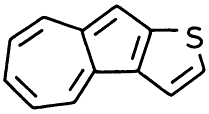
CHEMISTRY LETTERS, pp. 1721-1724, 1983.

SYNTHESIS OF AZULENO[1,2-b]- AND AZULENO[1,2-c]THIOPHENES BY THE REACTIONS OF 2H-CYCLOHEPTA[b]FURAN-2-ONES WITH ENAMINES OF 3-OXOTETRAHYDROTHIOPHENES

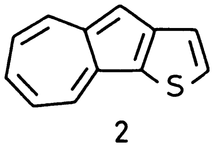
Kunihide FUJIMORI,* Takefumi FUJITA, Kameji YAMANE,
Masafumi YASUNAMI,† and Kahei TAKASE†
Department of Chemistry, Faculty of Science, Shinshu University,
Asahi, Matsumoto 390
† Department of Chemistry, Faculty of Science, Tohoku University,
Aramaki-aza-Aoba, Sendai 980

New heterocyclic compounds, azuleno[1,2-b]- and azuleno[1,2-c]thiophene, are synthesized by the reaction of 3-methoxycarbonyl-2H-cyclohepta[b]furan-2-one with morpholino enamines of 3-oxotetrahydrothiophene, followed by dehydrogenation of resulting dihydrocompounds with 2,3-dichloro-5,6-dicyano-p-benzoquinone.

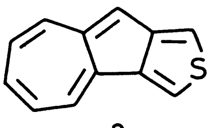
Among possible three isomers of azulenothiophenes which are consisted by condensation of azulene with thiophene at 1,2-position, only azuleno[2,1-b]thiophene (1) has been synthesized by two different methods.1) The authors (M. Y. and K. T.) have found the facile synthetic method of azulene derivatives by the reaction of 2H-cyclohepta[b]furan-2-ones with enamines.2) In this communication, we wish to report the synthesis of other two azulenothiophenes, azuleno[1,2-b]- (2) and azuleno[1,2-c]thiophene (3), by the application of this new azulene synthesis using enamines derived from 3-oxotetrahydrothiophenes.



1



2

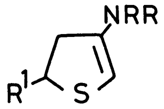
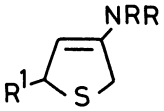


3

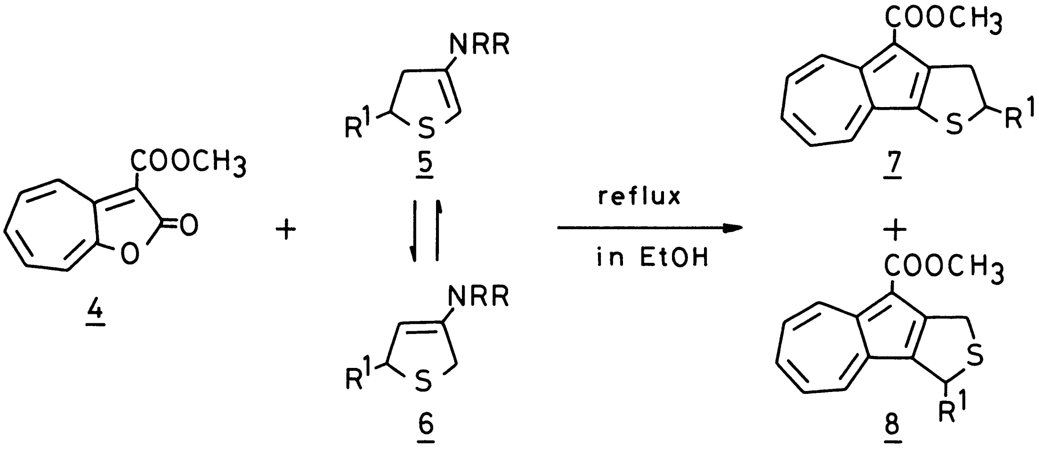
The condensation of 3-oxotetrahydrothiophene and its 5-methyl derivatives with morpholine and pyrrolidine gave isomeric mixtures of two enamines, respectively.3) The composition of these isomeric enamines was determined by ^{13}C NMR as shown in Table 1.4) Further separation of these bond isomers has not been successful.

A suspension of 3-methoxycarbonyl-2H-cyclohepta[b]furan-2-one (4)5) in anhydrous ethanol containing 3.5 molar equivalents of morpholino enamines (mixture of 5a and 6a in the above ratio) was refluxed for 90 h under an argon atmosphere. After evaporation of the solvent, the residual products were isolated by chromatography on silica gel using benzene-hexane as solvent to give methyl 1,2-dihydroazuleno[1,2-b]thiophene-9-carboxylate (7a)[bluish green prisms, mp 143-144 °C] and methyl 1,3-dihydroazuleno[1,2-c]thiophene-9-carboxylate (8a)[purple micro needles, mp 174-

Table 1. Composition of Isomeric Enamines

NRR	R^1				
Morpholino	H	5a	42%	6a	58%
	CH_3	5a'	43	6a'	57
Pyrrolidinyl	H	5b	28	6b	72
	CH_3	5b'	23	6b'	77

175 °C] in 66 and 21% yield, respectively. In a similar manner, the reaction of 4 with the morpholino enamines (5a' and 6a' in above ratio) yielded 7b [bluish green prisms, mp 84-85 °C] and 8b [purple micro needles, mp 147-149 °C] in 42 and 9% yields, respectively. In these azulene syntheses, the product ratio did not depend on the composition but on the reactivities of these enamines.6)

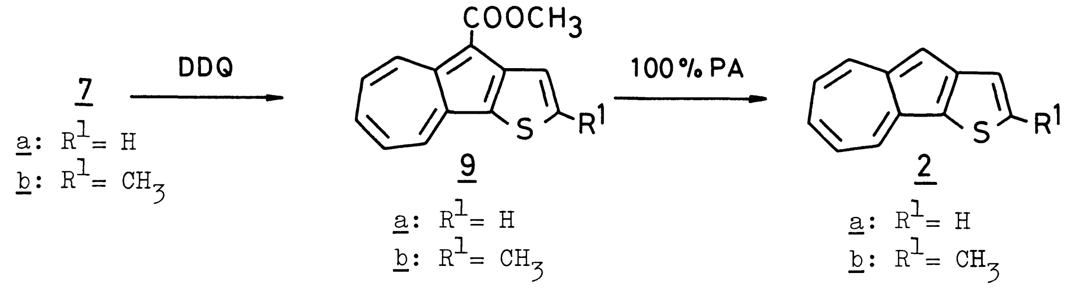


5, 6
a: R^1= H, NRR= morpholino
a': R^1= CH_3, NRR= morpholino

7, 8
a: R^1= H
b: R^1= CH_3

Dehydrogenation of these dihydroazulenothiophenes to azulenothiophenes was established in the following manner. Thus, a solution of 7a in benzene containing 1.2 molar equivalents of DDQ was refluxed for 3 h. After removing precipitated hydroquinone, the product was isolated by chromatography on alumina using benzene as solvent to give methyl azuleno[1,2-b]thiophene-9-carboxylate (9a) [greenish blue prisms, mp 109-110 °C] in a 73% yield.

Heating of 9a with 100% phosphoric acid at 90-95 °C resulted in demethoxycarbonylation to give azuleno[1,2-b]thiophene (2a) [green plates, mp 102-103 °C] in an almost quantitative yield. In a similar treatment of 7b, methyl 2-methylazuleno[1,2-b]thiophene-9-carboxylate (9b) [greenish blue prisms, mp 101-103 °C] (82% yield) and 2-methylazuleno[1,2-b]thiophene (2b) [green micro needles, mp 75-76 °C] (99% yield) were obtained. These azuleno[1,2-b]thiophenes were very stable at room temperature. Spectral data were shown in Table 2.

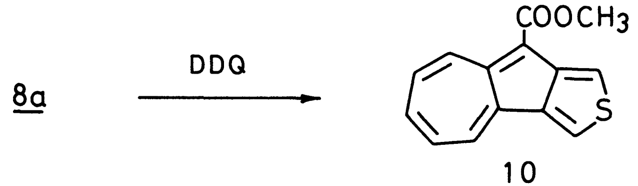


7
a: R^1= H
b: R^1= CH_3

9
a: R^1= H
b: R^1= CH_3

2
a: R^1= H
b: R^1= CH_3

Further, the dehydrogenation of 8a to azuleno[1,2-c]thiophene having an ortho-quinoid structure is interested. A solution of 8a in benzene was refluxed in the presence of 1.2 molar equivalents of DDQ for 3 h, and the product was isolated by column chromatography to give methyl azuleno[1,2-c]thiophene carboxylate (10) [yellowish brown prisms, mp 132 °C(decomp)] in 65% yield. This azuleno[1,2-c]thiophene derivative was fairly unstable at room temperature. The spectral data were shown in Table 2. The UV spectrum of 10 is similar to that of heptafluvene rather than azulene. The demethoxycarbonylation of 10 was unsuccessful so far.



10

The vicinal coupling constants on ^1H NMR of these azulenothiophenes indicate that 7-membered ring of 2a, 2b, 9a, and 9b exhibits some bond alternation.[7] The molecular structure of 2a has been determined by means of x-ray diffraction.[8] The molecule was planer within 0.06(2) Å. The observed bond alternation in 7-membered ring was in accordance with that suggested by the ^1H NMR.

The azulene synthesis by the reaction of 2H-cyclohepta[b]furan-2-one with pyrrolidinyl enamines (5b, 6b) did not give good results. Detailed studies are now in progress.

Table 2. Spectral Data of 2a-b, 9a-b, and 10

	UV λmax nm(log ε); ^1H NMR($CDCl_3$) δ ppm, J in Hz; ^{13}C NMR($CDCl_3$) δ ppm
2a	^1H NMR: 6.9-7.6(4H, m, H-5,6,7,9), 7.37(1H, d, J=5.1, H-1), 7.69(1H, d, J=5.1, H-2), 8.21(1H, dm, J=10.4, H-8), 8.31(1H, d, J=8.8, H-4) ^{13}C NMR: 109.6(d), 119.1(d), 122.1(d), 122.9(d), 130.3(s), 130.9(d), 133.0(s), 133.2(d), 135.7(d), 136.8(d), 142.6(s), 152.9(s) UV(in cyclohexane): 283(4.57), 307(4.69), 311(4.71), 314(4.66)(sh), 321(4.72), 325(4.76), 345(3.44), 361(3.73), 379(3.82), 398(3.76), 630(2.71), 670(2.65), 690(2.68), 740(2.32), 768(2.40)
2b	^1H NMR: 2.71(3H, d, J=1.0, CH_3-2), 6.9-7.6(5H, m, H-1,5,6,7,9), 8.21(1H, d, J=9.3, H-4), 8.22(1H, d, J=10.4, H-8)

^{13}C NMR: 17.5(q), 108.8(d), 117.4(d), 121.9(d), 122.5(d), 129.2(s), 130.1(d), 132.3(s), 135.0(d), 135.9(d), 142.4(s), 149.5(s), 153.7(s)

UV(in cyclohexane): 284(4.47), 311(4.69), 322(4.73), 350(3.42), 366(3.66), 385 (3.80), 405(3.90), 627(2.62), 663(2.57), 686(2.59), 736(2.24), 763(2.28)

9a ^{1}H NMR: 3.94(3H, s, COOC$\underline{H}_3$), 7.2-7.8(3H, m, H-5,6,7), 7.73(2H, d, J=1.3, H-1,2), 8.42(1H, d, J=9.1, H-4), 9.67(1H, dm, J=10.2, H-8)

^{13}C NMR: 51.0(q), 108.1(s), 121.3(d), 126.8(d), 127.9(d), 130.5(s), 132.9(d), 134.4(d), 135.5(s), 137.4(d), 137.4(d), 145.4(s), 153.2(s), 165.7(s)

9b ^{1}H NMR: 2.69(1H, d, J=1.0, C$\underline{H}_3$-2), 2.97(3H, s, COOC$\underline{H}_3$), 7.2-7.8(4H, m, H-1,5,6,7), 8.25(1H, d, J=8.9, H-4), 9.59(1H, dm, J=9.8, H-8)

^{13}C NMR: 17.4(q), 50.9(q), 107.2(s), 119.7(d), 126.4(d), 127.6(d), 129.4(s), 132.0(d), 135.0(s), 136.4(d), 136.5(d), 144.9(s), 151.1(s), 154.1(s), 165.6(s)

10 ^{1}H NMR: 3.94(3H, s, COOC$\underline{H}_3$), 6.8-7.2(3H, m, H-5,6,7), 7.7-7.9(1H, m, H-4), 7.41(1H, d, J=2.2, H-1 or 3), 7.82(1H, d, J=2.2, H-3 or 1), 8.8-9.0(1H, m, H-8)

^{13}C NMR: 51.1(q), 109.9(d), 110.4(s), 116.0(d), 129.3(d), 130.2(d), 130.7(d), 135.1(d), 135.6(d), 138.6(s), 140.1(s), 144.9(s), 151.4(s), 166.0(s)

UV(in cyclohexane): 227(4.37), 296(4.42), 305(4.40), 325(4.45), 355(4.10)(sh), 408(3.77), 433(3.92), 454(3.82), 464(3.85), 512(2.70), 555(2.70), 608(2.62), 675(2.27)(sh)

References

1) K. Matsui, Nippon Kagaku Zasshi, 82, 1517, 1520, 1522, 1665(1961); K. Yamane, K. Fujimori, and T. Takeuchi, Bull. Chem. Soc. Jpn., 54, 2537(1981).
2) P. W. Yang, M. Yasunami, and K. Takase, Tetrahedron Lett., 1971, 4275; K. Takase and M. Yasunami, Yuki Gosei Kagaku Kyokaishi, 39, 1172(1981).
3) F. A. Buiter, J. H. S. Weiland, and H. Wynberg, Rec. Trav. Chim., 83, 1160(1964).
4) ^{13}C NMR spectra were measured by method of decoupling without NOE.
5) The compound was synthesized by the reaction of tropolone tosylate with dimethyl malonate in the presence of sodium methoxide., M. Yasunami and K. Takase, unpublished results.
6) G. Pitacco, F. Paolo Colonna, E. Valentin, and A. Risaliti, J. Chem. Soc., Perkin Trans. 1, 1974, 1625.
7) It has been also known that the vicinal coupling constants on ^{1}H NMR of benz[a]azulene indicate a high degree of bond alternation in the azulene ring., D. J. Bertelli and P. Crewa, Tetrahedron, 26, 4717(1970).
8) S. Kashino, M. Haisa, K. Fujimori, and K. Yamane, Acta Crystallogr., Sect. B, 38, 2729(1982).
9) The satisfactory elemental analyses have been obtained for all new compounds described in this paper.

(Received August 25, 1983)