

## Diaquabis(2-bromobenzoato- $\kappa$ O)bis(*N,N*-diethylnicotinamide- $\kappa$ N<sup>1</sup>)cobalt(II)

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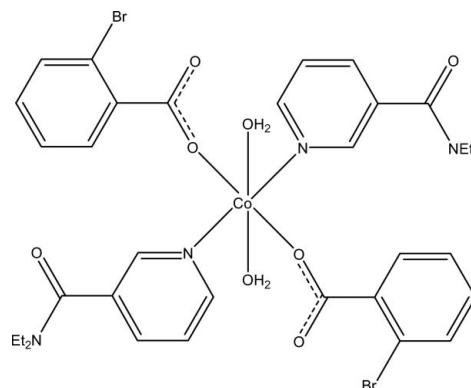
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Key indicators: single-crystal X-ray study;  $T = 100$  K; mean  $\sigma(\text{C}-\text{C}) = 0.003$  Å;  $R$  factor = 0.028;  $wR$  factor = 0.064; data-to-parameter ratio = 19.4.

In the mononuclear title compound,  $[\text{Co}(\text{C}_7\text{H}_4\text{BrO}_2)_2(\text{C}_{10}\text{H}_{14}\text{N}_2\text{O})_2(\text{H}_2\text{O})_2]$ , the  $\text{Co}^{\text{II}}$  ion is located on a crystallographic inversion center. The asymmetric unit is completed by one 2-bromobenzoate anion, one diethylnicotinamide (DNA) ligand and one coordinated water molecule; all ligands are monodentate. The four O atoms in the equatorial plane around  $\text{Co}^{\text{II}}$  form a slightly distorted square-planar arrangement, while the slightly distorted octahedral coordination is completed by the two pyridine N atoms of the DNA ligands in axial positions. The dihedral angle between the carboxylate group and the attached benzene ring is  $84.7(1)^\circ$ ; the pyridine and benzene rings are oriented at a dihedral angle of  $43.64(6)^\circ$ . In the crystal structure, intermolecular  $\text{O}-\text{H}\cdots\text{O}$  and  $\text{C}-\text{H}\cdots\text{O}$  hydrogen bonds link the molecules into a three-dimensional network.

### Related literature

For niacin, see: Krishnamachari (1974). For *N,N*-diethylnicotinamide, see: Bigoli *et al.* (1972). For related structures, see: Hökelek, Dal, Tercan, Aybirdi *et al.* (2009); Hökelek *et al.* (2009*a,b,c,d,e*); Necefoğlu *et al.* (2010).



### Experimental

#### Crystal data

$[\text{Co}(\text{C}_7\text{H}_4\text{BrO}_2)_2(\text{C}_{10}\text{H}_{14}\text{N}_2\text{O})_2(\text{H}_2\text{O})_2]$   
 $M_r = 851.43$   
 Monoclinic,  $P2_1/n$   
 $a = 13.0106(2)$  Å  
 $b = 10.3513(2)$  Å  
 $c = 14.9580(3)$  Å

$\beta = 114.311(1)^\circ$   
 $V = 1835.86(6)$  Å<sup>3</sup>  
 $Z = 2$   
 Mo  $K\alpha$  radiation  
 $\mu = 2.70$  mm<sup>-1</sup>  
 $T = 100$  K  
 $0.31 \times 0.28 \times 0.23$  mm

#### Data collection

Bruker Kappa APEXII CCD  
 area-detector diffractometer  
 Absorption correction: multi-scan  
 (SADABS; Bruker, 2005)  
 $T_{\text{min}} = 0.489$ ,  $T_{\text{max}} = 0.576$

16787 measured reflections  
 4528 independent reflections  
 3700 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.029$

#### Refinement

$R[F^2 > 2\sigma(F^2)] = 0.028$   
 $wR(F^2) = 0.064$   
 $S = 1.04$   
 4528 reflections  
 233 parameters

H atoms treated by a mixture of independent and constrained refinement  
 $\Delta\rho_{\text{max}} = 0.60$  e Å<sup>-3</sup>  
 $\Delta\rho_{\text{min}} = -0.32$  e Å<sup>-3</sup>

**Table 1**

Hydrogen-bond geometry (Å, °).

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
O4—H41 <sup>i</sup> ···O3 <sup>i</sup>	0.82 (3)	1.94 (3)	2.757 (2)	174 (3)
O4—H42 <sup>i</sup> ···O1 <sup>ii</sup>	0.78 (3)	1.90 (3)	2.644 (2)	159 (2)
C4—H4 <sup>i</sup> ···O1 <sup>iii</sup>	0.93	2.56	3.184 (3)	125
C10—H10 <sup>i</sup> ···O2 <sup>iv</sup>	0.93	2.44	3.368 (2)	174
C12—H12 <sup>i</sup> ···O3 <sup>v</sup>	0.93	2.33	3.259 (2)	179
C16—H16A <sup>i</sup> ···O3 <sup>vi</sup>	0.97	2.57	3.506 (2)	163
C16—H16B <sup>i</sup> ···O1 <sup>i</sup>	0.97	2.52	3.460 (3)	164

Symmetry codes: (i)  $-x + \frac{3}{2}, y + \frac{1}{2}, -z + \frac{1}{2}$ ; (ii)  $-x + 1, -y, -z$ ; (iii)  $-x + \frac{1}{2}, y + \frac{1}{2}, -z + \frac{1}{2}$ ; (iv)  $-x + \frac{3}{2}, y - \frac{1}{2}, -z + \frac{1}{2}$ ; (v)  $x - \frac{1}{2}, -y - \frac{1}{2}, z - \frac{1}{2}$ ; (vi)  $-x + 2, -y, -z + 1$ .

Data collection: APEX2 (Bruker, 2007); cell refinement: SAINT (Bruker, 2007); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: ORTEP-3 for Windows (Farrugia, 1997) and PLATON (Spek, 2009); software used to prepare material for publication: WinGX (Farrugia, 1999) and PLATON.

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ometer. This work was supported financially by Kafkas University Research Fund (grant No. 2009-FEF-03).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: IM2218).

## References

- Bigoli, F., Braibanti, A., Pellinghelli, M. A. & Tiripicchio, A. (1972). *Acta Cryst.* **B28**, 962–966.
- Bruker (2005). *SADABS*. Bruker AXS Inc., Madison, Wisconsin, USA.
- Bruker (2007). *APEX2* and *SAINT*. Bruker AXS Inc., Madison, Wisconsin, USA.
- Farrugia, L. J. (1997). *J. Appl. Cryst.* **30**, 565.
- Farrugia, L. J. (1999). *J. Appl. Cryst.* **32**, 837–838.
- Hökelek, T., Dal, H., Tercan, B., Aybirdi, Ö. & Necefoğlu, H. (2009). *Acta Cryst.* **E65**, m1051–m1052.
- Hökelek, T., Dal, H., Tercan, B., Özbek, F. E. & Necefoğlu, H. (2009a). *Acta Cryst.* **E65**, m545–m546.
- Hökelek, T., Dal, H., Tercan, B., Özbek, F. E. & Necefoğlu, H. (2009b). *Acta Cryst.* **E65**, m533–m534.
- Hökelek, T., Dal, H., Tercan, B., Özbek, F. E. & Necefoğlu, H. (2009c). *Acta Cryst.* **E65**, m513–m514.
- Hökelek, T., Dal, H., Tercan, B., Özbek, F. E. & Necefoğlu, H. (2009d). *Acta Cryst.* **E65**, m481–m482.
- Hökelek, T., Yılmaz, F., Tercan, B., Özbek, F. E. & Necefoğlu, H. (2009e). *Acta Cryst.* **E65**, m766–m767.
- Krishnamachari, K. A. V. R. (1974). *Am. J. Clin. Nutr.* **27**, 108–111.
- Necefoğlu, H., Çimen, E., Tercan, B., Ermiş, E. & Hökelek, T. (2010). *Acta Cryst.* **E66**, m556–m557.
- Sheldrick, G. M. (2008). *Acta Cryst.* **A64**, 112–122.
- Spek, A. L. (2009). *Acta Cryst.* **D65**, 148–155.

## supporting information

*Acta Cryst.* (2010). E66, m1132–m1133 [https://doi.org/10.1107/S1600536810032630]

**Diaquabis(2-bromobenzoato- $\kappa$ O)bis(*N,N*-diethylnicotinamide- $\kappa$ N<sup>1</sup>)cobalt(II)****Tuncer Hökelek, Güner Saka, Barış Tercan, Füreyâ Elif Öztürkkan and Hacali Necefoğlu****S1. Comment**

As a part of our ongoing investigation on transition metal complexes of nicotinamide (NA), one form of niacin (Krishnamachari, 1974), and/or the nicotinic acid derivative *N,N*-diethylnicotinamide (DENA), an important respiratory stimulant (Bigoli *et al.*, 1972), the title compound was synthesized and its crystal structure is reported herein.

The title compound, (I), is a mononuclear complex, in which the Co<sup>II</sup> ion is located on a crystallographic inversion center. The asymmetric unit contains one 2-bromobenzoate (BB) anion, one diethylnicotinamide (DENA) ligand and one coordinated water molecule, all ligands are monodentate (Fig. 1). The crystal structures of some DENA complexes of Co<sup>II</sup>, Ni<sup>II</sup>, Mn<sup>II</sup> and Zn<sup>II</sup> ions, [Co(C<sub>8</sub>H<sub>7</sub>O<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (II) (Necefoğlu *et al.*, 2010), [Co(C<sub>9</sub>H<sub>10</sub>NO<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (III) (Hökelek, Dal, Tercan, Aybirdi *et al.*, 2009), [Ni(C<sub>7</sub>H<sub>4</sub>ClO<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (IV) (Hökelek *et al.*, 2009*a*), [Ni(C<sub>7</sub>H<sub>4</sub>BrO<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (V) (Hökelek *et al.*, 2009*e*), [Mn(C<sub>7</sub>H<sub>4</sub>BrO<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (VI) (Hökelek *et al.*, 2009*b*), [Mn(C<sub>7</sub>H<sub>4</sub>ClO<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (VII) (Hökelek *et al.*, 2009*c*) and [Zn(C<sub>7</sub>H<sub>4</sub>BrO<sub>2</sub>)<sub>2</sub>(C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>O)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>], (VIII) (Hökelek *et al.*, 2009*d*) have been reported before.

The four O atoms (O2, O4 and symmetry-related atoms O2', O4') in the equatorial plane around the Co<sup>II</sup> ion form a slightly distorted square-planar arrangement. The slightly distorted octahedral coordination is completed by the two pyridyl N atoms of DENA ligands (N1, N1') in axial positions (Fig. 1). The near equality of C1—O1 [1.242 (2) Å] and C1—O2 [1.264 (2) Å] in the carboxylate group indicates a delocalized bonding arrangement rather than localized single and double bonds. The average Co—O bond length is 2.092 (1) Å (Table 1), and the Co<sup>II</sup> ion is displaced out of the least-squares plane of the carboxylate group (O1/C1/O2) by -0.3436 (1) Å. The dihedral angle between the planar carboxylate moiety and the benzene ring A (C2—C7) is 84.7 (1)°, while that between rings A and B (N1/C8—C12) is 43.64 (6)°.

In the crystal structure, intermolecular O—H...O and C—H...O hydrogen bonds (Table 2) link the molecules into a three-dimensional network (Fig. 2).

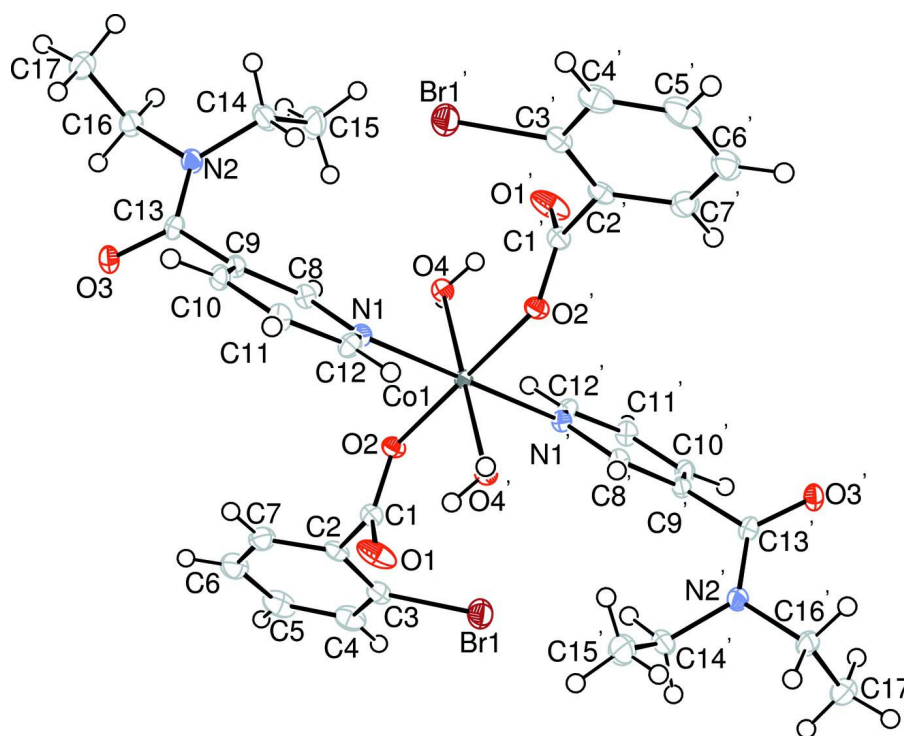
**S2. Experimental**

The title compound was prepared by the reaction of CoSO<sub>4</sub> × 7 H<sub>2</sub>O (1.40 g, 5 mmol) in H<sub>2</sub>O (40 ml) and diethylnicotinamide (1.78 g, 10 mmol) in H<sub>2</sub>O (20 ml) with sodium 2-bromobenzoate (2.23 g, 10 mmol) in H<sub>2</sub>O (50 ml). The mixture was filtered and set aside to crystallize at ambient temperature for two weeks, giving pink single crystals (yield; 3.065 g, 72%).

**S3. Refinement**

Atoms H41 and H42 (for H<sub>2</sub>O) were located from a difference Fourier map and refined isotropically. The remaining H atoms were positioned geometrically with C—H = 0.93, 0.97 and 0.96 Å for aromatic, methylene and methyl H atoms and constrained to ride on their parent atoms, with  $U_{\text{iso}}(\text{H}) = xU_{\text{eq}}(\text{C})$ , where  $x = 1.5$  for methyl H and  $x = 1.2$  for all other

H atoms.

**Figure 1**

The molecular structure of the title compound, showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 50% probability level. [Symmetry code: (') 1-x, -y, -z.]

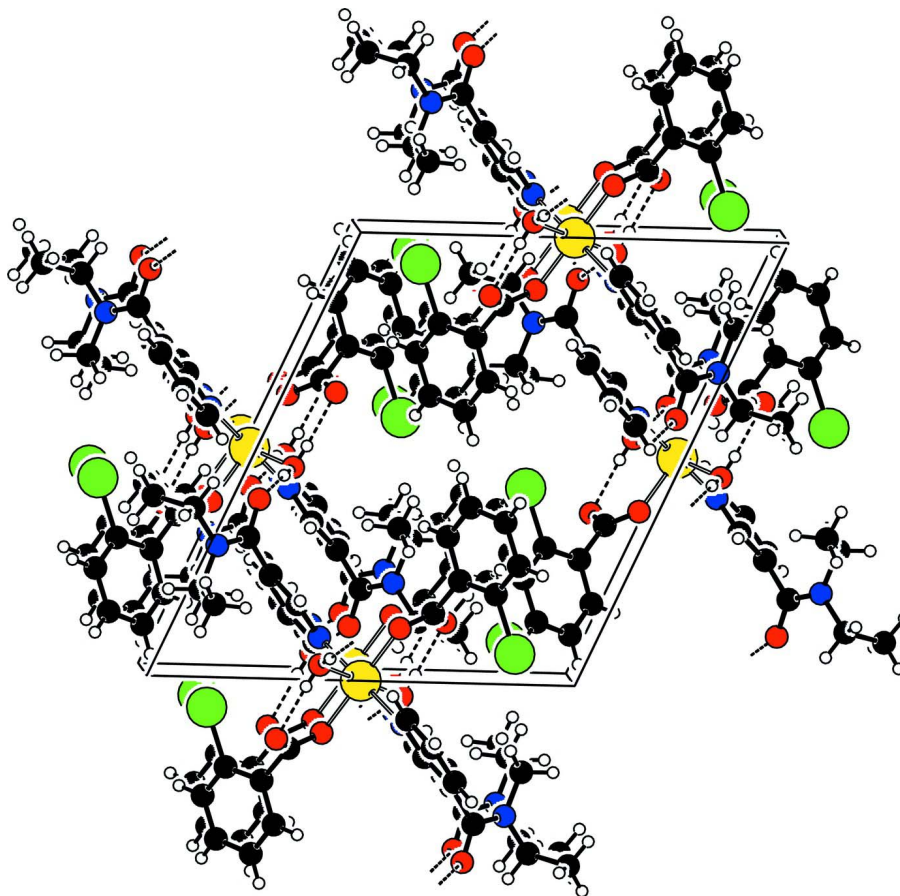


Figure 2

Partial packing diagram, viewed down the *b* axis, with the *a* axis horizontal and the *c* axis vertical. Hydrogen bonds are shown as dashed lines.

### Diaquabis(2-bromobenzoato- $\kappa$ O)bis(*N,N*-diethylnicotinamide- $\kappa$ N<sup>1</sup>)cobalt(II)

#### Crystal data

$[\text{Co}(\text{C}_7\text{H}_4\text{BrO}_2)_2(\text{C}_{10}\text{H}_{14}\text{N}_2\text{O})_2(\text{H}_2\text{O})_2]$

$M_r = 851.43$

Monoclinic,  $P2_1/n$

Hall symbol: -P 2<sub>1</sub>/n

$a = 13.0106(2) \text{ \AA}$

$b = 10.3513(2) \text{ \AA}$

$c = 14.9580(3) \text{ \AA}$

$\beta = 114.311(1)^\circ$

$V = 1835.86(6) \text{ \AA}^3$

$Z = 2$

$F(000) = 866$

$D_x = 1.540 \text{ Mg m}^{-3}$

Mo  $K\alpha$  radiation,  $\lambda = 0.71073 \text{ \AA}$

Cell parameters from 6465 reflections

$\theta = 2.5\text{--}28.3^\circ$

$\mu = 2.70 \text{ mm}^{-1}$

$T = 100 \text{ K}$

Block, pink

$0.31 \times 0.28 \times 0.23 \text{ mm}$

#### Data collection

Bruker Kappa APEXII CCD area-detector diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

$\varphi$  and  $\omega$  scans

Absorption correction: multi-scan (*SADABS*; Bruker, 2005)

$T_{\min} = 0.489$ ,  $T_{\max} = 0.576$

16787 measured reflections

4528 independent reflections

3700 reflections with  $I > 2\sigma(I)$

$R_{\text{int}} = 0.029$   
 $\theta_{\text{max}} = 28.4^\circ$ ,  $\theta_{\text{min}} = 1.8^\circ$   
 $h = -17 \rightarrow 17$

$k = -13 \rightarrow 13$   
 $l = -19 \rightarrow 17$

### Refinement

Refinement on  $F^2$   
 Least-squares matrix: full  
 $R[F^2 > 2\sigma(F^2)] = 0.028$   
 $wR(F^2) = 0.064$   
 $S = 1.04$   
 4528 reflections  
 233 parameters  
 0 restraints  
 Primary atom site location: structure-invariant  
 direct methods

Secondary atom site location: difference Fourier  
 map  
 Hydrogen site location: inferred from  
 neighbouring sites  
 H atoms treated by a mixture of independent  
 and constrained refinement  
 $w = 1/[\sigma^2(F_o^2) + (0.0277P)^2 + 0.7345P]$   
 where  $P = (F_o^2 + 2F_c^2)/3$   
 $(\Delta/\sigma)_{\text{max}} < 0.001$   
 $\Delta\rho_{\text{max}} = 0.60 \text{ e } \text{\AA}^{-3}$   
 $\Delta\rho_{\text{min}} = -0.32 \text{ e } \text{\AA}^{-3}$

### Special details

**Geometry.** All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

**Refinement.** Refinement of  $F^2$  against ALL reflections. The weighted R-factor  $wR$  and goodness of fit  $S$  are based on  $F^2$ , conventional R-factors  $R$  are based on  $F$ , with  $F$  set to zero for negative  $F^2$ . The threshold expression of  $F^2 > 2\sigma(F^2)$  is used only for calculating R-factors(gt) etc. and is not relevant to the choice of reflections for refinement. R-factors based on  $F^2$  are statistically about twice as large as those based on  $F$ , and R- factors based on ALL data will be even larger.

### Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters ( $\text{\AA}^2$ )

	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Br1	0.178480 (15)	0.14223 (2)	0.071476 (14)	0.02693 (7)
Co1	0.5000	0.0000	0.0000	0.01023 (8)
O1	0.36578 (13)	-0.11744 (14)	0.13111 (11)	0.0287 (3)
H41	0.603 (2)	0.226 (3)	0.0534 (18)	0.037 (7)*
H42	0.6254 (19)	0.163 (2)	-0.0114 (19)	0.030 (7)*
O2	0.46952 (9)	0.04937 (13)	0.12000 (8)	0.0152 (3)
O3	0.93287 (10)	-0.11547 (13)	0.39609 (9)	0.0169 (3)
O4	0.61748 (10)	0.15516 (14)	0.03719 (10)	0.0142 (3)
N1	0.64001 (11)	-0.12268 (15)	0.09116 (10)	0.0132 (3)
N2	0.98258 (12)	0.00503 (16)	0.29417 (11)	0.0164 (3)
C1	0.40749 (14)	-0.00794 (18)	0.15390 (13)	0.0150 (4)
C2	0.38447 (14)	0.06833 (18)	0.22975 (13)	0.0158 (4)
C3	0.28874 (15)	0.1439 (2)	0.20361 (13)	0.0187 (4)
C4	0.27047 (16)	0.2238 (2)	0.27075 (15)	0.0247 (4)
H4	0.2063	0.2751	0.2512	0.030*
C5	0.34959 (17)	0.2251 (2)	0.36688 (15)	0.0275 (5)
H5	0.3394	0.2790	0.4123	0.033*
C6	0.44413 (16)	0.1466 (2)	0.39613 (15)	0.0264 (5)
H6	0.4958	0.1456	0.4614	0.032*
C7	0.46161 (15)	0.0693 (2)	0.32779 (14)	0.0217 (4)
H7	0.5256	0.0176	0.3476	0.026*

C8	0.72933 (13)	-0.07013 (18)	0.16504 (12)	0.0138 (4)
H8	0.7295	0.0185	0.1752	0.017*
C9	0.82096 (13)	-0.14176 (18)	0.22667 (12)	0.0129 (3)
C10	0.82087 (13)	-0.27504 (19)	0.21376 (12)	0.0153 (4)
H10	0.8800	-0.3260	0.2555	0.018*
C11	0.72976 (14)	-0.32932 (19)	0.13661 (13)	0.0164 (4)
H11	0.7275	-0.4177	0.1248	0.020*
C12	0.64230 (13)	-0.25033 (18)	0.07735 (13)	0.0156 (4)
H12	0.5822	-0.2878	0.0254	0.019*
C13	0.91718 (13)	-0.08168 (18)	0.31162 (12)	0.0132 (4)
C14	0.97403 (16)	0.0414 (2)	0.19635 (14)	0.0267 (5)
H14A	0.9242	-0.0188	0.1483	0.032*
H14B	1.0479	0.0345	0.1954	0.032*
C15	0.92981 (17)	0.1775 (3)	0.16739 (17)	0.0392 (6)
H15A	0.9321	0.1992	0.1058	0.059*
H15B	0.9759	0.2371	0.2169	0.059*
H15C	0.8535	0.1825	0.1611	0.059*
C16	1.08067 (14)	0.0566 (2)	0.37816 (13)	0.0189 (4)
H16A	1.0633	0.0604	0.4353	0.023*
H16B	1.0961	0.1438	0.3634	0.023*
C17	1.18452 (15)	-0.0267 (2)	0.40117 (15)	0.0256 (5)
H17A	1.2461	0.0075	0.4575	0.038*
H17B	1.2042	-0.0268	0.3460	0.038*
H17C	1.1689	-0.1134	0.4146	0.038*

*Atomic displacement parameters (Å<sup>2</sup>)*

	$U^{11}$	$U^{22}$	$U^{33}$	$U^{12}$	$U^{13}$	$U^{23}$
Br1	0.02492 (10)	0.03337 (14)	0.02163 (10)	0.00625 (9)	0.00871 (7)	0.00300 (9)
Co1	0.01015 (13)	0.01029 (18)	0.00981 (15)	-0.00021 (13)	0.00367 (11)	-0.00054 (14)
O1	0.0486 (9)	0.0161 (8)	0.0359 (8)	-0.0111 (7)	0.0320 (7)	-0.0081 (7)
O2	0.0167 (5)	0.0160 (7)	0.0148 (6)	-0.0032 (5)	0.0084 (5)	-0.0023 (6)
O3	0.0195 (6)	0.0154 (7)	0.0119 (6)	-0.0016 (5)	0.0027 (5)	0.0017 (5)
O4	0.0166 (5)	0.0111 (7)	0.0152 (6)	0.0006 (5)	0.0069 (5)	0.0005 (6)
N1	0.0139 (6)	0.0131 (8)	0.0122 (7)	0.0000 (6)	0.0049 (5)	-0.0001 (6)
N2	0.0163 (6)	0.0176 (9)	0.0131 (7)	-0.0036 (6)	0.0040 (5)	0.0003 (7)
C1	0.0163 (7)	0.0141 (10)	0.0157 (8)	0.0017 (7)	0.0076 (6)	0.0007 (8)
C2	0.0208 (8)	0.0127 (10)	0.0178 (9)	-0.0038 (8)	0.0119 (7)	-0.0002 (8)
C3	0.0222 (8)	0.0189 (10)	0.0177 (9)	-0.0027 (8)	0.0109 (7)	-0.0003 (8)
C4	0.0302 (9)	0.0212 (11)	0.0310 (11)	0.0018 (9)	0.0209 (8)	-0.0018 (10)
C5	0.0403 (11)	0.0244 (12)	0.0278 (11)	-0.0071 (10)	0.0240 (9)	-0.0107 (10)
C6	0.0286 (9)	0.0330 (13)	0.0193 (9)	-0.0096 (9)	0.0116 (8)	-0.0070 (10)
C7	0.0191 (8)	0.0245 (12)	0.0218 (9)	-0.0035 (8)	0.0089 (7)	-0.0021 (9)
C8	0.0167 (7)	0.0112 (9)	0.0133 (8)	0.0005 (7)	0.0059 (6)	-0.0002 (7)
C9	0.0138 (7)	0.0132 (9)	0.0110 (8)	-0.0004 (7)	0.0044 (6)	0.0006 (8)
C10	0.0155 (7)	0.0143 (10)	0.0149 (8)	0.0044 (7)	0.0051 (6)	0.0042 (8)
C11	0.0199 (8)	0.0108 (9)	0.0169 (9)	-0.0002 (7)	0.0060 (7)	-0.0006 (8)
C12	0.0137 (7)	0.0160 (10)	0.0150 (8)	-0.0015 (7)	0.0037 (6)	-0.0023 (8)



C13	0.0133 (7)	0.0100 (9)	0.0135 (8)	0.0024 (7)	0.0026 (6)	-0.0004 (7)
C14	0.0255 (9)	0.0390 (14)	0.0146 (9)	-0.0125 (10)	0.0071 (7)	0.0024 (10)
C15	0.0280 (10)	0.0483 (16)	0.0315 (12)	-0.0094 (11)	0.0023 (9)	0.0222 (12)
C16	0.0179 (8)	0.0189 (11)	0.0161 (9)	-0.0066 (8)	0.0033 (7)	-0.0018 (8)
C17	0.0181 (8)	0.0306 (12)	0.0242 (10)	-0.0013 (9)	0.0049 (7)	0.0041 (9)

*Geometric parameters (Å, °)*

Br1—C3	1.9053 (18)	C6—C7	1.388 (3)
Co1—O2	2.0559 (12)	C6—H6	0.9300
Co1—O2 <sup>i</sup>	2.0559 (12)	C7—H7	0.9300
Co1—O4 <sup>i</sup>	2.1272 (13)	C8—H8	0.9300
Co1—N1 <sup>i</sup>	2.1783 (14)	C9—C8	1.384 (2)
O1—C1	1.242 (2)	C9—C10	1.393 (3)
O2—C1	1.264 (2)	C9—C13	1.503 (2)
O3—C13	1.244 (2)	C10—C11	1.388 (2)
O4—Co1	2.1272 (13)	C10—H10	0.9300
O4—H41	0.82 (3)	C11—H11	0.9300
O4—H42	0.78 (3)	C12—C11	1.385 (2)
N1—C12	1.340 (2)	C12—H12	0.9300
N1—C8	1.345 (2)	C14—C15	1.516 (3)
N1—Co1	2.1783 (14)	C14—H14A	0.9700
N2—C13	1.334 (2)	C14—H14B	0.9700
N2—C14	1.470 (2)	C15—H15A	0.9600
N2—C16	1.474 (2)	C15—H15B	0.9600
C2—C1	1.510 (2)	C15—H15C	0.9600
C2—C7	1.395 (2)	C16—C17	1.518 (3)
C3—C2	1.384 (3)	C16—H16A	0.9700
C3—C4	1.395 (3)	C16—H16B	0.9700
C4—C5	1.381 (3)	C17—H17A	0.9600
C4—H4	0.9300	C17—H17B	0.9600
C5—H5	0.9300	C17—H17C	0.9600
C6—C5	1.386 (3)		
O2—Co1—O2 <sup>i</sup>	180.00 (5)	C6—C7—C2	120.88 (18)
O2—Co1—O4	87.71 (5)	C6—C7—H7	119.6
O2 <sup>i</sup> —Co1—O4	92.29 (5)	N1—C8—C9	123.11 (17)
O2—Co1—O4 <sup>i</sup>	92.29 (5)	N1—C8—H8	118.4
O2 <sup>i</sup> —Co1—O4 <sup>i</sup>	87.71 (5)	C9—C8—H8	118.4
O2—Co1—N1	90.60 (5)	C8—C9—C10	119.13 (15)
O2 <sup>i</sup> —Co1—N1	89.40 (5)	C8—C9—C13	122.05 (16)
O2—Co1—N1 <sup>i</sup>	89.40 (5)	C10—C9—C13	118.68 (15)
O2 <sup>i</sup> —Co1—N1 <sup>i</sup>	90.60 (5)	C9—C10—H10	121.1
O4 <sup>i</sup> —Co1—O4	180.00 (7)	C11—C10—C9	117.90 (16)
O4—Co1—N1	87.18 (5)	C11—C10—H10	121.1
O4 <sup>i</sup> —Co1—N1	92.82 (5)	C10—C11—H11	120.4
O4—Co1—N1 <sup>i</sup>	92.82 (5)	C12—C11—C10	119.25 (18)
O4 <sup>i</sup> —Co1—N1 <sup>i</sup>	87.18 (5)	C12—C11—H11	120.4



N1 <sup>i</sup> —Co1—N1	180.00 (13)	N1—C12—C11	123.24 (16)
C1—O2—Co1	128.18 (12)	N1—C12—H12	118.4
Co1—O4—H41	121.8 (17)	C11—C12—H12	118.4
Co1—O4—H42	100.9 (18)	O3—C13—N2	122.44 (15)
H42—O4—H41	109 (2)	O3—C13—C9	118.27 (15)
C8—N1—Co1	119.70 (12)	N2—C13—C9	119.29 (15)
C12—N1—Co1	122.99 (11)	N2—C14—C15	112.75 (18)
C12—N1—C8	117.32 (15)	N2—C14—H14A	109.0
C13—N2—C14	125.02 (15)	N2—C14—H14B	109.0
C13—N2—C16	118.37 (15)	C15—C14—H14A	109.0
C14—N2—C16	116.09 (14)	C15—C14—H14B	109.0
O1—C1—O2	126.67 (17)	H14A—C14—H14B	107.8
O1—C1—C2	118.94 (15)	C14—C15—H15A	109.5
O2—C1—C2	114.40 (16)	C14—C15—H15B	109.5
C3—C2—C1	121.13 (16)	C14—C15—H15C	109.5
C3—C2—C7	117.86 (17)	H15A—C15—H15B	109.5
C7—C2—C1	120.95 (16)	H15A—C15—H15C	109.5
C2—C3—Br1	119.59 (14)	H15B—C15—H15C	109.5
C2—C3—C4	122.13 (17)	N2—C16—C17	111.41 (16)
C4—C3—Br1	118.26 (14)	N2—C16—H16A	109.3
C3—C4—H4	120.6	N2—C16—H16B	109.3
C5—C4—C3	118.71 (19)	C17—C16—H16A	109.3
C5—C4—H4	120.6	C17—C16—H16B	109.3
C4—C5—C6	120.46 (18)	H16A—C16—H16B	108.0
C4—C5—H5	119.8	C16—C17—H17A	109.5
C6—C5—H5	119.8	C16—C17—H17B	109.5
C5—C6—C7	119.88 (18)	C16—C17—H17C	109.5
C5—C6—H6	120.1	H17A—C17—H17B	109.5
C7—C6—H6	120.1	H17A—C17—H17C	109.5
C2—C7—H7	119.6	H17B—C17—H17C	109.5
O4—Co1—O2—C1	-175.42 (14)	C3—C2—C1—O1	-86.0 (2)
O4 <sup>i</sup> —Co1—O2—C1	4.58 (14)	C3—C2—C1—O2	94.2 (2)
N1—Co1—O2—C1	-88.27 (14)	C7—C2—C1—O1	96.9 (2)
N1 <sup>i</sup> —Co1—O2—C1	91.73 (14)	C7—C2—C1—O2	-82.9 (2)
Co1—O2—C1—O1	12.3 (3)	C1—C2—C7—C6	175.44 (17)
Co1—O2—C1—C2	-167.89 (11)	C3—C2—C7—C6	-1.8 (3)
C8—N1—Co1—O2	-61.76 (13)	Br1—C3—C2—C1	4.6 (2)
C8—N1—Co1—O2 <sup>i</sup>	118.24 (13)	Br1—C3—C4—C5	179.62 (15)
C8—N1—Co1—O4	25.92 (13)	Br1—C3—C2—C7	-178.19 (14)
C8—N1—Co1—O4 <sup>i</sup>	-154.08 (13)	C2—C3—C4—C5	-1.4 (3)
C12—N1—Co1—O2	118.37 (14)	C4—C3—C2—C1	-174.33 (17)
C12—N1—Co1—O2 <sup>i</sup>	-61.63 (14)	C4—C3—C2—C7	2.9 (3)
C12—N1—Co1—O4	-153.95 (14)	C3—C4—C5—C6	-1.2 (3)
C12—N1—Co1—O4 <sup>i</sup>	26.05 (14)	C7—C6—C5—C4	2.2 (3)
Co1—N1—C8—C9	179.40 (13)	C5—C6—C7—C2	-0.7 (3)
Co1—N1—C12—C11	-178.31 (13)	C10—C9—C8—N1	-1.4 (3)
C8—N1—C12—C11	1.8 (3)	C13—C9—C8—N1	-177.05 (15)

C12—N1—C8—C9	-0.7 (2)	C8—C9—C10—C11	2.4 (3)
C14—N2—C13—O3	174.95 (18)	C13—C9—C10—C11	178.18 (15)
C14—N2—C13—C9	-4.8 (3)	C8—C9—C13—O3	114.69 (19)
C16—N2—C13—O3	3.6 (3)	C8—C9—C13—N2	-65.5 (2)
C16—N2—C13—C9	-176.22 (15)	C10—C9—C13—O3	-61.0 (2)
C13—N2—C14—C15	110.3 (2)	C10—C9—C13—N2	118.79 (19)
C13—N2—C16—C17	88.6 (2)	C9—C10—C11—C12	-1.4 (3)
C16—N2—C14—C15	-78.2 (2)	N1—C12—C11—C10	-0.8 (3)
C14—N2—C16—C17	-83.5 (2)		

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

#### Hydrogen-bond geometry ( $\text{\AA}$ , $^\circ$ )

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O4—H41 $\cdots$ O3 <sup>ii</sup>	0.82 (3)	1.94 (3)	2.757 (2)	174 (3)
O4—H42 $\cdots$ O1 <sup>i</sup>	0.78 (3)	1.90 (3)	2.644 (2)	159 (2)
C4—H4 $\cdots$ O1 <sup>iii</sup>	0.93	2.56	3.184 (3)	125
C10—H10 $\cdots$ O2 <sup>iv</sup>	0.93	2.44	3.368 (2)	174
C12—H12 $\cdots$ O3 <sup>v</sup>	0.93	2.33	3.259 (2)	179
C16—H16A $\cdots$ O3 <sup>vi</sup>	0.97	2.57	3.506 (2)	163
C16—H16B $\cdots$ O1 <sup>ii</sup>	0.97	2.52	3.460 (3)	164

Symmetry codes: (i)  $-x+1, -y, -z$ ; (ii)  $-x+3/2, y+1/2, -z+1/2$ ; (iii)  $-x+1/2, y+1/2, -z+1/2$ ; (iv)  $-x+3/2, y-1/2, -z+1/2$ ; (v)  $x-1/2, -y-1/2, z-1/2$ ; (vi)  $-x+2, -y, -z+1$ .