

Infrared Spectra of Hindered 4(1*H*)-Quinolones

By B. Staskun

Spectra of 2,3,8-trisubstituted 4(1*H*)-quinolones showed effective steric hindrance to intermolecular hydrogen bonding.

A FEATURE of the infrared spectra of solid 4(1*H*)-quinolones such as (I) is the broad NH stretching absorption in the 3300—2500 cm.⁻¹ region usually consisting of multiple overlapping peaks; this is interpreted as an indication of intermolecular hydrogen bonding to different extents.¹⁻³ A similar absorption is shown by 3-acetyl-2-aryl-4(1*H*)-quinolones⁴ [*e.g.*, (IIa)

and (IIb)], the *N*-methylphenylhydrazone of 3-acetyl-2-phenyl-4(1*H*)-quinolone (IIIa),⁵ and by 3-(1-methyl-indol-2-yl)-2-phenyl-4(1*H*)-quinolone(IVa);⁵ in dilute chloroform solutions of these compounds, the free νNH occurs at *ca.* 3420 cm.⁻¹ (Table).

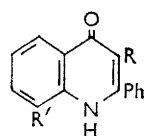
³ A. R. Katritzky and A. P. Ambler in "Physical Methods in Heterocyclic Chemistry," ed. A. R. Katritzky, Academic Press Inc., New York, 1963, vol. II, p. 263.

⁴ P. C. Anderson and B. Staskun, *J. Org. Chem.*, 1965, **30**, 3033.

⁵ B. Staskun, *J. Org. Chem.*, 1966, **31**, 2674.

¹ S. F. Mason, *J. Chem. Soc.*, 1957, 4874.

² J. R. Price and J. B. Willis, *Austral. J. Chem.*, 1959, **12**, 589.



- (I) R = H
 (II) R = COMe
 (III) R = C(Me):N·N(Me)Ph
 (IV) R = 1-methylindol-2-yl
- a; R' = H
 b; R' = Me
 c; R' = Ph

The 8-methyl- and 8-phenyl-substituted hydrazones (IIIb and IIIc) and indoles (IVb and IVc) have been prepared and analysed; the infrared spectra of the solids differ significantly from the other 4(1H)-quinolones above in showing the respective ν NH as a single and sharp (medium) absorption in the region 3300—3400 cm^{-1} , i.e., near the free ν NH observed for the compounds in chloroform solution (Table). The spectra are in accord with and provide evidence for the predominating "oxo" tautomeric form of the structures.

Infrared stretching frequencies (cm^{-1}) of substituted 4(1H)-quinolones in the NH and C=O regions

(ab = Absent, s = strong, m = medium, w = weak, sh = shoulder)

Dil. soln. (CHCl_3)^a

Solid (KBr disc)^b

Compound	NH	CO		NH	CO	
		Keto	Amide		Keto	Amide
Ia ^c	3420	ab	1630, 1610	3260m, 3140m, 3090m, 3060m, 2960m	ab	1632s, 1608s, sh
Ib ^c	3440	ab	1625, 1610	3240m, 3150m, 3095m, 3050m, 2940m	ab	1625s, 1608s, sh
Ic	3410	ab	1620	3400w, 3215m, 3120m, 3105m	ab	1625s, sh, 1612s, sh
IIa ^d	3415, (3420) ^e	1693	1613	3400w, 3250m, 3200m, 3080m, 2980m, 2930m	1690s, 1665s	1625s
IIb ^d	3425	1690	1615	3240m, 3200m, 3140m, 3100m, 3050m, 2970m, 2925m	1680s	1612s
IIc	3395	1695	1617	3385m	1690s	1612s
IIIa ^f	3415	ab	1627sh, 1610	3400w, 3250w, 3200w, 3055m, 2900m, 2860m	ab	1629s
IIIb	3430	ab	1615	3420w, 3280m	ab	1610s
IIIc	3400	ab	1613	3400m	ab	1610s
IVa ^f	(3420) ^e	ab	— ^g	3250w, 3180w, 3040m, 2900m	ab	1625s, 1610s
IVb	3430	ab	1618	3320m	ab	1610s
IVc	3405	ab	1618	3395m	ab	1615s

^a Concentrations ca. 0.5% (w/w) in a 0.1 mm. cell. ^b 1—1.5 mg. sample per 100 mg. KBr. ^c Ref. 4. ^d Ref. 6. ^e Centre of broad absorption band in ca. 0.5% pyridine soln. ^f Ref. 5. ^g Not measured.

It appears that the 2, 3, and 8 substituents in the quinolone together form a combination which sterically prevents or hinders association *via* hydrogen bonding in the solid state. In this respect the "hindrance capacity" of the 8-phenyl group seems to be relatively substantial and intermolecular hydrogen bonding was negligible even in 3-acetyl-2,8-diphenyl-4(1H)-quinolone (IIc) but occurred in 2,8-diphenyl-4(1H)-quinolone (Ic). The effect on ν NH of 5-substituents in (IIa), (IIIa), and (IVa) is under consideration.

EXPERIMENTAL

Infrared absorption spectra were determined on a Perkin-Elmer model 521 spectrophotometer. New compounds are described below.

Methyl β -Amino-(N-2-biphenylbenzimidoyl)crotonate.—N-2-Biphenylbenzimidoyl chloride was prepared by refluxing 2-benzamidobiphenyl (4.1 g., 0.015 mole) with excess of thionyl chloride (6 ml.) for $\frac{3}{4}$ hr. and distilling off unchanged thionyl chloride under reduced pressure. The crude chloride (residual yellow viscous oil) was condensed with excess of methyl β -aminocrotonate (2.9 g., 0.025 mole)

* The hydrazones (IIIa—c) underwent conversion into the corresponding indoles (IVa—c) in the mass spectrometer as evidenced by the presence in their spectra of a peak at $M - 17$.

^b B. Staskun, *J. Org. Chem.*, 1961, **26**, 2791.

in dry chloroform (60 ml.) at ca. 4° for 3 days⁴ and gave the title crotonate (3.5 g., ca. 65% crude yield). Recrystallisation from methanol afforded very pale yellow crystals, m. p. 151—152° (Found: C, 77.9; H, 6.1. $\text{C}_{24}\text{H}_{22}\text{N}_2\text{O}_2$ requires C, 77.8; H, 5.95%), soluble in chloroform and in ether, and forming a yellow hydrochloride, sparingly soluble in cold water and in chloroform.

2,8-Diphenyl-4(1H)-quinolone (Ic).—The above crotonate (0.2 g.) was cyclised by stirring with medicinal liquid paraffin (6 ml.) at ca. 250° for 20 min. and the resulting 4(1H)-quinolone (Ic) was isolated (0.07 g., ca. 35% crude yield) and purified as before⁴ to give colourless crystals, m. p. 175—177°, from dilute ethanol [Found: C, 84.7; H, 5.1; N, 4.4%; M (mass spectrometer), 297. $\text{C}_{21}\text{H}_{15}\text{NO}$ requires C, 84.85; H, 5.05; N, 4.7%; M , 297].

3-Acetyl-2,8-diphenyl-4(1H)-quinolone (IIc).—Treatment

of the above crotonate (2 g.) with polyphosphoric acid (20 g.)^{4,6} at 150—170° for 30 min. furnished the quinolone (IIc) (1.45 g., ca. 80% crude yield). Recrystallisation from dilute ethanol gave colourless crystals, m. p. 206—207° (Found: C, 81.6; H, 5.25; N, 4.15. $\text{C}_{23}\text{H}_{17}\text{NO}_2$ requires C, 81.4; H, 5.0; N, 4.1%), soluble in chloroform and in dilute alkali, insoluble in dilute hydrochloric acid.

N-Methylphenylhydrazone of 3-Acetyl-8-methyl-2-phenyl-4(1H)-quinolone (IIIb).—3-Acetyl-8-methyl-2-phenyl-4(1H)-quinolone⁶ (IIb) (2 g.) was treated⁵ with excess of *asym.*-methylphenylhydrazine (Fluka technical, 4 ml.) in 50% (v/v) acetic acid (80 ml.) for 30 min. and yielded the crude quinolone (IIIb) (2.0 g., ca. 70%; m. p. 100—190°) which after fractional recrystallisation from dilute methanol was obtained as yellow crystals (0.5 g.), m. p. 201—202° [Found: C, 78.75; H, 6.1; N, 11.0%; M (mass spectrometer *), 381. $\text{C}_{25}\text{H}_{23}\text{N}_3\text{O}$ requires C, 78.74; H, 6.04; N, 11.02%; M , 381].

N-Methylphenylhydrazone of 3-Acetyl-2,8-diphenyl-4(1H)-quinolone (IIIc).—Condensation of 3-acetyl-2,8-diphenyl-4(1H)-quinolone (IIc) (1 g.) with excess of *asym.*-methylphenylhydrazine (2 ml.) as above afforded (IIIc) in ca. 70% crude yield. Fractional recrystallisation from dilute methanol gave yellow crystals, m. p. 186—188° [Found: C, 81.1; H, 5.9%. M (mass spectrometer *), 443. $\text{C}_{30}\text{H}_{25}\text{N}_3\text{O}$

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requires C, 81.3; H, 5.6%; *M*, 443), soluble in chloroform.

8-Methyl-3-(1-methylindol-2-yl)-2-phenyl-4(1H)-quinolone (IVb).—The 8-methylhydrazone (IIIb) (0.2 g.) was boiled with concentrated hydrochloric acid (5 ml.) for about 1 min. (method *D* in ref. 5) and converted into *indole* (IVb) in *ca.* 50% crude yield. Recrystallisation from aqueous pyridine (charcoal) gave colourless crystals, m. p. 270—272° (Found: C, 82.2; H, 5.6; N, 7.6%; *M* (mass spectrometer), 364. $C_{25}H_{20}N_2O$ requires C, 82.4; H, 5.5; N, 7.7%; *M*, 364). Compound (IVb) was obtained also from the hydrazone (IIIb) and polyphosphoric acid (method *B* in ref. 5) in *ca.* 70% crude yield.

3-(1-Methylindol-2-yl)-2,8-diphenyl-4(1H)-quinolone (IVc).

—Heating hydrazone (IIIc) (0.2 g.) with concentrated hydrochloric acid as above afforded *indole* (IVc) in *ca.* 50% crude yield; crystals (from dilute methanol), m. p. 202—203° (Found: C, 84.6; H, 5.3; N, 6.25; *M* (mass spectrometer), 426. $C_{30}H_{22}N_2O$ requires C, 84.5; H, 5.2; N, 6.6%; *M*, 426). The indole derivatives (IVb) and (IVc) were sparingly soluble in warm 2*N*-sodium hydroxide and dissolved in ethanol. Their solutions in glacial acetic acid became red on short boiling.⁵

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DEPARTMENT OF CHEMISTRY INCLUDING BIOCHEMISTRY,
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG,
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