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## Structure Reports

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## 3-Aminopyridin-1-ium 3-carboxybenzoate

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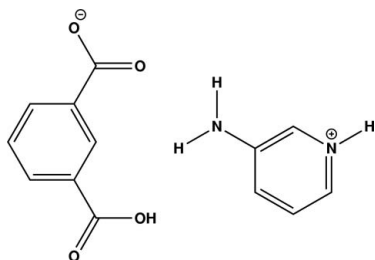
Received 14 March 2012; accepted 12 April 2012

Key indicators: single-crystal X-ray study;  $T = 298$  K; mean  $\sigma(\text{C}-\text{C}) = 0.003$  Å;  $R$  factor = 0.055;  $wR$  factor = 0.154; data-to-parameter ratio = 12.0.

In the title organic salt,  $\text{C}_5\text{H}_7\text{N}_2^+ \cdot \text{C}_8\text{H}_5\text{O}_4^-$ , the carboxylic group is nearly coplanar with the benzene ring [dihedral angle  $1.9$  ( $4^\circ$ )] whereas the carboxylate group is twisted relative to the benzene ring by  $13.6$  ( $4^\circ$ ). In the crystal,  $\text{N}-\text{H} \cdots \text{O}$  and  $\text{O}-\text{H} \cdots \text{O}$  hydrogen bonds connect the components into a three-dimensional framework consisting of stacks of alternating pairs of anions and cations exhibiting  $\pi-\pi$  stacking interactions with centroid-centroid distances in the range  $3.676$  ( $2$ )– $3.711$  ( $1$ ) Å. The  $\pi-\pi$  stacks extend along  $[110]$  and  $[\bar{1}10]$ .

## Related literature

For background to crystal engineering with carboxylic acids and pyridine, see: Aakeröy & Salmon (2005); Almarsson & Zaworotko (2004); Mohamed *et al.* (2009); Sarma *et al.* (2009).



## Experimental

## Crystal data

$\text{C}_5\text{H}_7\text{N}_2^+ \cdot \text{C}_8\text{H}_5\text{O}_4^-$   
 $M_r = 260.25$   
 Monoclinic,  $P2_1/c$   
 $a = 11.9282$  ( $13$ ) Å  
 $b = 8.3715$  ( $9$ ) Å  
 $c = 13.1421$  ( $14$ ) Å  
 $\beta = 113.138$  ( $2$ )°

$V = 1206.8$  ( $2$ ) Å<sup>3</sup>  
 $Z = 4$   
 Mo  $K\alpha$  radiation  
 $\mu = 0.11$  mm<sup>-1</sup>  
 $T = 298$  K  
 $0.42 \times 0.28 \times 0.19$  mm

## Data collection

Bruker SMART APEX CCD area-detector diffractometer  
 9652 measured reflections

2216 independent reflections  
 1668 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.065$

## Refinement

$R[F^2 > 2\sigma(F^2)] = 0.055$   
 $wR(F^2) = 0.154$   
 $S = 1.05$   
 2216 reflections  
 184 parameters  
 4 restraints

H atoms treated by a mixture of independent and constrained refinement  
 $\Delta\rho_{\text{max}} = 0.23$  e Å<sup>-3</sup>  
 $\Delta\rho_{\text{min}} = -0.38$  e Å<sup>-3</sup>

Table 1

Hydrogen-bond geometry (Å, °).

| $D-\text{H} \cdots A$                                | $D-\text{H}$ | $\text{H} \cdots A$ | $D \cdots A$ | $D-\text{H} \cdots A$ |
|------------------------------------------------------|--------------|---------------------|--------------|-----------------------|
| $\text{O1}-\text{H1} \cdots \text{O3}^{\text{i}}$    | 0.86 (1)     | 1.76 (1)            | 2.616 (2)    | 173 (3)               |
| $\text{N1}-\text{H1A} \cdots \text{O4}^{\text{ii}}$  | 0.89 (1)     | 2.02 (1)            | 2.880 (2)    | 162 (2)               |
| $\text{N1}-\text{H1B} \cdots \text{O2}^{\text{iii}}$ | 0.91 (1)     | 2.11 (2)            | 2.967 (3)    | 157 (2)               |
| $\text{N9}-\text{H9} \cdots \text{O3}^{\text{iv}}$   | 0.91 (1)     | 1.97 (1)            | 2.858 (3)    | 167 (3)               |
| $\text{N9}-\text{H9} \cdots \text{O4}^{\text{iv}}$   | 0.91 (1)     | 2.25 (2)            | 2.930 (3)    | 131 (3)               |

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

Table 2

Intermolecular  $\pi-\pi$  stacking interactions in the title compound (Å).

| centroid               | centroid               | distance  | Symmetry-code |
|------------------------|------------------------|-----------|---------------|
| $\text{C1}-\text{C6}$  | $\text{C1}-\text{C6}$  | 3.711 (1) | (i)           |
| $\text{C1}-\text{C6}$  | $\text{N9}-\text{C14}$ | 3.676 (2) | (ii)          |
| $\text{N9}-\text{C14}$ | $\text{N9}-\text{C14}$ | 3.701 (2) | (iii)         |

(i)  $-x+1, -y, -z$ ; (ii)  $x, -y+\frac{1}{2}, z-\frac{1}{2}$ ; (iii)  $-x, -y, -z+1$

Data collection: *SMART* (Bruker, 2007); cell refinement: *SAINT* (Bruker, 2007); data reduction: *SAINT*; program(s) used to solve structure: *SHELXTL* (Sheldrick, 2008); program(s) used to refine structure: *SHELXTL*; molecular graphics: *SHELXTL*; software used to prepare material for publication: *SHELXTL*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: GK2468).

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## supporting information

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**3-Aminopyridin-1-ium 3-carboxybenzoate**

**Jose J. Campos-Gaxiola, Simón Hernández-Ortega, David Morales-Morales and Adriana Cruz Enríquez**

**S1. Comment**

The identification of supramolecular synthons between common functional groups is the first step towards crystal engineering. Specific recognition of the carboxylic acid group and pyridine (acid-pyridine synthon) (Aakeröy & Salmon, 2005; Almarsson & Zaworotko, 2004), or their analogs with proton transfer (Mohamed *et al.*, 2009; Sarma *et al.*, 2009), has been well studied. Both carboxylic acid and pyridine are popular substrates in supramolecular synthesis and herein we report the molecular and crystal structure of 3-aminopyridin-1-ium 3-carboxybenzoate.

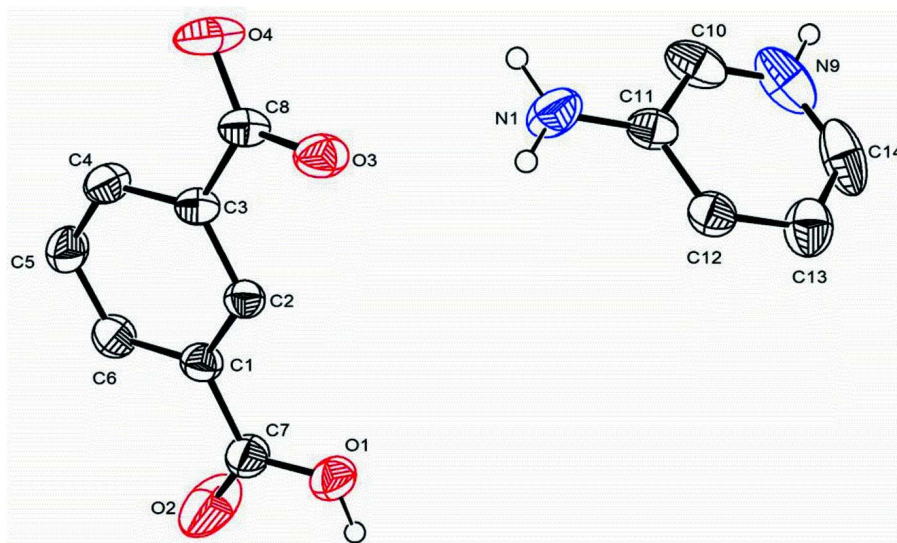
The asymmetric unit consists of one 3-aminopyridin-1-ium cation (3AP<sup>+</sup>) and one 3-carboxybenzoate anion (3CB<sup>-</sup>), shown in Figure 1. The geometry of intermolecular interactions are given in Table 1. The 3CB<sup>-</sup> anion is almost planar with the carboxyl and carboxylate groups forming dihedral angles of 1.9 (4)° and 13.6 (4)°, respectively. A typical pyridinium-carboxylate R<sup>2</sup><sub>2</sub>(7) synthon is not observed in this organic salt as the pyridinium N9-H9 group forms a three-center interaction with the carboxylate O3 and O4 atoms acting as acceptors (Table 1). Two 3CB<sup>-</sup> anions are connected *via* a short O-H...O hydrogen bonds and the pairs of hydrogen bonded anions are bridged by the primary amino group forming two N-H...O hydrogen bonds. These three interactions generate R<sup>6</sup><sub>6</sub>(18) ring motif and a two-dimensional assembly parallel to (-1 0 2). Adjacent assemblies are connected by hydrogen bonds between the pyridinium N-H groups and the carboxylate groups into a three dimensional framework. This framework consists of stacks of alternating pairs of anions and cations exhibiting  $\pi$ - $\pi$  stacking interactions with centroid-centroid distances in the range 3.676 (2)-3.711 (1) Å (Table 2). The  $\pi$ - $\pi$  stacks are extending along [1 1 0] and [-1 1 0].

**S2. Experimental**

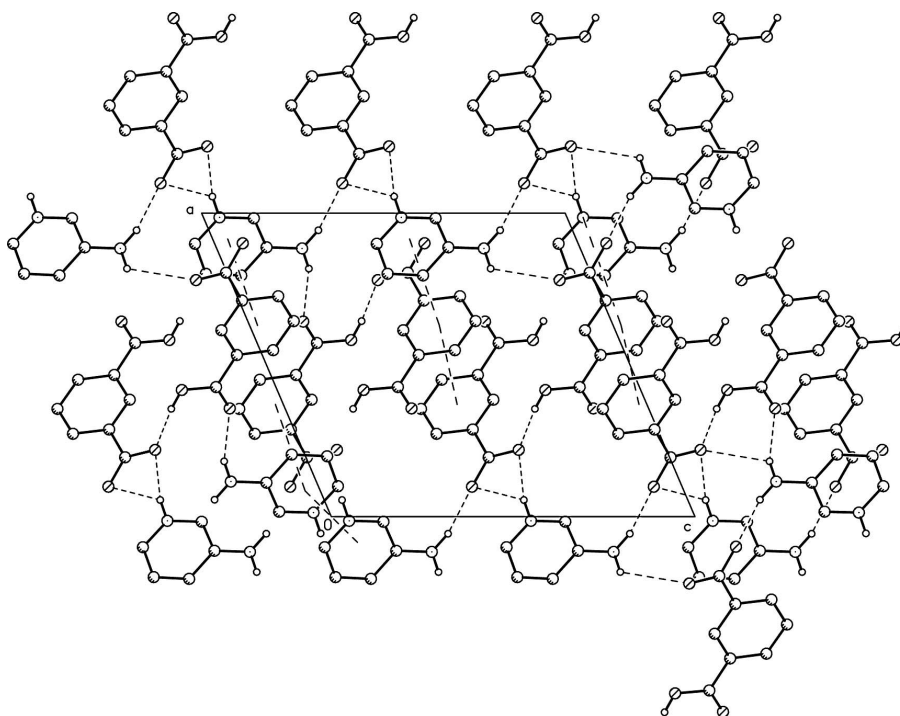
3-Aminopyridine (0.531 mmol), benzene-1,3-dicarboxylic acid (0.531 mmol) and CH<sub>3</sub>OH (8 ml) were mixed and the resulting solution allowed to stand at room temperature. After two weeks, colorless crystals of the title compound were obtained (m.p. 498 K).

**S3. Refinement**

H atoms were positioned geometrically and constrained using riding-model approximation C—H = 0.93 Å,  $U_{\text{iso}}(\text{H}) = 1.2 U_{\text{eq}}(\text{C})$ . Hydrogen atoms bonded to O (H1) and N (H1A, H1B and H9) were located in difference Fourier maps. The coordinates of the O—H and N—H hydrogen atoms were refined with distance restraints: O—H = 0.86 (1) Å, N—H = 0.90 (1) Å and  $U_{\text{iso}}(\text{H}) = 1.2 U_{\text{eq}}(\text{O}, \text{N})$ .

**Figure 1**

Asymmetric unit of the title compound with displacement ellipsoids drawn at the 40% probability level. Hydrogen atoms from C-H groups are omitted.

**Figure 2**

Packing diagram of the title compound. The intermolecular O—H...O, N—H...O hydrogen bonds and  $\pi\cdots\pi$  interactions are shown as dashed lines.

## 3-Aminopyridin-1-ium 3-carboxybenzoate

## Crystal data

 $\text{C}_5\text{H}_7\text{N}_2^+ \cdot \text{C}_8\text{H}_5\text{O}_4^-$  $M_r = 260.25$ Monoclinic,  $P2_1/c$ 

Hall symbol: -P 2ybc

 $a = 11.9282$  (13) Å $b = 8.3715$  (9) Å $c = 13.1421$  (14) Å $\beta = 113.138$  (2)° $V = 1206.8$  (2) Å<sup>3</sup> $Z = 4$  $F(000) = 544$  $D_x = 1.432$  Mg m<sup>-3</sup>Mo  $K\alpha$  radiation,  $\lambda = 0.71073$  Å

Cell parameters from 4087 reflections

 $\theta = 3.0$ – $25.3$ ° $\mu = 0.11$  mm<sup>-1</sup> $T = 298$  K

Prism, colourless

 $0.42 \times 0.28 \times 0.19$  mm

## Data collection

Bruker SMART APEX CCD area-detector  
diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

Detector resolution: 0.83 pixels mm<sup>-1</sup> $\omega$  scans

9652 measured reflections

2216 independent reflections

1668 reflections with  $I > 2\sigma(I)$  $R_{\text{int}} = 0.065$  $\theta_{\text{max}} = 25.4$ °,  $\theta_{\text{min}} = 1.9$ ° $h = -14 \rightarrow 14$  $k = -10 \rightarrow 10$  $l = -15 \rightarrow 15$ 

## Refinement

Refinement on  $F^2$ 

Least-squares matrix: full

 $R[F^2 > 2\sigma(F^2)] = 0.055$  $wR(F^2) = 0.154$  $S = 1.05$ 

2216 reflections

184 parameters

4 restraints

Primary atom site location: structure-invariant  
direct methodsSecondary atom site location: difference Fourier  
mapHydrogen site location: inferred from  
neighbouring sitesH atoms treated by a mixture of independent  
and constrained refinement $w = 1/[\sigma^2(F_o^2) + (0.0836P)^2 + 0.2115P]$ where  $P = (F_o^2 + 2F_c^2)/3$  $(\Delta/\sigma)_{\text{max}} < 0.001$  $\Delta\rho_{\text{max}} = 0.23$  e Å<sup>-3</sup> $\Delta\rho_{\text{min}} = -0.38$  e Å<sup>-3</sup>

## 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 (Å<sup>2</sup>)

|    | <i>x</i>     | <i>y</i>      | <i>z</i>      | $U_{\text{iso}}^*/U_{\text{eq}}$ |
|----|--------------|---------------|---------------|----------------------------------|
| O1 | 0.58230 (14) | 0.2128 (2)    | 0.26222 (13)  | 0.0548 (5)                       |
| H1 | 0.6446 (16)  | 0.257 (3)     | 0.3133 (16)   | 0.066*                           |
| O2 | 0.6431 (2)   | 0.3505 (3)    | 0.15207 (17)  | 0.1158 (10)                      |
| O3 | 0.22032 (13) | -0.15499 (19) | 0.09404 (13)  | 0.0517 (5)                       |
| O4 | 0.09883 (14) | -0.1061 (2)   | -0.07778 (15) | 0.0694 (6)                       |

|     |              |             |               |             |
|-----|--------------|-------------|---------------|-------------|
| N1  | 0.11595 (19) | 0.0115 (3)  | 0.26504 (17)  | 0.0627 (6)  |
| H1A | 0.0560 (18)  | 0.027 (3)   | 0.1989 (12)   | 0.075*      |
| H1B | 0.1824 (17)  | −0.047 (3)  | 0.270 (2)     | 0.075*      |
| C1  | 0.46713 (18) | 0.1929 (2)  | 0.06964 (17)  | 0.0403 (5)  |
| C2  | 0.38557 (17) | 0.0848 (2)  | 0.08307 (17)  | 0.0361 (5)  |
| H2  | 0.3967       | 0.0498      | 0.1535        | 0.043*      |
| C3  | 0.28745 (17) | 0.0288 (2)  | −0.00859 (17) | 0.0369 (5)  |
| C4  | 0.27335 (19) | 0.0822 (3)  | −0.11310 (18) | 0.0452 (6)  |
| H4  | 0.2077       | 0.0461      | −0.1749       | 0.054*      |
| C5  | 0.3553 (2)   | 0.1878 (3)  | −0.12654 (19) | 0.0511 (6)  |
| H5  | 0.3453       | 0.2216      | −0.1970       | 0.061*      |
| C6  | 0.4514 (2)   | 0.2428 (3)  | −0.03560 (18) | 0.0477 (6)  |
| H6  | 0.5065       | 0.3141      | −0.0446       | 0.057*      |
| C7  | 0.5726 (2)   | 0.2594 (3)  | 0.16453 (19)  | 0.0497 (6)  |
| C8  | 0.19579 (18) | −0.0850 (2) | 0.00273 (18)  | 0.0420 (5)  |
| N9  | 0.0135 (3)   | 0.2041 (3)  | 0.4558 (3)    | 0.0770 (8)  |
| H9  | −0.0550 (17) | 0.256 (3)   | 0.451 (3)     | 0.092*      |
| C10 | 0.0165 (2)   | 0.1532 (3)  | 0.3625 (3)    | 0.0608 (7)  |
| H10 | −0.0470      | 0.1791      | 0.2959        | 0.073*      |
| C11 | 0.11220 (19) | 0.0622 (2)  | 0.36152 (19)  | 0.0443 (6)  |
| C12 | 0.2049 (2)   | 0.0253 (3)  | 0.46412 (19)  | 0.0453 (5)  |
| H12 | 0.2703       | −0.0377     | 0.4673        | 0.054*      |
| C13 | 0.1992 (3)   | 0.0818 (3)  | 0.5596 (2)    | 0.0601 (7)  |
| H13 | 0.2613       | 0.0589      | 0.6276        | 0.072*      |
| C14 | 0.1005 (3)   | 0.1731 (3)  | 0.5541 (3)    | 0.0776 (10) |
| H14 | 0.0951       | 0.2122      | 0.6183        | 0.093*      |

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

|     | $U^{11}$    | $U^{22}$    | $U^{33}$    | $U^{12}$     | $U^{13}$    | $U^{23}$     |
|-----|-------------|-------------|-------------|--------------|-------------|--------------|
| O1  | 0.0476 (10) | 0.0693 (11) | 0.0425 (10) | −0.0175 (8)  | 0.0122 (7)  | −0.0059 (8)  |
| O2  | 0.1051 (17) | 0.170 (2)   | 0.0587 (13) | −0.1032 (17) | 0.0171 (12) | −0.0029 (14) |
| O3  | 0.0402 (9)  | 0.0588 (10) | 0.0498 (10) | −0.0096 (7)  | 0.0110 (7)  | 0.0132 (8)   |
| O4  | 0.0380 (9)  | 0.0790 (12) | 0.0653 (12) | −0.0198 (9)  | −0.0074 (8) | 0.0209 (10)  |
| N1  | 0.0545 (13) | 0.0724 (15) | 0.0462 (13) | 0.0151 (11)  | 0.0038 (10) | −0.0017 (11) |
| C1  | 0.0343 (11) | 0.0422 (12) | 0.0442 (12) | −0.0037 (9)  | 0.0151 (9)  | −0.0032 (9)  |
| C2  | 0.0322 (10) | 0.0388 (11) | 0.0361 (11) | 0.0012 (8)   | 0.0121 (8)  | 0.0021 (9)   |
| C3  | 0.0299 (10) | 0.0365 (11) | 0.0404 (12) | 0.0017 (8)   | 0.0098 (9)  | 0.0020 (9)   |
| C4  | 0.0401 (12) | 0.0502 (13) | 0.0379 (12) | −0.0036 (10) | 0.0075 (9)  | 0.0010 (10)  |
| C5  | 0.0539 (14) | 0.0619 (15) | 0.0382 (13) | −0.0053 (12) | 0.0189 (11) | 0.0047 (11)  |
| C6  | 0.0453 (13) | 0.0520 (13) | 0.0490 (14) | −0.0113 (10) | 0.0222 (10) | 0.0014 (11)  |
| C7  | 0.0459 (13) | 0.0583 (14) | 0.0436 (13) | −0.0140 (11) | 0.0164 (11) | −0.0023 (11) |
| C8  | 0.0306 (11) | 0.0409 (12) | 0.0476 (13) | −0.0003 (9)  | 0.0081 (10) | 0.0050 (10)  |
| N9  | 0.0859 (19) | 0.0427 (13) | 0.136 (3)   | 0.0153 (12)  | 0.079 (2)   | 0.0137 (15)  |
| C10 | 0.0443 (14) | 0.0436 (14) | 0.099 (2)   | 0.0090 (11)  | 0.0326 (14) | 0.0114 (13)  |
| C11 | 0.0364 (12) | 0.0365 (12) | 0.0572 (14) | −0.0002 (9)  | 0.0155 (10) | 0.0022 (10)  |
| C12 | 0.0417 (12) | 0.0433 (12) | 0.0523 (14) | 0.0060 (10)  | 0.0200 (10) | −0.0008 (10) |
| C13 | 0.0775 (18) | 0.0521 (15) | 0.0565 (16) | −0.0061 (13) | 0.0326 (14) | −0.0062 (12) |

|     |           |             |           |              |           |              |
|-----|-----------|-------------|-----------|--------------|-----------|--------------|
| C14 | 0.130 (3) | 0.0440 (15) | 0.102 (3) | -0.0105 (17) | 0.092 (2) | -0.0148 (15) |
|-----|-----------|-------------|-----------|--------------|-----------|--------------|

*Geometric parameters (Å, °)*

|            |             |             |             |
|------------|-------------|-------------|-------------|
| O1—C7      | 1.303 (3)   | C4—H4       | 0.9300      |
| O1—H1      | 0.864 (10)  | C5—C6       | 1.370 (3)   |
| O2—C7      | 1.193 (3)   | C5—H5       | 0.9300      |
| O3—C8      | 1.262 (3)   | C6—H6       | 0.9300      |
| O4—C8      | 1.236 (2)   | N9—C10      | 1.312 (4)   |
| N1—C11     | 1.354 (3)   | N9—C14      | 1.327 (4)   |
| N1—H1A     | 0.892 (10)  | N9—H9       | 0.905 (10)  |
| N1—H1B     | 0.909 (10)  | C10—C11     | 1.376 (3)   |
| C1—C6      | 1.385 (3)   | C10—H10     | 0.9300      |
| C1—C2      | 1.390 (3)   | C11—C12     | 1.401 (3)   |
| C1—C7      | 1.488 (3)   | C12—C13     | 1.367 (3)   |
| C2—C3      | 1.390 (3)   | C12—H12     | 0.9300      |
| C2—H2      | 0.9300      | C13—C14     | 1.382 (4)   |
| C3—C4      | 1.390 (3)   | C13—H13     | 0.9300      |
| C3—C8      | 1.501 (3)   | C14—H14     | 0.9300      |
| C4—C5      | 1.380 (3)   |             |             |
| C7—O1—H1   | 110.8 (18)  | O2—C7—C1    | 122.2 (2)   |
| C11—N1—H1A | 123.9 (18)  | O1—C7—C1    | 115.60 (19) |
| C11—N1—H1B | 116.5 (18)  | O4—C8—O3    | 122.5 (2)   |
| H1A—N1—H1B | 119 (3)     | O4—C8—C3    | 118.6 (2)   |
| C6—C1—C2   | 119.72 (19) | O3—C8—C3    | 118.89 (18) |
| C6—C1—C7   | 117.55 (19) | C10—N9—C14  | 123.3 (2)   |
| C2—C1—C7   | 122.73 (19) | C10—N9—H9   | 116 (2)     |
| C1—C2—C3   | 120.16 (19) | C14—N9—H9   | 120 (2)     |
| C1—C2—H2   | 119.9       | N9—C10—C11  | 121.0 (3)   |
| C3—C2—H2   | 119.9       | N9—C10—H10  | 119.5       |
| C2—C3—C4   | 118.80 (19) | C11—C10—H10 | 119.5       |
| C2—C3—C8   | 121.75 (19) | N1—C11—C10  | 121.0 (2)   |
| C4—C3—C8   | 119.45 (19) | N1—C11—C12  | 121.9 (2)   |
| C5—C4—C3   | 121.0 (2)   | C10—C11—C12 | 117.2 (2)   |
| C5—C4—H4   | 119.5       | C13—C12—C11 | 120.1 (2)   |
| C3—C4—H4   | 119.5       | C13—C12—H12 | 119.9       |
| C6—C5—C4   | 119.7 (2)   | C11—C12—H12 | 119.9       |
| C6—C5—H5   | 120.2       | C12—C13—C14 | 119.5 (3)   |
| C4—C5—H5   | 120.2       | C12—C13—H13 | 120.3       |
| C5—C6—C1   | 120.6 (2)   | C14—C13—H13 | 120.3       |
| C5—C6—H6   | 119.7       | N9—C14—C13  | 118.9 (2)   |
| C1—C6—H6   | 119.7       | N9—C14—H14  | 120.6       |
| O2—C7—O1   | 122.2 (2)   | C13—C14—H14 | 120.6       |

*Hydrogen-bond geometry (Å, °)*

| <i>D</i> —H $\cdots$ <i>A</i>             | <i>D</i> —H | H $\cdots$ <i>A</i> | <i>D</i> $\cdots$ <i>A</i> | <i>D</i> —H $\cdots$ <i>A</i> |
|-------------------------------------------|-------------|---------------------|----------------------------|-------------------------------|
| N1—H1 <i>B</i> $\cdots$ O3                | 0.91 (1)    | 2.69 (2)            | 3.277 (3)                  | 124 (2)                       |
| O1—H1 $\cdots$ O3 <sup>i</sup>            | 0.86 (1)    | 1.76 (1)            | 2.616 (2)                  | 173 (3)                       |
| N1—H1 <i>A</i> $\cdots$ O4 <sup>ii</sup>  | 0.89 (1)    | 2.02 (1)            | 2.880 (2)                  | 162 (2)                       |
| N1—H1 <i>B</i> $\cdots$ O2 <sup>iii</sup> | 0.91 (1)    | 2.11 (2)            | 2.967 (3)                  | 157 (2)                       |
| N9—H9 $\cdots$ O3 <sup>iv</sup>           | 0.91 (1)    | 1.97 (1)            | 2.858 (3)                  | 167 (3)                       |
| N9—H9 $\cdots$ O4 <sup>iv</sup>           | 0.91 (1)    | 2.25 (2)            | 2.930 (3)                  | 131 (3)                       |

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