Thienoquinolines, IV¹

Synthesis of Thieno(2,3-b)quinolines

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2-Oxo-3-vinylquinolines, 2-Chloro-3-vinylquinolines, 2-Thioxo-3-vinylquinolines,
Thieno(2,3-b)quinolines

Synthesis of several thieno(2,3-b)quinolines is described starting from appropriately substituted 2-oxo-3-vinylquinolines.

In a recent communication², we have demonstrated the utility of 3-vinyl-2-quinolones for the synthesis of thieno(2,3-b)quinolines. Since then, we have expanded the method to include a variety of hitherto unknown thieno(2,3-b)quinolines and the present paper is concerned with the synthesis of them. The synthetic transformation of the vinylquinolone to the thienoquinoline involves thionation of the vinylquinolone by treatment with phosphoryl chloride followed by heating the resulting 2-chloroquinoline with thiourea, and subjecting the vinylthione, thus obtained, to a bromine addition-dehydrobromination sequence as outlined below:

Compound	R ⁴	R ⁵	R ⁶	R ⁷	R ⁸
a	CH ₃	H	-O-CH ₂ -O-	H	H
b	CH ₃	H	Cl	Cl	H
c	CH ₃	H	Br	H	H
d	CH ₃	H	NO ₂	H	H
e	C ₆ H ₅	H	CH ₃	H	H
f	C ₆ H ₅	H	Cl	H	H
g	C ₆ H ₅	H	Br	H	H
h	C ₆ H ₄ Cl	H	CH ₃	H	H

The intermediate bromine addition-product need not be isolated. The structures of the thienoquinolines except **4i** and **4d** as well as those of the chloroquinolines were fully attested by their NMR spectra. The NMR spectra of the quinolinethiones could not be obtained because of their poor solubility in the usual spectral solvents.

Experimental

Melting points were determined on a Boetius micro-heating table and are uncorrected. The NMR spectra were determined on a Varian A-60 spectrometer (TMS as internal standard) and IR spectra on a Beckman IR-20 spectrophotometer.

3-Vinyl-2-quinolones

The vinylquinolones (**1d**, **1f**, **1h**), which are now newly reported, were prepared from 2-amino-5-nitroaceto⁴-, 2-amino-5-chlorobenzo⁵-, and 2-amino-5-methyl(2'-chloro)benzo⁶-phenones, respectively, according to the procedure described earlier³. The results are summarised in Table I.

2-Chloro-3-vinylquinolines

The chloroquinolines (**2a**, **2b**, **2c**, **2d**, **2f**, **2h**) were obtained respectively from the vinylquinolones (**1a**)⁷, (**1b**)⁷, (**1c**)⁷, (**1d**), (**1f**), and (**1h**), by heating with phosphoryl chloride on a steam bath according to the procedure described earlier². The results are summarised in Table II.

3-Vinylquinolin-2(1H)-thiones

The thiones listed in Table III were obtained from the respective 2-chloro-3-vinylquinolines according to the procedure previously described².

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Table I. 3-Vinyl-2-quinolones (1).

Compound	m.p. [°C]	Yield %	IR (KBr)* ν [cm ⁻¹]	Analysis	Calcd Found
1d	195 (dec) (HOAc)	60	1640, 1395 (–NO ₂) 985 and 910	C ₁₂ H ₁₀ N ₂ O ₃ (230.2)	C 62.61 H 4.38 C 62.36 H 4.18
1f	237–240 (CHCl ₃)	92	1635, 995 and 930	C ₁₇ H ₁₂ NOCl (281.7)	C 72.47 H 4.30 C 72.30 H 4.15
1h	184–185 (CHCl ₃)	86	1640, 1010 and 925	C ₁₈ H ₁₄ NOCl (296.8)	C 73.26 H 4.78 C 72.83 H 4.47

* The last two peaks are due to the vinyl absorptions.

Table II. 2-Chloro-3-vinylquinolines (2)

Com- pound	m.p.* [°C]	Yield [%]	Analysis	Calcd Found	IR (KBr)** ν [cm ⁻¹]	¹ H NMR (CDCl ₃) H _A H _B H _X ***	δ [ppm] others
2a	109–112	86	C ₁₃ H ₁₀ NO ₂ Cl (247.7)	C 63.04 C 63.10	H 4.07 1610, 1560, H 4.11 985, 940	5.47 5.72 6.83	2.54 (s, 3H, CH ₃) 7.09 (s, 1H, C-5-H) 8.10 (s, 2H, O–CH ₂ –O) 7.21 (s, 1H, C-8-H)
2b	113–114	90	C ₁₂ H ₈ NCl ₃ (272.5)	C 52.88 C 52.80	H 2.96 1620, 1550, H 2.88 1005, 930	5.47 5.83 6.83	2.70 (s, 3H, CH ₃) 8.10 (s, 2H, C-5 & C-8-H)
2c	121–122	90	C ₁₂ H ₉ NCl Br (282.6)	C 51.00 C 51.12	H 3.21 1600, 1560, H 3.30 1000, 930	5.53 5.85 6.97	2.75 (s, 3H, CH ₃) 8.23 (d, 1H, C-5-H, <i>J</i> = 2.5 Hz) 7.83–7.97 (m, 2H, C-7 & C-8-H)
2d	161–163	71	C ₁₂ H ₉ N ₂ O ₂ Cl (248.7)	C 57.94 C 57.76	H 3.65 1610, 1560, H 3.58 1340 (NO ₂), 990, 905	5.58 5.97 7.00	2.90 (s, 3H, CH ₃) 9.07 (d, 1H, C-5-H, <i>J</i> = 2.5 Hz) 8.57 (dd, 1H, C-7-H, <i>J</i> = 2.5, 9 Hz) 8.17 (d, 1H, C-8-H, <i>J</i> = 9 Hz)
2f	116–117	94	C ₁₇ H ₁₁ NCl ₂ (300.2)	C 68.01 C 67.92	H 3.69 1610, 1560, H 3.58 1030, 940	5.28 5.53 6.73	7.23–7.82 (m, 7H) 8.10 (d, 1H, C-8-H, <i>J</i> = 9 Hz)
2h	135–137	73	C ₁₈ H ₁₃ NCl ₂ (314.2)	C 68.82 C 68.74	H 4.17 1620, 1590, H 4.07 1010, 930	5.23 5.48 6.82	7.22–7.60 (m, 6H) 2.45 (s, 3H, CH ₃) 8.10 (d, 1H, C-8-H, <i>J</i> = 9 Hz)

* Recrystallised from benzene/petroleum ether (b.p. 60–80 °C).

** The last two peaks given are due to vinyl absorptions.

*** The coupling constants *J*_{AX}, *J*_{BX}, and *J*_{AB} were found to be 18, 11 and 2 Hz, respectively, for all the compounds.

Thieno(2,3-*b*)quinolines

The thienoquinolines (**4a–4h**) were prepared from their respective 3-vinylquinolin-2(1H)-thiones by bromination-dehydrobromination sequence as described earlier². The results are summarised in Table IV. The thiones **3e** and **3g** have been reported earlier¹.

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Table III. 3-Vinylquinolin-2(1H)-thiones (**3**)

Compound	m.p.* [°C]	Yield [%]	Analysis	Calcd Found	IR (KBr)** ν [cm ⁻¹]
3a	195 (sint. at 176)	80	C ₁₃ H ₁₁ NO ₂ S (245.3)	C 63.63 H 4.52 C 63.38 H 4.51	1185, 1000 and 945
3b	167–170	88	C ₁₂ H ₉ NSCl (270.2)	C 53.33 H 3.36 C 53.37 H 3.52	1190, 990 and 945
3c	161–167	84	C ₁₂ H ₁₀ NSBr (280.2)	C 51.42 H 3.60 C 51.28 H 3.41	1180, 985 and 935
3d	180–183 (sint. at 177)	50	C ₁₂ H ₁₀ N ₂ O ₂ S (246.3)	C 58.52 H 4.09 C 58.30 H 3.89	1180, 1320 (–NO ₂), 980 and 910
3f	150–152	94	C ₁₇ H ₁₂ NSCl (297.8)	C 68.55 H 4.06 C 68.65 H 4.12	1180, 1030 and 925
3h	98–103	72	C ₁₈ H ₁₄ NSCl (311.8)	C 69.34 H 4.53 C 69.26 H 4.40	1180, 1000 and 925

* Recrystallised from chloroform.

** The first peak is due to thiocarbonyl and the last two are due to the vinyl absorptions.

Table IV. Thieno(2,3-b)quinolines (**4**).

Com- pound	m.p. [°C]	Yield [%]	Analysis	Calcd Found	¹ H NMR* δ [ppm]			
4a	212–216 (CHCl ₃)	84	C ₁₃ H ₉ NO ₂ S (243.3)	C 64.25 H 3.73 N 5.77 C 64.10 H 3.73 N 5.88	7.80 (bs, 3H, C-2, C-3 and C-8-H) 7.75 (s, 1H, C-5-H) 6.40 (s, 2H, O–CH ₂ –O) 3.25 (s, 3H, CH ₃)			
4b	219–221 (HOAc)	93	C ₁₂ H ₇ NSCl ₂ (268.1)	C 53.75 H 2.63 N 5.23 C 53.57 H 2.48 N 5.10	7.91 (bs, 2H, C-2 and C-3-H) 3.38 (s, 3H, CH ₃) 8.71 (s, 1H, C-5-H) 8.41 (s, 1H, C-8-H)			
4c**	183–184 (CHCl ₃)	86	C ₁₂ H ₈ NS Br (278.2)	C 51.81 H 2.90 N 5.04 C 52.12 H 2.75 N 4.85	—			
4d**	278–279 (HOAc)	60	C ₁₂ H ₈ N ₂ O ₂ S (244.3)	C 58.99 H 3.29 N 11.48 C 59.17 H 3.35 N 11.57	—			
4e	102–103 (benzenepetrol)	78	C ₁₈ H ₁₃ NS (275.4)	C 78.52 H 4.76 N 5.09 C 78.64 H 4.84 N 5.15	7.57 (d, 1H, C-2-H, <i>J</i> = 6 Hz) 7.15 (d, 1H, C-3-H, <i>J</i> = 6 Hz) 2.50 (s, 3H, CH ₃) 8.23 (d, 1H, C-8-H, <i>J</i> = 9 Hz) 7.10–7.85 (m, 7H, C-5, C-7-H and phenyl protons)			
4f	136–137 (benzenepetrol)	77	C ₁₇ H ₁₀ NSCl (295.8)	C 69.18 H 3.41 N 4.74 C 69.09 H 3.50 N 4.81	7.17 (d, 1H, C-3-H, <i>J</i> = 6 Hz) 7.93 (d, 1H, C-5-H, <i>J</i> = 2.5 Hz) 8.25 (d, 1H, C-8-H, <i>J</i> = 9 Hz) 7.5–7.83 (m, 7H, C-2, C-7-H and phenyl protons)			
4g	152–153 (benzenepetrol)	81	C ₁₇ H ₁₀ NS Br (340.2)	C 60.01 H 2.96 N 4.12 C 60.10 H 3.06 N 4.20	7.13 (d, 1H, C-3-H, <i>J</i> = 6 Hz) 8.10 (bs, 1H, C-5-H) 7.83 (dd, 1H, C-7-H, <i>J</i> = 2.5, 9 Hz) 8.17 (d, 1H, C-8-H, <i>J</i> = 9 Hz) 7.45–7.72 (m, 6H, C-2-H and phenyl protons)			
4h	139–140 (benzenepetrol)	52	C ₁₈ H ₁₂ NSCl (309.8)	C 69.79 H 3.91 N 4.50 C 69.65 H 3.82 N 4.41	6.88 (d, 1H, C-3-H, <i>J</i> = 6 Hz) 2.45 (s, 3H, CH ₃) 8.15 (d, 1H, C-8-H, <i>J</i> = 9 Hz) 7.22–7.78 (m, 7H, C-2, C-5, C-7-H and phenyl protons)			

* NMR spectra of **4a** and **4b** were taken in CF₃COOH and the rest in CDCl₃ solutions.

** The NMR spectra for these compounds could not be taken because of their poor solubility in the usual solvents.

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