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Ethyl 5-cyano-8-nitro-2,3,4,4a,5,6-hexahydro-1*H*-pyrido[1,2-*a*]quinoline-5-carboxylate

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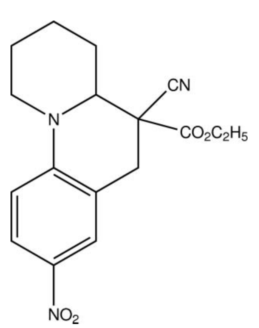
Key indicators: single-crystal X-ray study; T = 223 K; mean σ(C–C) = 0.003 Å; R factor = 0.055; wR factor = 0.096; data-to-parameter ratio = 11.5.

In the title compound, $C_{17}H_{19}N_3O_4$, the piperidine ring adopts a chair conformation. The crystal structure features inversion dimers linked by pairs of weak C—H···N hydrogen bonds.

Related literature

For the therapeutic properties of quinoline derivatives, see: Dalla Via *et al.* (2008); Gasparotto *et al.* (2006); Ferlin *et al.* (2000). A similar heterocyclic structure, Mitomycin C, is used in cancer therapy, see: Crooke & Bradner (1976); Danishefsky & Ciufolini (1984); Remers (1980). For related structures, see: Zhuravleva *et al.* (2009); Oliveira *et al.* (2006). For ring conformation analysis, see: Cremer & Pople (1975). For reference bond lengths, see: Allen *et al.* (1987).



Experimental

Crystal data

$C_{17}H_{19}N_3O_4$
M_r = 329.36
Triclinic, $P\bar{1}$
a = 8.8257 (4) Å
b = 9.2256 (5) Å
c = 10.5011 (6) Å
α = 88.246 (4)°
β = 75.089 (2)°
γ = 83.289 (3)°
V = 820.57 (8) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 0.10 mm^{-1}
T = 223 K
0.20 × 0.20 × 0.20 mm

Data collection

Nonius KappaCCD diffractometer
10064 measured reflections
4189 independent reflections
2794 reflections with $I > 2\sigma(I)$
R_{int} = 0.04

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.055
$wR(F^2)$ = 0.096
S = 1.04
2503 reflections
217 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.21 e Å^{-3}
$\Delta\rho_{min}$ = −0.26 e Å^{-3}

Table 1
Hydrogen-bond geometry (Å, °).

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
C7—H72···N3^{i}	0.97	2.56	3.492 (3)	161

Symmetry code: (i) $-x+1, -y+1, -z+1$.

Data collection: *COLLECT* (Nonius, 2001); cell refinement: *DENZO/SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *DENZO/SCALEPACK*; program(s) used to solve structure: *SIR2004* (Burla *et al.*, 2005); program(s) used to refine structure: *CRYSTALS* (Betteridge *et al.*, 2003); molecular graphics: *PLATON* (Spek, 2009); software used to prepare material for publication: *CRYSTALS*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: BQ2218).

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supplementary materials

Acta Cryst. (2010). E**66**, o1735 [**doi:10.1107/S160053681002283X**]

Ethyl 5-cyano-8-nitro-2,3,4,4a,5,6-hexahydro-1*H*-pyrido[1,2-*a*]quinoline-5-carboxylate

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Comment

Tricyclic quinoline derivatives have diverse and important therapeutic properties (Dalla Via *et al.*, 2008; Gasparotto *et al.*, 2006; Ferlin *et al.*, 2000). These heterocyclic are similar to Mitomycin C which is a powerful antibiotic used in cancerous chemotherapy (Crooke *et al.*, 1976; Remers *et al.*, 1980; Danishefsky *et al.*, 1984). They are also used as intermediate compound to elaborate keratic fiber colorings. Here, we report the single X-ray determination of the title compound $C_{17}H_{19}N_3O_4$, (I), in order to have a best insight of its structure and then to undertake a study of its possible therapeutic activity. The molecular structure of this compound and its atomic labeling scheme are shown in Figure 1. The bond lenghts distances are within the accepted range (Allen *et al.*, 1987). In (I), there are two coupled rings: quinoline and piperidine rings. The geometrical characteristics relating bond distances in quinoline ring are consistent and present no particularity with the recently reported (Oliveira *et al.*, 2006; Zhuravleva *et al.*, 2009). By least squares planes method, it is observed that carbon atom C8 deviates of -0.4074Å to quinoline cycle plane what proves that quinoline ring is not veritably plane. Concerning piperidine ring, it assumes a chair conformation which the puckering parameters (Cremer & Pople, 1975): θ=7.78°, Q=0.6147Å and Φ=42.46°. The crystal packing is due to the weak hydrogen bonds C-H···N which ensure crystal cohesion (Table 1 and Figure 2).

Experimental

3.5 g, 10 mmol of malonic arylidene was dissolved in 10 ml of dimethylformamide. The melange was heated to reflux during 24 h. After cooling to ambient temperature, 20 ml of water was added to the melange. After extraction to ethyl acetate (150 ml), the organic layers were dried on magnesium sulfate, filtered and concentrated under reduced pressure. The residue was purified by chromatography on silica gel using hexane/ethyl acetate (80/20) to obtain yellow crystals with 45% yields. The melting point is 424 K

Refinement

The H atoms were all located in a difference map and then treated as ridings atoms with C—H in the range 0.93–0.98Å and U_{iso}(H) in the range 1.2–1.5 times U_{eq} of the parent atom.

Figures

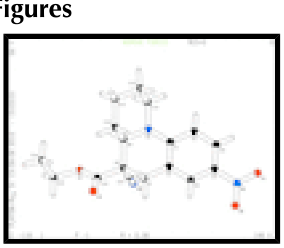


Fig. 1. The title compound with displacement ellipsoids drawn at the 50% probability level.

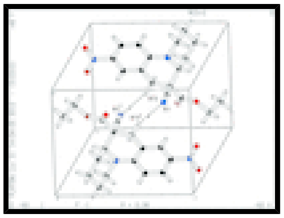


Fig. 2. The crystal packing of (I). Hydrogen bonds C-H···N are shown as dashes lines: Symmetry code : (i) -x+1, -y+1, -z+1.

Ethyl 5-cyano-8-nitro-2,3,4,4a,5,6-hexahydro- 1*H*-pyrido[1,2-*a*]quinoline-5-carboxylate

Crystal data

$C_{17}H_{19}N_3O_4$	$Z = 2$
$M_r = 329.36$	$F(000) = 348$
Triclinic, $P\overline{1}$	$D_x = 1.333$ Mg m^{-3}
Hall symbol: -P 1	Melting point: 424 K
$a = 8.8257$ (4) Å	Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
$b = 9.2256$ (5) Å	Cell parameters from 10064 reflections
$c = 10.5011$ (6) Å	$\theta = 2–29°$
$\alpha = 88.246$ (4)°	$\mu = 0.10$ mm^{-1}
$\beta = 75.089$ (2)°	$T = 223$ K
$\gamma = 83.289$ (3)°	Prism, yellow
$V = 820.57$ (8) Å^3	0.20 × 0.20 × 0.20 mm

Data collection

Nonius KappaCCD diffractometer	$R_{int} = 0.04$
graphite	$\theta_{max} = 29.1°$, $\theta_{min} = 2.0°$
φ and ω scans	$h = 0\rightarrow12$
10064 measured reflections	$k = -11\rightarrow12$
4189 independent reflections	$l = -13\rightarrow14$
2794 reflections with $I > 2\sigma(I)$	

Refinement

Refinement on F^2	Primary atom site location: structure-invariant direct methods
Least-squares matrix: full	Hydrogen site location: inferred from neighbouring sites
$R[F^2 > 2\sigma(F^2)] = 0.055$	H-atom parameters constrained
$wR(F^2) = 0.096$	$w = 1/[\sigma^2(F^2) + (0.02P)^2 + 0.5P]$, where $P = (\max(F_o^2,0) + 2F_c^2)/3$
$S = 1.04$	$(\Delta/\sigma)_{max} = 0.0002$
2503 reflections	$\Delta\rho_{max} = 0.21$ e Å^{-3}
217 parameters	$\Delta\rho_{min} = -0.26$ e Å^{-3}
0 restraints	

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2)

	x	*y*	*z*	U_{iso}*/U_{eq}
C1	0.70920 (19)	0.86006 (18)	0.50748 (17)	0.0241
N1	0.70324 (17)	0.85963 (14)	0.63954 (14)	0.0268
O3	0.66155 (17)	0.46173 (14)	0.84947 (13)	0.0393
C9	0.7451 (2)	0.72488 (18)	0.70764 (17)	0.0256
C2	0.6873 (2)	0.99129 (19)	0.43830 (18)	0.0287
C6	0.7271 (2)	0.72669 (18)	0.43802 (17)	0.0269
C5	0.7160 (2)	0.72795 (19)	0.30929 (18)	0.0308
C4	0.6920 (2)	0.8595 (2)	0.24574 (17)	0.0311
O4	0.8187 (2)	0.35165 (15)	0.66714 (15)	0.0548
O2	0.6821 (2)	0.74186 (19)	0.05771 (16)	0.0639
C3	0.6790 (2)	0.99068 (19)	0.30939 (18)	0.0308
C7	0.7604 (2)	0.58338 (19)	0.50323 (18)	0.0325
C8	0.6879 (2)	0.59435 (18)	0.65159 (17)	0.0278
C10	0.9210 (2)	0.7072 (2)	0.70064 (19)	0.0327
N3	0.3802 (2)	0.63652 (18)	0.69548 (19)	0.0450
N2	0.6797 (2)	0.8591 (2)	0.11110 (17)	0.0436
O1	0.6673 (2)	0.97711 (19)	0.05381 (15)	0.0652
C13	0.7303 (2)	0.98771 (19)	0.70769 (18)	0.0310
C17	0.5143 (2)	0.61781 (18)	0.67811 (19)	0.0322
C12	0.9039 (2)	0.9820 (2)	0.70523 (19)	0.0346
C14	0.7321 (2)	0.45278 (19)	0.72194 (19)	0.0328
C11	0.9606 (2)	0.8393 (2)	0.7643 (2)	0.0358
C15	0.6946 (3)	0.3372 (2)	0.9327 (2)	0.0461
C16	0.8465 (4)	0.3441 (3)	0.9667 (3)	0.0711
H91	0.6874	0.7364	0.8009	0.0307*
H51	0.7270	0.6393	0.2640	0.0374*
H31	0.6639	1.0787	0.2640	0.0358*
H71	0.8751	0.5568	0.4875	0.0395*
H72	0.7193	0.5065	0.4655	0.0388*
H101	0.9454	0.6173	0.7460	0.0386*
H102	0.9806	0.7000	0.6083	0.0399*
H122	0.9191	1.0653	0.7543	0.0424*
H121	0.9656	0.9890	0.6138	0.0425*
H112	1.0737	0.8312	0.7531	0.0436*
H111	0.9082	0.8405	0.8586	0.0444*
H152	0.6075	0.3476	1.0124	0.0547*
H151	0.6960	0.2467	0.8845	0.0545*
H162	0.8619	0.2658	1.0269	0.0858*
H161	0.8453	0.4366	1.0086	0.0858*
H163	0.9346	0.3328	0.8875	0.0858*
H21	0.6783	1.0810	0.4814	0.0340*
H131	0.6679	0.9883	0.7985	0.0380*
H132	0.6990	1.0760	0.6639	0.0380*

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C1	0.0202 (8)	0.0264 (9)	0.0259 (9)	−0.0011 (6)	−0.0068 (7)	−0.0010 (7)
N1	0.0338 (9)	0.0213 (7)	0.0269 (8)	0.0003 (6)	−0.0122 (7)	−0.0028 (6)
O3	0.0480 (9)	0.0337 (7)	0.0313 (8)	0.0038 (6)	−0.0057 (6)	0.0066 (6)
C9	0.0293 (9)	0.0242 (8)	0.0237 (9)	−0.0009 (7)	−0.0087 (7)	0.0007 (7)
C2	0.0264 (9)	0.0269 (9)	0.0316 (10)	−0.0020 (7)	−0.0061 (8)	0.0012 (7)
C6	0.0268 (9)	0.0274 (9)	0.0258 (9)	−0.0008 (7)	−0.0066 (7)	0.0000 (7)
C5	0.0332 (10)	0.0331 (10)	0.0262 (9)	−0.0035 (8)	−0.0076 (8)	−0.0024 (7)
C4	0.0301 (10)	0.0422 (11)	0.0206 (9)	−0.0055 (8)	−0.0058 (7)	0.0036 (7)
O4	0.0801 (12)	0.0323 (8)	0.0403 (9)	0.0185 (8)	−0.0056 (8)	0.0011 (6)
O2	0.0985 (15)	0.0666 (11)	0.0350 (9)	−0.0240 (10)	−0.0255 (9)	−0.0007 (8)
C3	0.0245 (9)	0.0345 (10)	0.0313 (10)	−0.0025 (7)	−0.0048 (8)	0.0086 (8)
C7	0.0452 (11)	0.0265 (9)	0.0259 (10)	0.0021 (8)	−0.0115 (9)	−0.0037 (7)
C8	0.0326 (10)	0.0233 (9)	0.0276 (10)	0.0006 (7)	−0.0097 (8)	0.0001 (7)
C10	0.0302 (10)	0.0314 (10)	0.0361 (11)	0.0007 (8)	−0.0101 (8)	0.0039 (8)
N3	0.0402 (11)	0.0384 (10)	0.0596 (12)	−0.0061 (8)	−0.0174 (9)	−0.0034 (8)
N2	0.0455 (11)	0.0574 (12)	0.0267 (9)	−0.0062 (9)	−0.0076 (8)	0.0059 (8)
O1	0.0931 (14)	0.0654 (11)	0.0342 (9)	0.0056 (10)	−0.0195 (9)	0.0154 (8)
C13	0.0372 (11)	0.0257 (9)	0.0320 (10)	−0.0002 (8)	−0.0132 (8)	−0.0046 (7)
C17	0.0422 (12)	0.0223 (9)	0.0349 (10)	−0.0051 (8)	−0.0141 (9)	−0.0009 (7)
C12	0.0362 (11)	0.0338 (10)	0.0358 (11)	−0.0078 (8)	−0.0110 (9)	−0.0017 (8)
C14	0.0400 (11)	0.0265 (9)	0.0321 (10)	−0.0015 (8)	−0.0105 (9)	0.0009 (8)
C11	0.0282 (10)	0.0431 (11)	0.0378 (11)	−0.0062 (8)	−0.0108 (8)	0.0019 (9)
C15	0.0573 (14)	0.0401 (12)	0.0364 (12)	0.0018 (10)	−0.0088 (10)	0.0141 (9)
C16	0.0735 (19)	0.086 (2)	0.0595 (17)	−0.0018 (15)	−0.0330 (15)	0.0224 (14)

Geometric parameters (Å, °)

C1—N1	1.374 (2)	C7—H72	0.971
C1—C2	1.412 (2)	C8—C17	1.476 (3)
C1—C6	1.422 (2)	C8—C14	1.541 (2)
N1—C9	1.472 (2)	C10—C11	1.525 (3)
N1—C13	1.474 (2)	C10—H101	0.973
O3—C14	1.324 (2)	C10—H102	0.977
O3—C15	1.469 (2)	N3—C17	1.143 (2)
C9—C8	1.546 (2)	N2—O1	1.235 (2)
C9—C10	1.524 (3)	C13—C12	1.520 (3)
C9—H91	0.983	C13—H131	0.970
C2—C3	1.375 (3)	C13—H132	0.970
C2—H21	0.941	C12—C11	1.524 (3)
C6—C5	1.380 (2)	C12—H122	0.979
C6—C7	1.504 (2)	C12—H121	0.979
C5—C4	1.388 (3)	C11—H112	0.969
C5—H51	0.941	C11—H111	0.979
C4—C3	1.379 (3)	C15—C16	1.482 (4)
C4—N2	1.446 (2)	C15—H152	0.979

O4—C14	1.194 (2)	C15—H151	0.987
O2—N2	1.229 (2)	C16—H162	0.966
C3—H31	0.942	C16—H161	0.969
C7—C8	1.526 (2)	C16—H163	0.980
C7—H71	0.985		

N1—C1—C2	121.61 (15)	C11—C10—H101	111.3
N1—C1—C6	120.57 (15)	C9—C10—H102	109.0
C2—C1—C6	117.69 (16)	C11—C10—H102	109.9
C1—N1—C9	121.40 (13)	H101—C10—H102	109.1
C1—N1—C13	122.69 (14)	C4—N2—O2	119.05 (17)
C9—N1—C13	109.99 (13)	C4—N2—O1	118.60 (18)
C14—O3—C15	117.40 (15)	O2—N2—O1	122.36 (18)
N1—C9—C8	109.45 (14)	N1—C13—C12	110.21 (14)
N1—C9—C10	110.06 (14)	N1—C13—H131	109.3
C8—C9—C10	114.36 (14)	C12—C13—H131	109.3
N1—C9—H91	107.0	N1—C13—H132	109.3
C8—C9—H91	108.0	C12—C13—H132	109.3
C10—C9—H91	107.7	H131—C13—H132	109.4
C1—C2—C3	121.40 (16)	C8—C17—N3	178.4 (2)
C1—C2—H21	119.3	C13—C12—C11	110.80 (15)
C3—C2—H21	119.3	C13—C12—H122	109.2
C1—C6—C5	120.13 (16)	C11—C12—H122	110.4
C1—C6—C7	120.45 (15)	C13—C12—H121	109.0
C5—C6—C7	119.41 (15)	C11—C12—H121	109.0
C6—C5—C4	120.19 (16)	H122—C12—H121	108.5
C6—C5—H51	119.8	C8—C14—O3	110.12 (15)
C4—C5—H51	120.0	C8—C14—O4	123.73 (18)
C5—C4—C3	120.93 (17)	O3—C14—O4	126.15 (17)
C5—C4—N2	119.57 (17)	C10—C11—C12	111.70 (16)
C3—C4—N2	119.49 (17)	C10—C11—H112	108.7
C4—C3—C2	119.60 (16)	C12—C11—H112	110.4
C4—C3—H31	119.5	C10—C11—H111	109.4
C2—C3—H31	120.9	C12—C11—H111	107.7
C6—C7—C8	110.18 (14)	H112—C11—H111	108.9
C6—C7—H71	110.2	O3—C15—C16	110.69 (19)
C8—C7—H71	108.6	O3—C15—H152	104.8
C6—C7—H72	110.0	C16—C15—H152	110.0
C8—C7—H72	110.7	O3—C15—H151	108.1
H71—C7—H72	107.2	C16—C15—H151	111.3
C9—C8—C7	109.74 (14)	H152—C15—H151	111.7
C9—C8—C17	108.75 (14)	C15—C16—H162	109.3
C7—C8—C17	109.52 (15)	C15—C16—H161	110.0
C9—C8—C14	109.75 (14)	H162—C16—H161	109.0
C7—C8—C14	111.10 (14)	C15—C16—H163	110.6
C17—C8—C14	107.93 (15)	H162—C16—H163	108.3
C9—C10—C11	109.16 (14)	H161—C16—H163	109.6
C9—C10—H101	108.3		

Hydrogen-bond geometry (Å, °)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
C7—H72···N3^{i}	0.97	2.56	3.492 (3)	161

Symmetry codes: (i) −*x*+1, −*y*+1, −*z*+1.

Fig. 1

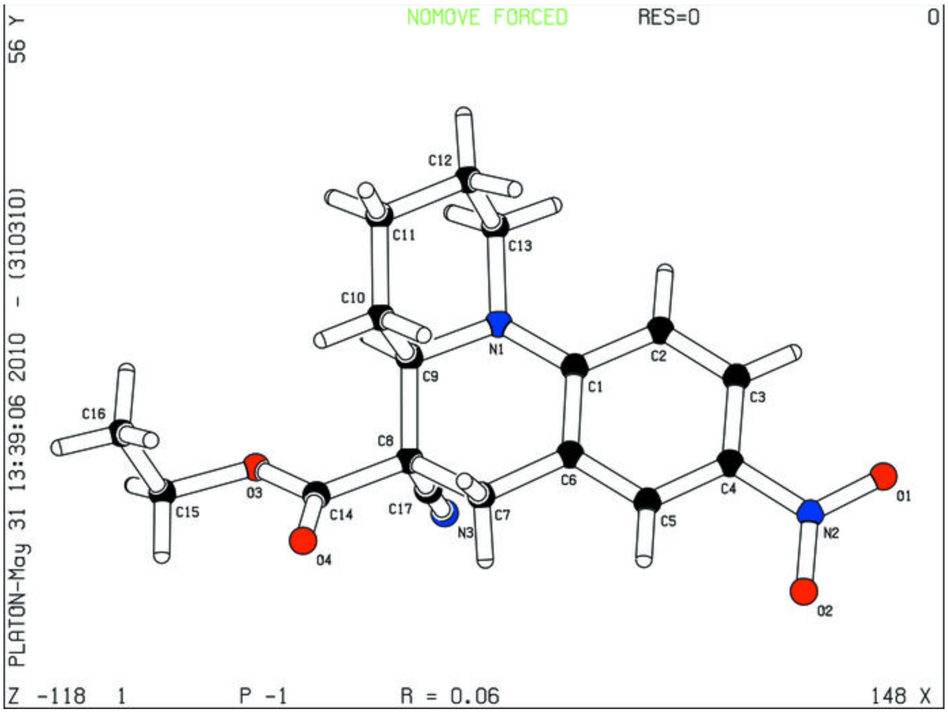
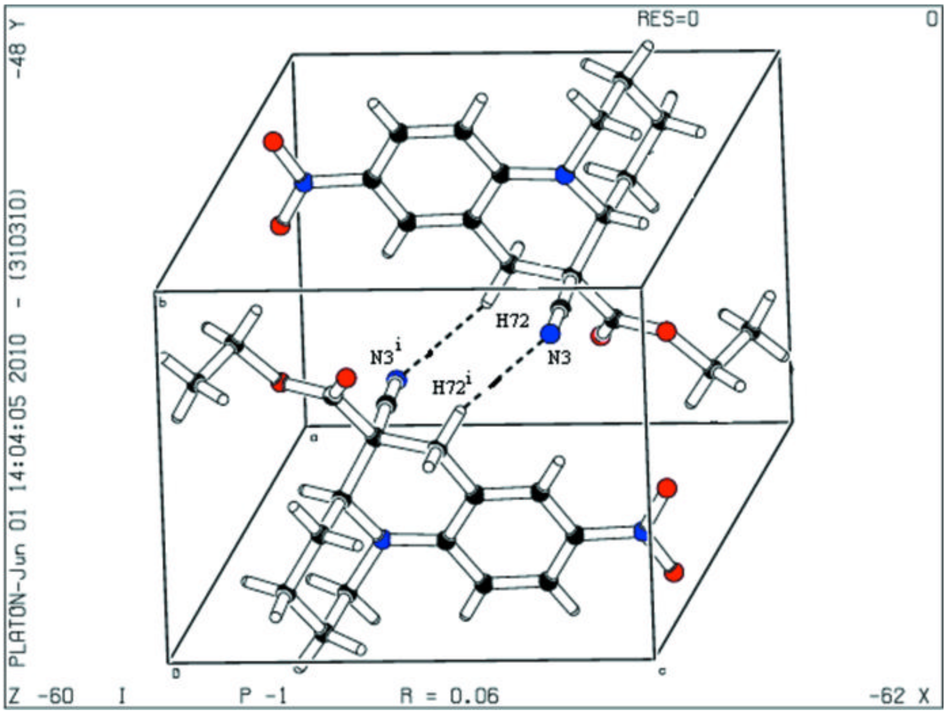

NOMOVE FORCED
RES=0
0
56 Y
PLATON-May 31 13:39:06 2010 - (310310)
Z -118 1
P -1
R = 0.06
148 X
C12
C11
C13
C10
N1
C2
C9
C1
C3
C16
C8
C6
C4
O3
C15
C14
C17
C7
C5
N2
O1
N3
O4
O2

Fig. 2


RES=0
0
-48 Y
PLATON-Jun 01 14:04:05 2010 - (310310)
H72
N3
N3i
H72i
Z -60
I
P -1
R = 0.06
-62 X