Chemistry of Heterocyclic Compounds, Vol. 44, No. 11, 2008

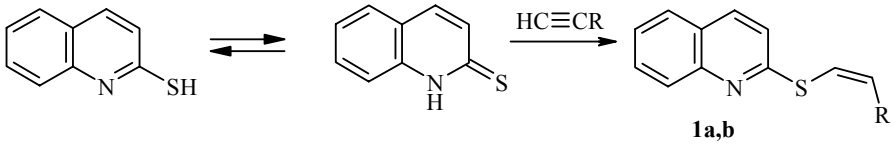
SYNTHESIS AND HALOCYCLIZATION OF 2-ALKENYLTHIOQUINOLINES

D. G. Kim

Bromination of 2-vinylthioquinoline and cis-2-styrylthioquinoline with molecular bromine leads to the formation of 2-bromo(3-phenyl)-2,3-dihydrothiazolo[3,2-a]quinolinium bromides, and of 2-allylthioquinoline to a mixture of 2- and 3-bromomethyl-2,3-dihydrothiazolo[3,2-a]quinolinium bromides. Iodine reacts with allylthioquinoline with the formation of 3-iodomethyl-2,3-dihydrothiazolo-[3,2-a]quinolinium triiodide.

Keywords: 2-alkenylthioquinolines, thiazolo[3,2-*a*]quinolinium halides, halocyclization.

It was shown previously [1] that 2-allylthio-4-methylquinoline reacts with halogens with the formation of 3-iodomethyl-9-methyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium halides. In the present work the interaction has been investigated of 2-vinylthioquinoline (**1a**), *cis*-2-styrylthioquinoline (**1b**), and 2-allylthioquinoline (**2**) with bromine and iodine. Vinyl sulfides **1a,b** have been obtained on interacting 2-quinolinethione with acetylene and phenylacetylene under various conditions [2]. Like 2-pyridinethione [3] 2-quinolinethione reacts with acetylene under pressure at 190-200°C, independent of the nature of the catalyst [KOH, CuCl, $Cd(OAc)_2$], exclusively at the sulfur atom with the formation of sulfide **1a**.



1a,b

a R = H, **b** R = Ph

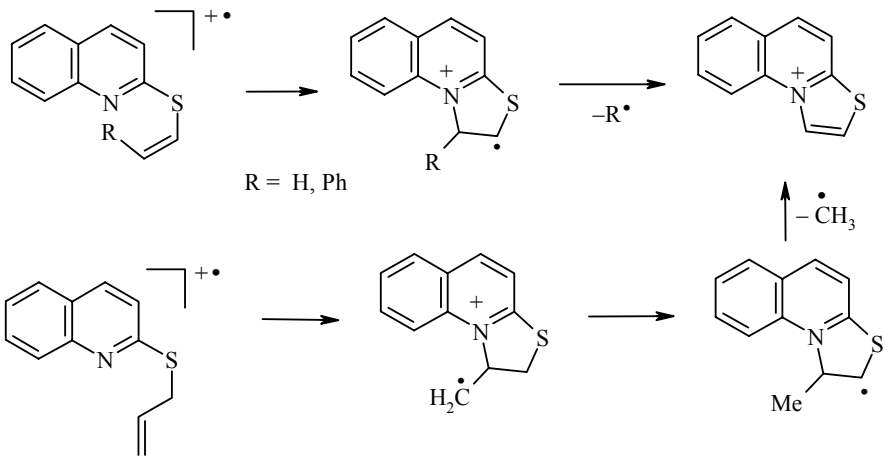
The interaction of 2-quinolinethione with phenylacetylene in dioxane and DMSO proceeds regio- and stereospecifically with the formation of compound **1b** and obeys the rule of *trans* addition of thiols to substituted acetylenes [4-6]. The reaction in dioxane proceeds in an autoclave at 150-180°C, but in superbasic medium (DMSO + KOH) [5] at 90-100°C and atmospheric pressure.

There were peaks in the mass spectra of compounds **1a,b** and **2** of moderate intensity for the molecular ions. The most intense peak for all these compounds had *m/e* 186, which is probably the thiazolo-[3,2-*a*]quinolinium cation formed according to the following scheme.

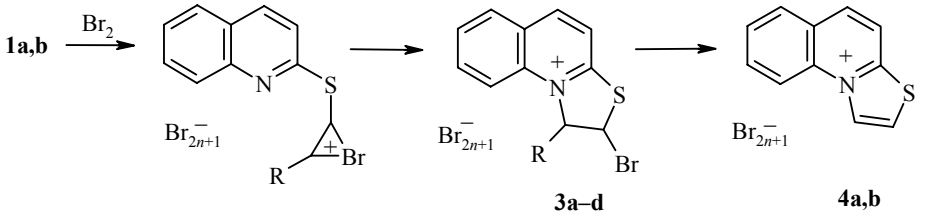
* Dedicated to Academician of the Russian Academy of Sciences B. A. Trofimov on his jubilee.

South Ural State University, Chelyabinsk 454080, Russia; e-mail: kim_dg48@mail.ru. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 11, pp. 1664-1668, November, 2008. Original article submitted May 28, 2008.

0009-3122/08/4411-1355©2008 Springer Science+Business Media, Inc.

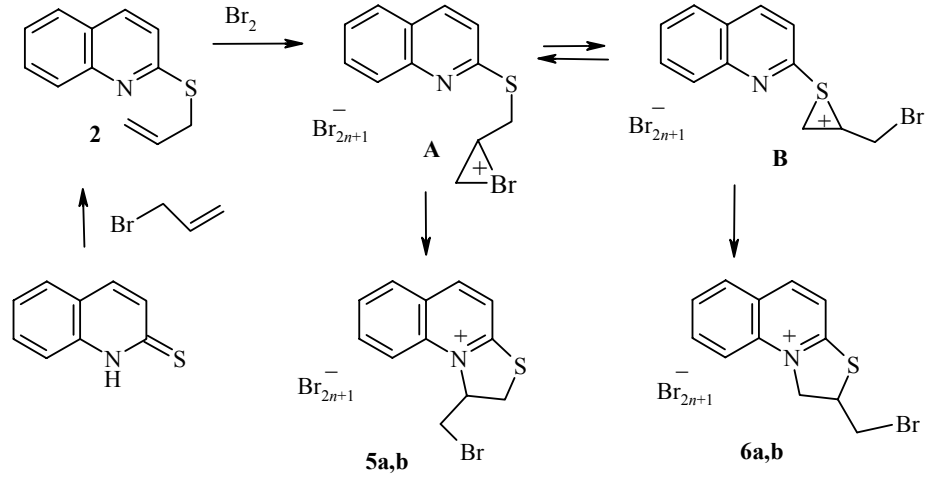


On interacting compound **1a** with bromine at 0°C the main products are 2-bromo-2,3-dihydrothiazolo[3,2-*a*]quinolinium bromide and tribromide **3a,b**, and at room temperature thiazolo[3,2-*a*]quinolinium bromide and tribromide **4a,b**. Tribromides **3b** and **4b** react readily with acetone with the formation of monobromides **3a** and **4a**.



3 a, c, 4a *n* = 0; **3 b, d**, **4b** *n* = 1; **3 a, b** R = H, **c, d** R = Ph

Compound **1b** reacts with bromine at room temperature with the formation of 2-bromo-3-phenyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium bromide and tribromide **3c,d**.

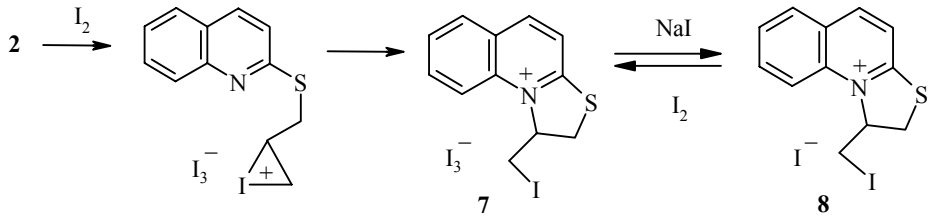


5, 6 a *n* = 0; **5, 6 b** *n* = 1

On brominating compound **2** in CCl_4 3-bromomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium bromide (**5**) is formed which in practice precipitates straight away from the reaction mixture. Then a mixture of bromide **5** and 2-bromomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium bromide (**6**) falls out of solution.

Probably compound **2** forms bromonium ion **A** with bromine, and is converted into thiiranium ion **B**. Bromide **5** is formed from the bromonium ion and bromide **6** from the thiiranium ion.

On interacting sulfide **2** with iodine the 3-iodomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium triiodide (**7**) is formed. Triiodide **7** reacts with sodium iodide with the formation of 3-iodomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium iodide (**8**), which in its turn, reacts with iodine with the formation of triiodide **7**.



In the ^{1}H NMR spectra of bromides and iodides **3-7** the proton signals of the pyridine ring were displaced significantly (~1 ppm) towards low field in comparison with the spectra of the initial sulfides **1a,b** and **2**. This is caused by the effect of the quaternized nitrogen atom.

The interaction of compounds **1a,b** with iodine proceeds in a markedly more complex way. Together with the iodocyclization products complexes with iodine were formed, which were not separated.

EXPERIMENTAL

The ^{1}H NMR spectra of compounds **1a,b, 2, 3a**, and **7** were obtained on a Tesla (100 MHz) spectrometer, and of compounds **3c, 4-6** on a Bruker (300 MHz) spectrometer, internal standard was TMS (compounds **1-6** in DMSO-d_6, compound **7** in acetone-d_6). Mass spectra (EI, 70 eV) were recorded on a Hewlett Packard GC/MS instrument, HP-5890 gas chromatograph, series II, with HP-5972 mass selective detector.

2-Vinylthioquinoline (1a). A mixture of 2-quinolinethione (4.84 g, 30 mmol), KOH (1.68 g, 30 mmol), dioxane (70 ml), water (3 ml), and acetylene at 15 atm was heated in an autoclave at 175-180°C for 1 h. The dioxane was distilled off, and the residue distilled in vacuum. Yield was 3.71 g (66%), bp 145°C (3 mm Hg). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 5.46 (2H, dd, *J* = 11.0 and *J* = 18.0, =CH_2); 6.95 (1H, m, CH=); 7.10-7.90 (6H, m, arom.). Found, %: C 70.71; H 4.92; S 16.79. $C_{11}H_9NS$. Calculated, %: C 70.55; H 4.84; S 17.12.

***cis*-2-Styrylthioquinoline (1b).** A mixture of 2-quinolinethione (1.61 g, 10 mmol), KOH (1.12 g, 20 mmol), water (3 ml), DMSO (10 ml), and phenylacetylene (2.94 g, 20 mmol) was heated at 100°C for 6 h, and then poured into water (300 ml). The precipitated solid was filtered off, dried, and crystallized from 2-propanol. Yield was 1.95 g (74%); mp 111°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 6.86 (1H, d, *J* = 11.0, =CHC_6H_5); 8.21 (1H, d, *J* = 8.4, H-8); 7.20-8.10 (11H, m, remaining protons). Found, %: C 77.35; H 5.21; S 12.12. $C_{17}H_{13}NS$. Calculated, %: C 77.53; H 4.98; S 12.18.

2-Allylthioquinoline (2) was obtained by the interaction of 2-quinolinethione with allyl bromide in isopropyl alcohol in the presence of sodium isopropylate. Bp 170°C (5 mm Hg). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 4.01 (2H, d, *J* = 7.0, SCH_2); 5.10, 5.35 (2H, 2 dd, *J* = 17.0 and *J* = 10.0, =CH_2); 6.05 (1H, m, CH=); 7.20-8.00 (5H, m, H-3,4,5,6,7); 8.04 (1H, d, *J* = 8.50, H-8).

2-Bromo-2,3-dihydrothiazolo[3,2-*a*]quinolinium Bromide (3a). A solution of bromine (0.52 ml, 1 mmol) in CCl_4 (30 ml) was added dropwise with stirring at 0°C during 30 min to a solution of compound **1a** (0.94 g, 5 mmol) in CCl_4 (30 ml). The precipitated solid was filtered off, and washed with acetone. Yield was 1.31 g (75%); mp 147°C (ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 5.85 (2H, m, NCH_2); 6.50 (1H, m, H-2); 7.70-8.50 (5H, m, H-5,6,7,8,10); 8.95 (1H, d, *J* = 8.8, H-9). Found, %: Br 46.47; S 9.32. $C_{11}H_9Br_2NS$. Calculated, %: Br 46.04; S 9.24.

2-Bromo-3-phenyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium Bromide (3c). A solution of bromine (0.11 ml, 2 mmol) in CH_2Cl_2 (10 ml) was added dropwise with stirring at 0°C during 30 min to a solution of compound **1b** (0.263 g, 1 mmol) in CH_2Cl_2 (10 ml). After 1 day the precipitated solid was filtered off and washed with acetone. Yield was 0.19 g (45%). Mp 168°C (ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 6.67 (1H, d, *J* = 3.7, CHBr); 7.12 (2H, d, *J* = 6.2, C_6H_5); 7.40 (3H, m, C_6H_5); 7.90-8.30 (4H, m, H-3,5,6,7); 8.48 (1H, d, *J* = 8.0, H-5); 8.60 (1H, d, *J* = 9.0, H-10); 9.30 (1H, d, *J* = 9.0, H-9). Found, %: Br 37.97; S 7.37. $C_{17}H_{13}Br_2NS$. Calculated, %: Br 37.76; S 7.58.

Thiazolo[3,2-*a*]quinolinium Bromide (4). A solution of bromine (0.26 ml, 5 mmol) in CCl_4 (30 ml) was added dropwise with stirring during 30 min to a solution of compound **1a** (0.94 g, 5 mmol) in CCl_4 (30 ml) at 25°C. After 1 day the precipitated solid was filtered off, and washed with acetone. Yield was 0.71 g (53%); mp 227°C (ethanol). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 7.96 (1H, dd, *J* = 7.1, *J* = 8.2, H-7); 8.15 (1H, dd, *J* = 7.1, *J* = 8.7, H-6); 8.42 (1H, d, *J* = 8.8, H-10); 8.68 (1H, d, *J* = 4.1, H-2); 8.75 (2H, m, H-5,8); 9.0 (1H, d, *J* = 8.8, H-9); 9.96 (1H, d, *J* = 4.1, H-3). Found, %: Br 30.87; S 12.42. $C_{11}H_8BrNS$. Calculated, %: Br 30.03; S 12.04.

3- and 2-Bromomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium Bromides 5 and 6. Bromine (0.11 ml, 2 mmol) in CH_2Cl_2 (7 ml) was added dropwise at 0°C to a solution of compound **2** (0.201 g, 1 mmol). A precipitate formed immediately, which was filtered off, washed with acetone, and with ethanol. Compound **5** was obtained (0.22 g, 63%); mp 215°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 4.20 (4H, m, SCH_2, CH_2Br); 6.69 (1H, m, H-3); 7.87 (1H, t, *J* = 7.5, H-7); 8.14 (1H, t, *J* = 7.7, H-6); 8.22 (1H, d, *J* = 8.8, H-10); 8.35 (2H, m, H-5,8); 8.96 (1H, d, *J* = 8.8, H-9). Found, %: Br 44.96; S 8.43. $C_{12}H_{11}Br_2NS$. Calculated, %: Br 44.26; S 8.88.

One day later a solid which had precipitated was filtered from the filtrate, and according to data of ^{1}H NMR spectra was a mixture of bromides **5** and **6**. ^{1}H NMR spectrum of compound **6**, δ, ppm (*J*, Hz): 4.10 (2H, m, CH_2Br); 4.92 (1H, m, H-2); 6.65 (1H, m, NCH_2); 7.90 (1H, m, H-7); 8.15 (1H, m, H-6); 8.20-8.40 (3H, m, H-5,8,10); 8.97 (1H, d, *J* = 8.9, H-9).

3-Iodomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium Triiodide (7). A solution of iodine (0.508 g, 2 mmol) in ether (70 ml) was added with stirring to a solution of compound **2** (0.201 g, 1 mmol) in ether (5 ml). The precipitated solid was filtered off after 4 h. Yield was 0.60 g (85%), mp 151°C (decomp.). ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 4.30 (4H, m, SCH_2, CH_2I); 6.64 (1H, m, H-3); 7.90-8.30 (5H, m, H-5,6,7,8,10); 8.96 (1H, d, *J* = 8.8, H-9). Found, %: I 71.84; S 4.43. $C_{12}H_{11}I_4NS$. Calculated, %: I 71.61; S 4.52.

3-Iodomethyl-2,3-dihydrothiazolo[3,2-*a*]quinolinium Iodide (8). A solution of NaI (0.38 g, 2 mmol) in acetone (3 ml) was poured into a solution of triiodide **6** (0.352 g, 0.5 mmol) in acetone (5 ml). After 1 h the solid was filtered off, and washed with acetone. Yield was 0.22 g (96%); mp 178°C (decomp.). Found, %: I 55.94; S 6.93. $C_{12}H_{11}I_2NS$. Calculated, %: I 55.77; S 7.05.

REFERENCES

1. D. G. Kim, A. V. Sashin, V. A. Kozlovskaya, and I. N. Andreeva, *Khim. Geterotsikl. Soedin.*, 1252 (1996). [*Chem. Heterocycl. Comp.*, **32,** 1075 (1996)].
2. D. Kim, G. G. Skvortsova, and L. M. Pachkova, *Abstracts, IV All-Union Conference on the Chemistry of Acetylene and Its Derivatives*, Baku (1979), Part. 1, p. 134.
3. G. G. Skvortsova, D. G. Kim, and L. V. Andriyankova, *Khim. Geterotsikl. Soedin.*, 364 (1978). [*Chem. Heterocycl. Comp.*, **14**, 297 (1978)].
4. W. E. Truce and J. A. Simms, *J. Am. Chem. Soc.*, **78,** 2756 (1956).
5. B. A. Trofimov, *Usp. Khim.*, **50,** 248 (1981).
6. B. A. Trofimov and S. V. Amosova, *Divinyl Sulfide and Its Derivatives* [in Russian], Nauka, Novosibirsk (1983), p. 42.