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## Structure Reports

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Diaquabis(2-bromobenzoato- $\kappa$ O)bis-(*N,N*-diethylnicotinamide- $\kappa$ N<sup>1</sup>)zinc(II)Tuncer Hökelek,<sup>a</sup> Hakan Dal,<sup>b</sup> Barış Tercan,<sup>c</sup> F. Elif Özbek<sup>d</sup> and Hacali Necefoğlu<sup>d\*</sup><sup>a</sup>Hacettepe University, Department of Physics, 06800 Beytepe, Ankara, Turkey,<sup>b</sup>Anadolu University, Faculty of Science, Department of Chemistry, 26470Yenişehir, Eskişehir, Turkey, <sup>c</sup>Karabük University, Department of Physics, 78050Karabük, Turkey, and <sup>d</sup>Kafkas University, Department of Chemistry, 63100 Kars,

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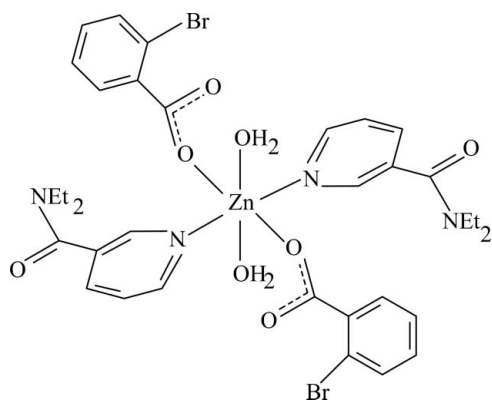
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Key indicators: single-crystal X-ray study;  $T = 100$  K; mean  $\sigma(\text{C}-\text{C}) = 0.003$  Å;  $R$  factor = 0.029;  $wR$  factor = 0.073; data-to-parameter ratio = 19.7.

In the centrosymmetric title complex,  $[\text{Zn}(\text{C}_7\text{H}_4\text{BrO}_2)_2(\text{C}_{10}\text{H}_{14}\text{N}_2\text{O})_2(\text{H}_2\text{O})_2]$ , the  $\text{Zn}^{\text{II}}$  atom is located on an inversion center. The asymmetric unit contains one 2-bromobenzoate (BB), one diethylnicotinamide (DNA) ligand and one coordinating water molecule. The four O atoms in the equatorial plane around the Zn atom form a slightly distorted square-planar arrangement, while the slightly distorted octahedral coordination is completed by the two N atoms of the DNA ligands in the axial positions. The dihedral angle between the carboxyl group and the adjacent benzene ring is  $85.51(12)^\circ$ , while the pyridine and benzene rings are oriented at a dihedral angle of  $44.07(6)^\circ$ . In the crystal structure,  $\text{O}-\text{H}\cdots\text{O}$  hydrogen bonds link the molecules into infinite chains.

## Related literature

For general background, see: Antolini *et al.* (1982); Bigoli *et al.* (1972); Nadzhafov *et al.* (1981); Shnulin *et al.* (1981). For related structures, see: Hökelek *et al.* (1995, 1997, 2007, 2008); (Hökelek & Necefoğlu (1996, 1997, 2007).



## Experimental

## Crystal data

 $[\text{Zn}(\text{C}_7\text{H}_4\text{BrO}_2)_2(\text{C}_{10}\text{H}_{14}\text{N}_2\text{O})_2(\text{H}_2\text{O})_2]$  $M_r = 857.91$ Monoclinic,  $P2_1/n$  $a = 13.0037(2)$  Å $b = 10.3387(2)$  Å $c = 14.9365(3)$  Å $\beta = 114.180(1)^\circ$  $V = 1831.90(6)$  Å<sup>3</sup> $Z = 2$ Mo  $K\alpha$  radiation $\mu = 2.91$  mm<sup>-1</sup> $T = 100$  K $0.40 \times 0.30 \times 0.23$  mm

## Data collection

Bruker Kappa APEXII CCD area-detector diffractometer

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

 $T_{\text{min}} = 0.368$ ,  $T_{\text{max}} = 0.517$ 

16722 measured reflections

4566 independent reflections

3769 reflections with  $I > 2\sigma(I)$  $R_{\text{int}} = 0.072$ 

## Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.029$  $wR(F^2) = 0.073$  $S = 0.98$ 

4566 reflections

232 parameters

3 restraints

H atoms treated by a mixture of independent and constrained refinement

 $\Delta\rho_{\text{max}} = 1.13$  e Å<sup>-3</sup> $\Delta\rho_{\text{min}} = -0.53$  e Å<sup>-3</sup>

Table 1

Selected bond lengths (Å).

Zn1—O1	2.0600 (12)	Zn1—N1	2.1962 (14)
Zn1—O4	2.1269 (12)		

Table 2

Hydrogen-bond geometry (Å, °).

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
$\text{O4}-\text{H41}\cdots\text{O3}^i$	0.88 (2)	1.88 (2)	2.7518 (18)	168 (3)
$\text{O4}-\text{H42}\cdots\text{O2}^{ii}$	0.87 (2)	1.81 (2)	2.640 (2)	158 (2)

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

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); software used to prepare material for publication: WinGX (Farrugia, 1999).

The authors are indebted to Anadolu University and the Medicinal Plants and Medicine Research Centre of Anadolu University, Eskişehir, Turkey, for the use of the X-ray diffractometer.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: XU2502).

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**supplementary materials**

*Acta Cryst.* (2009). E65, m481-m482 [ doi:10.1107/S160053680901191X ]

## Diaquabis(2-bromobenzoato- $\kappa O$ )bis(*N,N*-diethylnicotinamide- $\kappa N^1$ )zinc(II)

T. Hökelek, H. Dal, B. Tercan, F. E. Özbek and H. Necefoglu

### Comment

Transition metal complexes with biochemically active ligands frequently show interesting physical and/or chemical properties, as a result they may find applications in biological systems (Antolini *et al.*, 1982). The structural functions and coordination relationships of the arylcarboxylate ion in transition metal complexes of benzoic acid derivatives change depending on the nature and position of the substituent groups on the benzene ring, the nature of the additional ligand molecule or solvent, and the medium of the synthesis (Nadzhafov *et al.*, 1981; Shnulin *et al.*, 1981). The nicotinic acid derivative *N,N*-diethylnicotinamide (DENA) is an important respiratory stimulant (Bigoli *et al.*, 1972).

The structure determination of the title compound, (I), a zinc complex with two 2-bromobenzoate (BB), two diethylnicotinamide (DENA) ligands and two water molecules, was undertaken in order to determine the properties of the ligands and also to compare the results obtained with those reported previously.

Compound (I) is a monomeric complex, with the Zn atom on a centre of symmetry. It contains two BB, two DENA ligands and two water molecules (Fig. 1). All ligands are monodentate. The four O atoms (O1, O4, and the symmetry-related atoms, O1', O4') in the equatorial plane around the Zn atom form a slightly distorted square-planar arrangement, while the slightly distorted octahedral coordination is completed by the two N atoms of the DENA ligands (N1, N1') in the axial positions (Table 1 and Fig. 1).

The near equality of the C1—O1 [1.263 (2) Å] and C1—O2 [1.240 (2) Å] bonds in the carboxylate group indicates a delocalized bonding arrangement, rather than localized single and double bonds, and may be compared with the corresponding distances: 1.256 (6) and 1.245 (6) Å in [Mn(DENA)<sub>2</sub>(C<sub>7</sub>H<sub>4</sub>ClO<sub>2</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>] (Hökelek *et al.*, 2008), 1.265 (6) and 1.275 (6) Å in [Mn(C<sub>9</sub>H<sub>10</sub>NO<sub>2</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>4</sub>].2(H<sub>2</sub>O) (Hökelek & Necefoglu, 2007), 1.260 (4) and 1.252 (4) Å in [Zn(DENA)<sub>2</sub>(C<sub>7</sub>H<sub>4</sub>FO<sub>2</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>] (Hökelek *et al.*, 2007), 1.259 (9) and 1.273 (9) Å in Cu<sub>2</sub>(DENA)<sub>2</sub>(C<sub>6</sub>H<sub>5</sub>COO)<sub>4</sub> (Hökelek *et al.*, 1995), 1.279 (4) and 1.246 (4) Å in [Zn<sub>2</sub>(DENA)<sub>2</sub>(C<sub>7</sub>H<sub>5</sub>O<sub>3</sub>)<sub>4</sub>].2H<sub>2</sub>O (Hökelek & Necefoglu, 1996), 1.251 (6) and 1.254 (7) Å in [Co(DENA)<sub>2</sub>(C<sub>7</sub>H<sub>5</sub>O<sub>3</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>] (Hökelek & Necefoglu, 1997) and 1.278 (3) and 1.246 (3) Å in [Cu(DENA)<sub>2</sub>(C<sub>7</sub>H<sub>4</sub>NO<sub>4</sub>)<sub>2</sub>(H<sub>2</sub>O)<sub>2</sub>] (Hökelek *et al.*, 1997). In (I), the average Zn—O bond length is 2.0935 (12) Å and the Zn atom is displaced out of the least-squares plane of the carboxylate group (O1/C1/O2) by 0.332 (1) Å. The dihedral angle between the planar carboxylate group and the benzene ring A (C2—C7) is 85.51 (12)°, while that between rings A and B (N1/C8—C12) is 44.07 (6)°.

In the crystal structure, intermolecular O—H...O hydrogen bonds (Table 2) link the molecules into infinite chains, in which they may be effective in the stabilization of the structure.

## Experimental

The title compound was prepared by the reaction of ZnSO<sub>4</sub>·H<sub>2</sub>O (0.89 g, 5 mmol) in H<sub>2</sub>O (20 ml) and DENA (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 3 d, giving colorless single crystals.

## Refinement

H atoms of water molecule were located in difference Fourier maps and refined isotropically, with restraints of O4—H41 = 0.885 (16) and O4—H42 = 0.869 (15) Å and H41—O4—H42 = 106 (2)°. 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.

## Figures

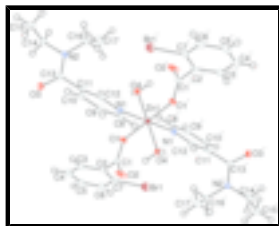


Fig. 1. The molecular structure of the title molecule with the atom-numbering scheme. Displacement ellipsoids are drawn at the 50% probability level. Primed atoms are generated by the symmetry operator (1 - x, -y, -z).

## Diaquabis(2-bromobenzoato-κO)bis(N,N-diethylnicotinamide-κN<sup>1</sup>)zinc(II)

### Crystal data

[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>]

$M_r = 857.91$

Monoclinic,  $P2_1/n$

Hall symbol: -P 2yn

$a = 13.0037$  (2) Å

$b = 10.3387$  (2) Å

$c = 14.9365$  (3) Å

$\beta = 114.180$  (1)°

$V = 1831.90$  (6) Å<sup>3</sup>

$Z = 2$

$F_{000} = 872$

$D_x = 1.555$  Mg m<sup>-3</sup>

Mo  $K\alpha$  radiation

$\lambda = 0.71073$  Å

Cell parameters from 8223 reflections

$\theta = 2.5$ – $28.3$ °

$\mu = 2.91$  mm<sup>-1</sup>

$T = 100$  K

Block, colorless

$0.40 \times 0.30 \times 0.23$  mm

### Data collection

Bruker Kappa APEXII CCD area-detector diffractometer

Radiation source: fine-focus sealed tube

Monochromator: graphite

4566 independent reflections

3769 reflections with  $I > 2\sigma(I)$

$R_{\text{int}} = 0.072$

$T = 100$  K  $\theta_{\max} = 28.3^\circ$   
 $\varphi$  and  $\omega$  scans  $\theta_{\min} = 1.8^\circ$   
 Absorption correction: multi-scan  
 (SADABS; Bruker, 2005)  $h = -17 \rightarrow 17$   
 $T_{\min} = 0.368$ ,  $T_{\max} = 0.517$   $k = -13 \rightarrow 12$   
 16722 measured reflections  $l = -15 \rightarrow 19$

### Refinement

Refinement on  $F^2$  Secondary atom site location: difference Fourier map  
 Least-squares matrix: full Hydrogen site location: inferred from neighbouring sites  
 $R[F^2 > 2\sigma(F^2)] = 0.029$  H atoms treated by a mixture of independent and constrained refinement  
 $wR(F^2) = 0.073$   $w = 1/[\sigma^2(F_o^2) + (0.0392P)^2]$   
 where  $P = (F_o^2 + 2F_c^2)/3$   
 $S = 0.98$   $(\Delta/\sigma)_{\max} < 0.001$   
 4566 reflections  $\Delta\rho_{\max} = 1.13 \text{ e } \text{\AA}^{-3}$   
 232 parameters  $\Delta\rho_{\min} = -0.53 \text{ e } \text{\AA}^{-3}$   
 3 restraints Extinction correction: none  
 Primary atom site location: structure-invariant direct methods

### Special details

**Geometry.** All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s 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  $F^2 > \sigma(F^2)$  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 ( $\text{\AA}^2$ )

	$x$	$y$	$z$	$U_{\text{iso}}^*/U_{\text{eq}}$
Zn1	0.5000	0.0000	0.0000	0.00901 (8)
Br1	0.179310 (15)	0.14083 (2)	0.071591 (15)	0.02340 (7)
O1	0.46937 (9)	0.05066 (12)	0.12022 (9)	0.0132 (3)
O2	0.36846 (12)	-0.11814 (12)	0.13299 (11)	0.0250 (3)
H41	0.609 (2)	0.2335 (18)	0.0563 (19)	0.054*
H42	0.621 (2)	0.165 (2)	-0.0200 (14)	0.051 (8)*
O3	0.93267 (10)	-0.11602 (12)	0.39616 (9)	0.0145 (3)
O4	0.61756 (10)	0.15513 (11)	0.03656 (10)	0.0124 (3)
N1	0.64061 (11)	-0.12404 (13)	0.09229 (11)	0.0112 (3)
N2	0.98312 (12)	0.00393 (14)	0.29399 (11)	0.0144 (3)

## supplementary materials

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C1	0.40861 (14)	-0.00793 (16)	0.15495 (13)	0.0126 (4)
C2	0.38508 (14)	0.06826 (17)	0.23084 (14)	0.0136 (4)
C3	0.46126 (15)	0.06990 (19)	0.32819 (14)	0.0195 (4)
H3	0.5255	0.0185	0.3482	0.023*
C4	0.44314 (17)	0.14731 (19)	0.39657 (16)	0.0239 (5)
H4	0.4946	0.1468	0.4619	0.029*
C5	0.34836 (17)	0.22509 (19)	0.36715 (15)	0.0239 (4)
H5	0.3375	0.2789	0.4124	0.029*
C6	0.26950 (16)	0.22321 (19)	0.27050 (15)	0.0221 (4)
H6	0.2050	0.2742	0.2507	0.026*
C7	0.28856 (15)	0.14373 (17)	0.20386 (15)	0.0166 (4)
C8	0.64246 (14)	-0.25181 (17)	0.07850 (14)	0.0136 (4)
H8	0.5822	-0.2893	0.0269	0.016*
C9	0.73019 (14)	-0.33078 (18)	0.13771 (14)	0.0145 (4)
H9	0.7280	-0.4193	0.1260	0.017*
C10	0.82084 (13)	-0.27652 (17)	0.21415 (13)	0.0129 (4)
H10	0.8799	-0.3276	0.2559	0.016*
C11	0.82133 (14)	-0.14260 (16)	0.22691 (13)	0.0118 (4)
C12	0.72970 (13)	-0.07125 (17)	0.16538 (13)	0.0120 (3)
H12	0.7299	0.0176	0.1752	0.014*
C13	0.91743 (13)	-0.08274 (16)	0.31181 (13)	0.0113 (3)
C14	1.08066 (14)	0.05572 (17)	0.37778 (14)	0.0157 (4)
H14A	1.0630	0.0598	0.4348	0.019*
H14B	1.0963	0.1429	0.3629	0.019*
C15	1.18465 (15)	-0.0281 (2)	0.40103 (15)	0.0227 (4)
H15A	1.2466	0.0073	0.4564	0.034*
H15B	1.2035	-0.0302	0.3452	0.034*
H15C	1.1694	-0.1144	0.4161	0.034*
C16	0.97478 (16)	0.0395 (2)	0.19646 (15)	0.0239 (4)
H16A	0.9254	-0.0213	0.1487	0.029*
H16B	1.0488	0.0327	0.1956	0.029*
C17	0.93007 (18)	0.1756 (2)	0.16644 (18)	0.0343 (6)
H17A	0.9327	0.1967	0.1048	0.051*
H17B	0.9756	0.2359	0.2156	0.051*
H17C	0.8536	0.1804	0.1599	0.051*

### Atomic displacement parameters ( $\text{\AA}^2$ )

	$U^{11}$	$U^{22}$	$U^{33}$	$U^{12}$	$U^{13}$	$U^{23}$
Zn1	0.00857 (13)	0.01000 (15)	0.00909 (15)	-0.00008 (10)	0.00427 (11)	-0.00017 (11)
Br1	0.02151 (11)	0.02979 (13)	0.01957 (12)	0.00542 (8)	0.00908 (9)	0.00255 (8)
O1	0.0148 (6)	0.0149 (6)	0.0135 (6)	-0.0024 (5)	0.0094 (5)	-0.0013 (5)
O2	0.0432 (9)	0.0140 (7)	0.0321 (9)	-0.0092 (6)	0.0300 (7)	-0.0064 (6)
O3	0.0162 (6)	0.0137 (6)	0.0112 (7)	-0.0013 (5)	0.0031 (5)	0.0008 (5)
O4	0.0138 (6)	0.0103 (6)	0.0138 (7)	-0.0008 (5)	0.0064 (5)	-0.0003 (5)
N1	0.0114 (7)	0.0109 (7)	0.0119 (8)	0.0006 (5)	0.0054 (6)	0.0000 (6)
N2	0.0141 (7)	0.0173 (8)	0.0114 (8)	-0.0032 (6)	0.0048 (6)	0.0002 (6)
C1	0.0138 (8)	0.0127 (9)	0.0131 (9)	0.0033 (6)	0.0074 (7)	0.0011 (7)

C2	0.0171 (8)	0.0109 (9)	0.0183 (9)	-0.0041 (7)	0.0128 (7)	-0.0020 (7)
C3	0.0174 (9)	0.0224 (11)	0.0205 (10)	-0.0018 (7)	0.0098 (8)	-0.0032 (8)
C4	0.0260 (10)	0.0318 (12)	0.0173 (10)	-0.0096 (8)	0.0123 (9)	-0.0067 (9)
C5	0.0349 (11)	0.0232 (11)	0.0243 (11)	-0.0068 (8)	0.0229 (9)	-0.0092 (9)
C6	0.0267 (10)	0.0206 (10)	0.0276 (11)	0.0011 (8)	0.0200 (9)	-0.0029 (9)
C7	0.0191 (9)	0.0187 (10)	0.0149 (9)	-0.0017 (7)	0.0102 (8)	0.0000 (8)
C8	0.0114 (8)	0.0157 (9)	0.0135 (9)	-0.0022 (6)	0.0050 (7)	-0.0013 (7)
C9	0.0171 (8)	0.0099 (8)	0.0172 (10)	0.0005 (7)	0.0076 (7)	0.0000 (7)
C10	0.0125 (8)	0.0143 (9)	0.0123 (9)	0.0026 (6)	0.0054 (7)	0.0023 (7)
C11	0.0119 (8)	0.0138 (9)	0.0107 (9)	-0.0016 (6)	0.0056 (7)	-0.0002 (7)
C12	0.0142 (8)	0.0114 (9)	0.0114 (9)	-0.0001 (6)	0.0063 (7)	-0.0002 (7)
C13	0.0097 (8)	0.0090 (8)	0.0132 (9)	0.0033 (6)	0.0026 (7)	0.0006 (7)
C14	0.0166 (8)	0.0152 (9)	0.0135 (9)	-0.0051 (7)	0.0043 (7)	-0.0023 (8)
C15	0.0175 (9)	0.0282 (11)	0.0213 (11)	-0.0017 (8)	0.0069 (8)	0.0031 (9)
C16	0.0200 (9)	0.0365 (12)	0.0147 (10)	-0.0114 (8)	0.0066 (8)	0.0017 (9)
C17	0.0270 (11)	0.0413 (14)	0.0281 (13)	-0.0069 (10)	0.0046 (10)	0.0191 (11)

*Geometric parameters (Å, °)*

Zn1—O1 <sup>i</sup>	2.0600 (12)	C6—H6	0.9300
Zn1—O1	2.0600 (12)	C7—C2	1.390 (2)
Zn1—O4	2.1269 (12)	C7—C6	1.389 (3)
Zn1—N1	2.1962 (14)	C8—C9	1.387 (2)
Zn1—O4 <sup>i</sup>	2.1269 (12)	C8—H8	0.9300
Zn1—N1 <sup>i</sup>	2.1962 (14)	C9—H9	0.9300
Br1—C7	1.903 (2)	C10—C9	1.380 (2)
O1—C1	1.263 (2)	C10—H10	0.9300
O2—C1	1.240 (2)	C11—C10	1.397 (2)
O3—C13	1.241 (2)	C11—C12	1.383 (2)
O4—Zn1	2.1269 (12)	C11—C13	1.502 (2)
O4—H41	0.885 (16)	C12—H12	0.9300
O4—H42	0.869 (15)	C13—N2	1.338 (2)
N1—Zn1	2.1962 (14)	C14—C15	1.522 (2)
N1—C8	1.339 (2)	C14—H14A	0.9700
N1—C12	1.340 (2)	C14—H14B	0.9700
N2—C14	1.470 (2)	C15—H15A	0.9600
N2—C16	1.463 (2)	C15—H15B	0.9600
C2—C1	1.511 (2)	C15—H15C	0.9600
C2—C3	1.384 (3)	C16—C17	1.518 (3)
C3—H3	0.9300	C16—H16A	0.9700
C4—C3	1.391 (3)	C16—H16B	0.9700
C4—C5	1.384 (3)	C17—H17A	0.9600
C4—H4	0.9300	C17—H17B	0.9600
C5—H5	0.9300	C17—H17C	0.9600
C6—C5	1.387 (3)		
O1 <sup>i</sup> —Zn1—O1	180.00 (5)	C6—C7—Br1	118.47 (14)
O1 <sup>i</sup> —Zn1—O4 <sup>i</sup>	87.69 (5)	C6—C7—C2	121.96 (19)
O1—Zn1—O4 <sup>i</sup>	92.31 (5)	N1—C8—C9	123.00 (16)

## supplementary materials

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O1 <sup>i</sup> —Zn1—O4	92.31 (5)	N1—C8—H8	118.5
O1—Zn1—O4	87.69 (5)	C9—C8—H8	118.5
O4 <sup>i</sup> —Zn1—O4	180.00 (7)	C8—C9—H9	120.4
O1 <sup>i</sup> —Zn1—N1 <sup>i</sup>	90.56 (5)	C10—C9—C8	119.27 (17)
O1—Zn1—N1 <sup>i</sup>	89.44 (5)	C10—C9—H9	120.4
O1 <sup>i</sup> —Zn1—N1	89.44 (5)	C9—C10—C11	118.05 (16)
O1—Zn1—N1	90.56 (5)	C9—C10—H10	121.0
O4 <sup>i</sup> —Zn1—N1 <sup>i</sup>	87.31 (5)	C11—C10—H10	121.0
O4—Zn1—N1 <sup>i</sup>	92.69 (5)	C10—C11—C13	118.64 (15)
O4 <sup>i</sup> —Zn1—N1	92.69 (5)	C12—C11—C10	118.91 (16)
O4—Zn1—N1	87.31 (5)	C12—C11—C13	122.28 (15)
N1 <sup>i</sup> —Zn1—N1	180.00 (14)	N1—C12—C11	123.12 (16)
C1—O1—Zn1	127.79 (11)	N1—C12—H12	118.4
Zn1—O4—H41	126.9 (17)	C11—C12—H12	118.4
Zn1—O4—H42	98.8 (17)	O3—C13—N2	122.56 (16)
H42—O4—H41	106 (2)	O3—C13—C11	118.34 (15)
C8—N1—Zn1	122.85 (11)	N2—C13—C11	119.10 (16)
C8—N1—C12	117.59 (15)	N2—C14—C15	111.29 (15)
C12—N1—Zn1	119.56 (11)	N2—C14—H14A	109.4
C13—N2—C14	118.24 (15)	N2—C14—H14B	109.4
C13—N2—C16	125.02 (15)	C15—C14—H14A	109.4
C16—N2—C14	116.24 (14)	C15—C14—H14B	109.4
O1—C1—C2	114.26 (15)	H14A—C14—H14B	108.0
O2—C1—O1	126.75 (16)	C14—C15—H15A	109.5
O2—C1—C2	118.99 (15)	C14—C15—H15B	109.5
C3—C2—C1	121.12 (16)	C14—C15—H15C	109.5
C3—C2—C7	118.06 (17)	H15A—C15—H15B	109.5
C7—C2—C1	120.76 (17)	H15A—C15—H15C	109.5
C2—C3—C4	120.98 (18)	H15B—C15—H15C	109.5
C2—C3—H3	119.5	N2—C16—C17	112.98 (18)
C4—C3—H3	119.5	N2—C16—H16A	109.0
C3—C4—H4	120.1	N2—C16—H16B	109.0
C5—C4—C3	119.8 (2)	C17—C16—H16A	109.0
C5—C4—H4	120.1	C17—C16—H16B	109.0
C4—C5—C6	120.33 (18)	H16A—C16—H16B	107.8
C4—C5—H5	119.8	C16—C17—H17A	109.5
C6—C5—H5	119.8	C16—C17—H17B	109.5
C5—C6—C7	118.77 (18)	C16—C17—H17C	109.5
C5—C6—H6	120.6	H17A—C17—H17B	109.5
C7—C6—H6	120.6	H17A—C17—H17C	109.5
C2—C7—Br1	119.57 (14)	H17B—C17—H17C	109.5
O4 <sup>i</sup> —Zn1—O1—C1	5.89 (14)	C1—C2—C3—C4	175.41 (16)
O4—Zn1—O1—C1	-174.11 (14)	C7—C2—C3—C4	-1.6 (3)
N1 <sup>i</sup> —Zn1—O1—C1	93.18 (14)	C5—C4—C3—C2	-0.7 (3)
N1—Zn1—O1—C1	-86.82 (14)	C3—C4—C5—C6	2.1 (3)
Zn1—O1—C1—O2	11.8 (3)	C7—C6—C5—C4	-1.1 (3)

Zn1—O1—C1—C2	-168.33 (11)	Br1—C7—C2—C1	4.8 (2)
C8—N1—Zn1—O1 <sup>i</sup>	-61.43 (14)	Br1—C7—C2—C3	-178.23 (13)
C8—N1—Zn1—O1	118.57 (14)	C6—C7—C2—C1	-174.44 (16)
C8—N1—Zn1—O4 <sup>i</sup>	26.23 (14)	C6—C7—C2—C3	2.6 (3)
C8—N1—Zn1—O4	-153.77 (14)	Br1—C7—C6—C5	179.54 (14)
C12—N1—Zn1—O1 <sup>i</sup>	117.92 (13)	C2—C7—C6—C5	-1.2 (3)
C12—N1—Zn1—O1	-62.08 (13)	N1—C8—C9—C10	-0.6 (3)
C12—N1—Zn1—O4 <sup>i</sup>	-154.42 (13)	C11—C10—C9—C8	-1.6 (3)
C12—N1—Zn1—O4	25.58 (13)	C12—C11—C10—C9	2.5 (3)
Zn1—N1—C8—C9	-178.82 (13)	C13—C11—C10—C9	177.93 (16)
C12—N1—C8—C9	1.8 (3)	C10—C11—C12—N1	-1.3 (3)
Zn1—N1—C12—C11	179.78 (13)	C13—C11—C12—N1	-176.57 (16)
C8—N1—C12—C11	-0.8 (2)	C10—C11—C13—O3	-61.1 (2)
C13—N2—C14—C15	88.7 (2)	C10—C11—C13—N2	118.94 (18)
C16—N2—C14—C15	-83.6 (2)	C12—C11—C13—O3	114.20 (19)
C13—N2—C16—C17	109.9 (2)	C12—C11—C13—N2	-65.8 (2)
C14—N2—C16—C17	-78.4 (2)	O3—C13—N2—C14	3.5 (2)
C3—C2—C1—O1	-83.7 (2)	O3—C13—N2—C16	175.04 (17)
C3—C2—C1—O2	96.2 (2)	C11—C13—N2—C14	-176.49 (14)
C7—C2—C1—O1	93.2 (2)	C11—C13—N2—C16	-4.9 (3)
C7—C2—C1—O2	-86.9 (2)		

Symmetry codes: (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>	0.88 (2)	1.88 (2)	2.7518 (18)	168 (3)
O4—H42 $\cdots$ O2 <sup>i</sup>	0.87 (2)	1.81 (2)	2.640 (2)	158 (2)

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

Fig. 1

