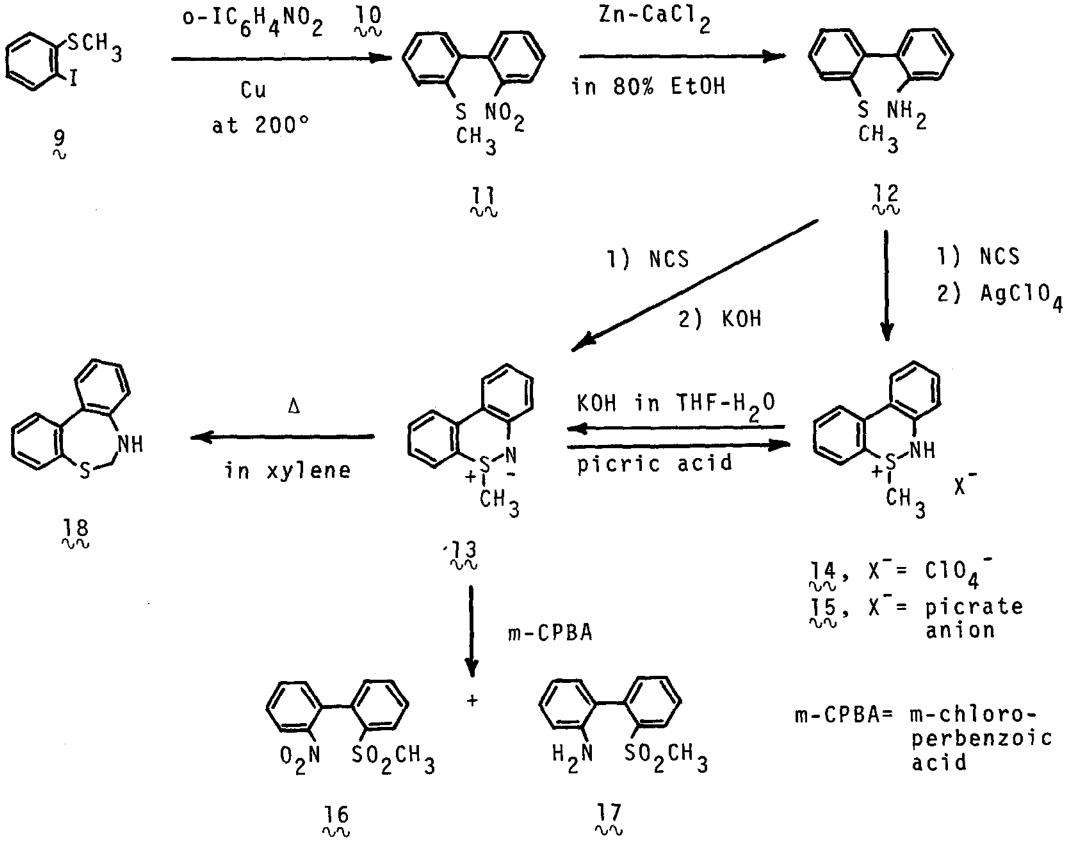


Scheme I

(1H, d, J=9 Hz, C_3-H), 6.75-7.45 (5H, m, ArH and C_4-H); MS (M^+) 163. The yield of 8 could be raised to 76 %, when the reaction mixture of 4a and NCS was directly treated with aqueous KOH solution. Attempts to prepare 6 or 8 from trans-olefin (4b) under the same reaction conditions were unsuccessful.

The nature of S-N bond in 8 is considered not to be ylenic but ylidic by the following observations: (a) The NMR spectrum of 8 showed a doublet (J=9 Hz) of C_3-H at δ 5.70 corresponding to an olefinic region. (b) Treatment of 8 with picric acid in ether afforded 2-methyl-1-aza-2-thiochromenium picrate (7) with yellow powder, mp 168-172° (decomp.) in quantitative yield.

The synthesis of 10-aza-9-thiaphenanthrene derivative (13) was also succeeded in the similar manner described above. Ullmann coupling reaction of o-iodophenyl methyl sulfide (9)$^{6)}$ and o-iodonitrobenzene (10)$^{7)}$ at 200° in the presence of copper powder gave 2-methylthio-2'-nitrobiphenyl (11) with yellow plates (from pet. ether), mp 40-42° in 51 % yield. Reduction of the nitro compound (11) using Zn-$CaCl_2$ in 80 % EtOH gave 2-amino-2'-methylthiobiphenyl (12) with colorless prisms (from hexane-benzene), mp 83-85° in 48 % yield. Reaction of the amino compound (12) with NCS in CH_2Cl_2 at -50°, followed by the deprotonation with aqueous KOH solution produced 10-methyl-9-aza-10-thiaphenanthrene (13) with yellow prisms (from hexane-CH_2Cl_2), mp 168-172° (decomp.) in almost quantitative yield: IR (KBr) ν max cm^{-1} 1595, 1460, 1420, 1290, 1230, 935; NMR ($CDCl_3$) δ 2.34 (3H, s, CH_3), 7.15-8.10 (8H, m, ArH); MS (M^+) 213. 9-Methyl-10-aza-10-thia-



Scheme II

phenanthrenium perchlorate (14) was isolated by adding silver perchlorate to the reaction mixture of 12 and NCS in CH_2Cl_2 in 64.1 % yield: colorless needles having mp 187-191°; IR (KBr) ν max cm^{-1} 3360 (NH), 1115 (ClO_4^-); NMR (DMSO-d_6) δ 2.93 (3H, s, CH_3), 3.75 (1H, br.s, NH), 7.25-8.45 (8H, m, ArH). Perchlorate (14) was also easily deprotonated with KOH in $THF-H_2O$ to yield 13 in quantitative yield. 13 was converted into azasulfonium picrate (15) by the reaction with picric acid in ether in 96.1 % yield, indicating that ylide-type bonding predominates in 13 as in the case of 8. It is reported that sulfilimines can be oxidized to the corresponding sulfoximides in good yields by reaction with potassium permanganate[8] or m-chloroperbenzoic acid.[9] However, when compound (13) was oxidized with such an oxidizing agent, ring-opening reaction occurred to give 2-nitro-2'-mesylbiphenyl (16) with yellow prisms (from ether-CH_2Cl_2), mp 145-146° and 2-amino-2'-mesylbiphenyl (17) with colorless plates (from ether-

CH_2Cl_2), mp 148-150° in yields of 10.9 and 6 %, respectively. Their structures were confirmed by the comparison of the melting points and the spectral data with those of authentic samples.

Although on standing at room temperature, **8** gradually decomposed to a complex mixture, **13** is very stable and can be stored indefinitely without change at room temperature. However, on refluxing in xylene for 3 hr, **13** underwent thermal ring expansion to give 1,3-thiazepin derivative (**18**) as an oil in 26 % yield: IR (neat) ν max cm^{-1} 3380 (NH); NMR ($CDCl_3$) δ 3.60 (1H, br.s, NH), 4.65 (2H, s, CH_2), 6.50-7.70 (8H, m, ArH); MS (M^+) 213.

We consider that the novel heterocyclic compounds synthesized as described above are very interesting and unique in the viewpoint of the electronic structure or chemical reactivities, comparing with well-known azathiabenzene oxides.10) Studies are being continued on the reactivities of them directing toward the synthesis of new heterocyclic compounds and on the X-ray crystallography.

REFERENCES AND FOOTNOTES

1) M. Hori, ACS/CSJ Chemical Congress, Honolulu, Hawaii, April 1979, Abstracts, ORGN-407.
2) For reviews: S. Oae, "Organic Chemistry of Sulfur", Plenum Press, N. Y. 383 (1977); Á. Kucsman, I. Kapovits, *Phosphorus and Sulfur*, **3**, 9 (1977); T. L. Gilchrist and C. J. Moody, *Chem. Revs.*, **77**, 409 (1977); N. Furukawa, *Kagaku no Ryoiki*, **32**, 31 (1978).
3) T. L. Gilchrist, C. W. Rees, and D. Vaughan, *Chem. Commun.*, 1978, 1049.
4) M. C. Caserio, R. E. Pratt, and R. J. Holland, *J. Amer. Chem. Soc.*, **88**, 5747 (1966).
5) Satisfactory analytical data were obtained for all new compounds.
6) Th. Zincke and G. Siebert, *Chem. Ber.*, **48**, 1242 (1915).
7) F. Ullmann, *ibid.*, **29**, 1878 (1896).
8) J. A. Franz and J. C. Martin, *J. Amer. Chem. Soc.*, **97**, 583 (1975); P. K. Claus, W. Rieder, P. Hofbauer, and E. Vilsmaier, *Tetrahedron*, **31**, 505 (1975).
9) D. J. Cram, J. Day, D. R. Rayner, D. M. von Schriltz, D. J. Duchamp, and D. C. Garwood, *J. Amer. Chem. Soc.*, **92**, 7363 (1970); J. G. Tillett, *Chem. Revs.*, **76**, 747 (1976).
10) T. R. Williams and D. J. Cram, *J. Amer. Chem. Soc.*, **93**, 7333 (1971); idem, *J. Org. Chem.*, **38**, 20 (1973); Y. Tamura, M. Tsunekawa, T. Miyamoto, and M. Ikeda, *ibid.*, **42**, 602 (1977); T. Fujiwara, T. Hombo, K. Tomita, Y. Tamura, and M. Ikeda, *Chem. Commun.*, 1978, 197.

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