

4-(4-Chlorophenyl)-3,7,7-trimethyl-1-[2-(4-nitrobenzoyl)ethyl]-4,7,8,9-tetrahydro-1*H*-pyrazolo[3,4-*b*]-quinolin-5(6*H*)-one-ethanol (1/1)

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Molecules of the title compound, C₂₈H₂₇ClN₄O₄·C₂H₆O, form a C(6) chain *via* an N—H···O hydrogen bond along the *c* axis by the operation of a *c*-glide plane, with N···O = 2.761 (3) Å and N—H···O = 165°. The molecules are further linked by a weak C—H···O interaction, with C···O = 3.344 (4) Å and C—H···O = 150°. Pendant hydrogen-bonded ethanol solvent molecules are attached to the chains by O—H···N hydrogen bonds, with O···N = 2.904 (3) Å and O—H···N = 175°.

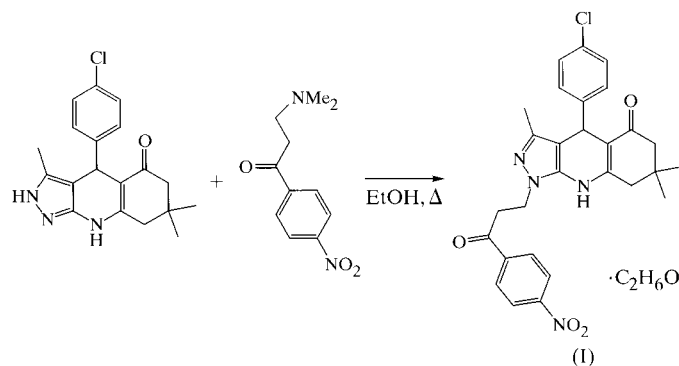
Comment

Pyrazolo[3,4-*b*]quinolines are of interest as possible antiviral agents (Crenshaw *et al.*, 1976, 1978; Smirnov & Crenshaw, 1977). Some of their derivatives exhibit parasitocidal properties (Bristol-Meyers, 1973) and have been studied as potential antimalarial agents (Gein Stein *et al.*, 1970). Other pyrazolo[3,4-*b*]quinolines have shown bactericidal activity (Farghaly *et al.*, 1989) and applications as vasodilators (Bell & Ackerman, 1990), and have even been evaluated for enzymatic inhibitory activity (Gatta *et al.*, 1991). We have previously prepared diverse 4-aryl-3,7,7-trimethyl-4,7,8,9-tetrahydro-2*H*-pyrazolo[3,4-*b*]quinolin-5(6*H*)-ones and reported their structures (Cannon *et al.*, 2001*a,b,c,d*). The present work was undertaken to expand the possible applications of such heterocycles, by using *N*-alkylation to prepare derivatives from azole systems. We report here the structure of the title compound, (I), which was prepared by the easy, efficient and regioselective method described below.

Selected bond lengths and angles for (I) are given in Table 1 and are similar to those reported in the four structures cited

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above (Cannon *et al.*, 2001*a,b,c,d*). Fig. 1 depicts the title molecule.



Molecules of (I) form C(6) chains (Bernstein *et al.*, 1995) *via* an N9—H9···O5ⁱ hydrogen bond along the *c* axis by the operation of the *c*-glide plane, as shown in Fig. 2 [symmetry code: (i) *x*, 1 − *y*, $\frac{1}{2}$ + *z*]. The molecules in these chains are then linked by weak C12—H12···O12ⁱ interactions and this interaction, together with the N9—H9···O5ⁱ hydrogen bond, forms an R₂²(23) ring (Bernstein *et al.*, 1995), as shown in Fig. 3. These linked chains are not connected to the chains related by the *C*-centring. Pendant hydrogen-bonded ethanol solvent molecules are attached to each molecule of (I). Details of the hydrogen bonding are given in Table 2.

There is significant π – π base-stacking between rings C131–C136 and N9/C8a/C4a/C4/C3a/C9a (at *x*, 1 − *y*, $\frac{1}{2}$ + *z*), where the distance between centres of gravity is 3.73 Å, the perpendicular distance of the centre of gravity of the former ring from the latter is 3.73 Å, the perpendicular distance of the centre of gravity of the latter from the former is 3.50 Å and the angle between the planes is 2.7°. In addition, ring C131–C136 is involved in π – π stacking with ring N1/N2/C3/C3a/C9a (at *x*,

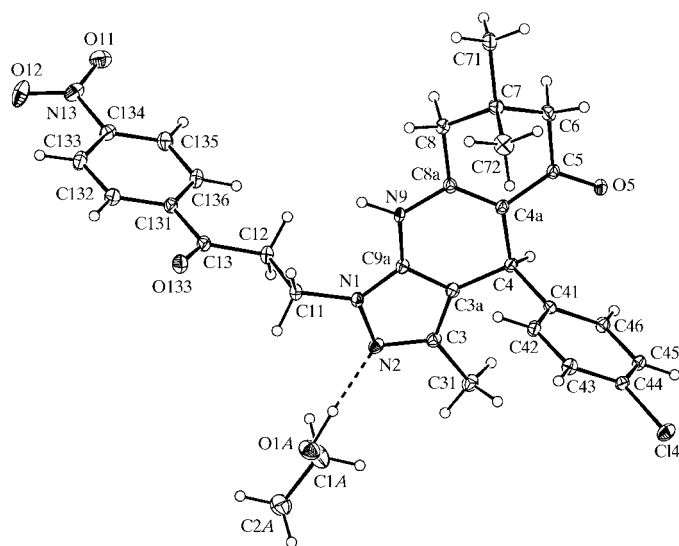


Figure 1
A view of (I) with the atomic numbering scheme. Displacement ellipsoids are drawn at the 30% probability level and H atoms are shown as small spheres of arbitrary radii.

$1 - y, \frac{1}{2} + z$), where the distance between centres of gravity is 3.76 Å, the perpendicular distance of the centre of gravity of the former from the latter is 3.53 Å, the perpendicular distance of the centre of gravity of the latter from the former is 3.52 Å and the angle between the planes is 0.73°.

This supramolecular structure is different from those reported by Cannon *et al.* (2001a,b,c,d), which were all similar.

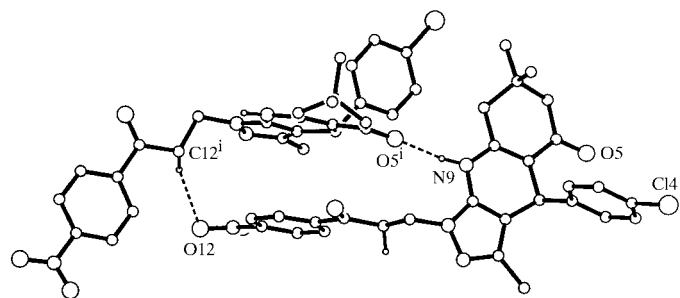


Figure 3
A view of the crystal structure of (I) showing the $R_2^2(23)$ ring [symmetry code: (i) $x, 1 - y, \frac{1}{2} + z$]. The solvent molecule has been omitted for clarity.

This difference is due to the presence of the 2-(4-nitrobenzoyl)ethyl substituent on N1, which locks the 1*H* form and precludes the presence of an H atom at N2, which is involved in the formation of the supramolecular structures of the

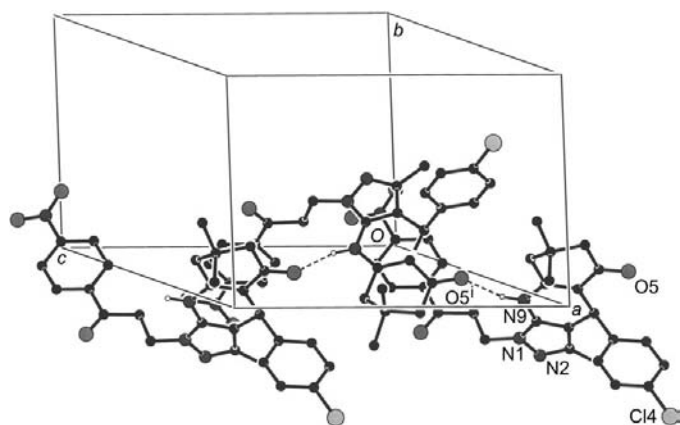


Figure 2
A view of the crystal structure of (I) showing the $C(6)$ chain [symmetry code: (i) $x, 1 - y, \frac{1}{2} + z$]. The solvent molecule has been omitted for clarity.

crystal structures cited above. In compound (I), the 1*H* configuration of the heterocyclic system results in an essentially planar pyridine ring, whereas in the published structures, this ring is intermediate between a boat and an envelope. Examination of the structure with *PLATON* (Spek, 2000) showed that there were no solvent-accessible voids in the crystal lattice apart from that occupied by the solvent molecule.

Experimental

A solution of 4-(4-chlorophenyl)-3,7,7-trimethyl-4,7,8,9-tetrahydro-2*H*-pyrazolo[3,4-*b*]quinolin-5(6*H*)-one (2.0 mmol) and 3-dimethylamino-4-nitropropiophenone (2.0 mmol) in absolute ethanol (15 ml) was refluxed for 50 min, and the resulting precipitate was filtered, washed with ethanol, dried and recrystallized from ethanol. Compound (I) was obtained as orange crystals (m.p. 466 K, yield 82%), from which suitable crystals were selected for X-ray diffraction. Analysis calculated for $C_{28}H_{28}ClN_4O_4$: C 64.80, H 5.24, N 10.80%; found: C 64.87, H 5.16, N 10.73%.

Crystal data

$C_{28}H_{27}ClN_4O_4 \cdot C_2H_6O$
 $M_r = 565.05$
Monoclinic, *Cc*
 $a = 23.6298$ (6) Å
 $b = 9.6215$ (3) Å
 $c = 14.2657$ (4) Å
 $\beta = 120.2930$ (16)°
 $V = 2800.51$ (14) Å³
 $Z = 4$

$D_x = 1.34$ Mg m⁻³
Mo $K\alpha$ radiation
Cell parameters from 5677 reflections
 $\theta = 3.1$ – 27.5°
 $\mu = 0.18$ mm⁻¹
 $T = 100$ (1) K
Block, orange
0.30 × 0.14 × 0.14 mm

Data collection

Nonius KappaCCD area-detector diffractometer
 φ and ω scans with κ offsets
Absorption correction: multi-scan (*DENZO-SMN*; Otwinowski & Minor, 1997)
 $T_{\min} = 0.947$, $T_{\max} = 0.975$
11 553 measured reflections

2465 independent reflections (plus 3212 Friedel-related reflections)
4821 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.04$
 $\theta_{\max} = 27.5^\circ$
 $h = -27 \rightarrow 30$
 $k = -11 \rightarrow 12$
 $l = -18 \rightarrow 18$

Refinement

Refinement on F^2
 $R[F^2 > 2\sigma(F^2)] = 0.043$
 $wR(F^2) = 0.098$
 $S = 1.00$
5677 reflections
365 parameters
H-atom parameters constrained

$w = 1/[\sigma^2(F_o^2) + (0.0495P)^2]$
where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\max} = 0.001$
 $\Delta\rho_{\max} = 0.24$ e Å⁻³
 $\Delta\rho_{\min} = -0.27$ e Å⁻³
Absolute structure: Flack (1983)
Flack parameter = 0.03 (5)

Table 1

Selected geometric parameters (Å, °).

N1—N2	1.377 (3)	N13—O12	1.241 (3)
N1—C9a	1.345 (3)	N13—C134	1.467 (3)
N1—C11	1.458 (3)	C13—O133	1.221 (3)
N2—C3	1.340 (3)	C4a—C5	1.445 (3)
C3—C3a	1.407 (3)	C5—O5	1.245 (2)
C3a—C9a	1.370 (3)	C5—C6	1.510 (3)
N13—O11	1.220 (3)		
C9a—N1—N2	110.40 (17)	N2—C3—C3a	111.53 (18)
C9a—N1—C11	129.60 (19)	C9a—C3a—C3	104.13 (18)
N2—N1—C11	119.99 (17)	N1—C9a—C3a	109.04 (19)
C3—N2—N1	104.89 (18)	N1—C9a—N9	126.19 (18)

Table 2

Hydrogen-bonding geometry (Å, °).

$D-H \cdots A$	$D-H$	$H \cdots A$	$D \cdots A$	$D-H \cdots A$
O1A—H1A ⁱ ⋯N2	1.05	1.86	2.904 (3)	175
N9—H9⋯O5 ⁱ	0.92	1.86	2.761 (3)	165
C12—H12B⋯O12 ⁱⁱ	0.99	2.45	3.344 (4)	150

Symmetry codes: (i) $x, 1 - y, \frac{1}{2} + z$; (ii) $x, 1 - y, z - \frac{1}{2}$.

The H atoms on atoms N9 and O1A were located on a difference map; all other H atoms were placed in calculated positions. All H atoms were treated as riding, with C—H = 0.95–1.00 Å, N—H = 0.92 Å and O—H = 1.05 Å. Those attached to atom C2A were calculated as six half H atoms.

Data collection: *KappaCCD Server Software* (Nonius, 1997); cell refinement: *DENZO-SMN* (Otwinowski & Minor, 1997); data reduction: *DENZO-SMN*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *ORTEPII* (Johnson, 1976) and *PLATON* (Spek, 2000); software used to prepare material for publication: *SHELXL97* and *PRPKAPPA* (Ferguson, 1999).

The X-ray data were collected at the EPSRC X-ray Crystallographic Service, University of Southampton. The authors thank the staff for all their help and advice.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: GG1082). Services for accessing these data are described at the back of the journal.

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