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Bis(2,2′-bipyridine-1κ^2N,N')-μ-bromido-1:2κ^2Br-tribromido-2κ^3Br-copper(II)-mercury(II)

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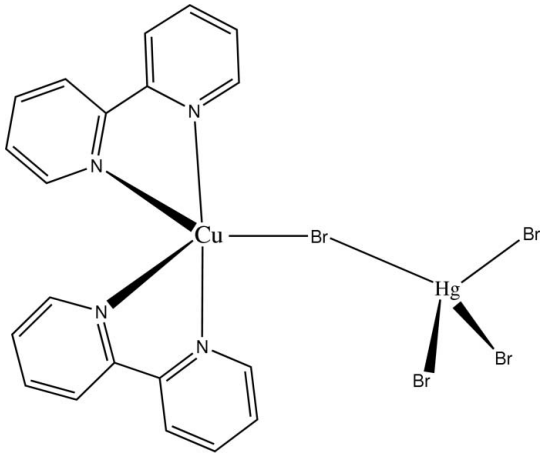
Key indicators: single-crystal X-ray study; T = 295 K; mean σ(C–C) = 0.018 Å; R factor = 0.060; wR factor = 0.110; data-to-parameter ratio = 17.4.

In the title compound, $[CuHgBr_4(C_{10}H_8N_2)_2]$, the Cu^{II} atom is coordinated by four N atoms of two bidentate 2,2′-bipyridine ligands and one Br atom of a tetrabromidomercurate anion in a distorted trigonal–bipyramidal geometry. The Br atom occupies an equatorial position and bridges the Cu^{II} and Hg atoms, with Hg—Br distances of 2.7503 (15) Å, longer by more than 0.15 Å than the terminal Hg—Br bonds. Weak π–π interactions between symmetry-related pyridine rings stabilize the packing; the shortest C—C distance between two parallel aromatic rings of bipy ligands is 3.491 (9) Å.

Related literature

For general background see: Majumdar *et al.* (1998); Leznoff *et al.* (2003); Choudhury *et al.* (1994); Oh *et al.* (2006); Addison *et al.* (1984). For related structures see: Song *et al.* (2004); Schunk & Thewalt (2001); Zheng *et al.* (2002).



Experimental

Crystal data

$[CuHgBr_4(C_{10}H_8N_2)_2]$
M_r = 896.14
Monoclinic, $P2_1/n$
a = 8.5510 (6) Å
b = 15.522 (4) Å
c = 18.056 (2) Å
β = 92.784 (8)°
V = 2393.8 (7) Å^3
Z = 4
Mo $K\alpha$ radiation
μ = 13.99 mm^{-1}
T = 295 (2) K
0.23 × 0.2 × 0.2 mm

Data collection

Enraf-Nonius CAD-4 diffractometer
Absorption correction: ψ scan (North *et al.*, 1968)
T_{min} = 0.050, T_{max} = 0.059
6320 measured reflections
4705 independent reflections
2406 reflections with $I > 2\sigma(I)$
R_{int} = 0.057
3 standard reflections
every 400 reflections
intensity decay: none

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.060
$wR(F^2)$ = 0.110
S = 0.99
4705 reflections
271 parameters
156 restraints
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.93 e Å^{-3}
$\Delta\rho_{min}$ = −1.13 e Å^{-3}

Table 1
Selected bond lengths (Å).

Br1—Cu1	2.632 (2)	Br3—Hg1	2.5512 (14)
Br1—Hg1	2.7502 (15)	Br4—Hg1	2.5780 (14)
Br2—Hg1	2.6008 (15)		

Data collection: *CAD-4 EXPRESS* (Enraf-Nonius, 1994); cell refinement: *CAD-4 EXPRESS*; data reduction: *XCAD4* (Harms & Wocadlo, 1995); program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *ORTEP-3 for Windows* (Farrugia, 1997); software used to prepare material for publication: *WinGX* (Farrugia, 1999).

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: DN3049).

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supplementary materials

Acta Cryst. (2007). E**63**, m1952-m1953 [**doi:10.1107/S160053680702925X**]

Bis(2,2'-bipyridine-1κ^2N,N')-μ-bromido-1:2κ^2Br-tribromido-2κ^3Br-copper(II)mercury(II)

Y.-M. Lee, H.-W. Ryu, S.-N. Choi, J. S. Choi and S. K. Kang

Comment

The metal ion assisted exchange reaction strategy for the synthesis of bis and tris-chelated copper(II) complexes with 1,10-phenanthroline (phen) and 2,2'-bipyridine (bipy) has been developed by Majumdar *et al.*, 1998 and Choudhury *et al.*, 1994; for example, the reaction of $Cu(phen)Cl_2$ with 2 moles of $Ag(phen)_2^+$ produces a pure tris $Cu(phen)_3^{2+}$ cation where two chlorides are transferred from Cu(II) to Ag(I), whereas two phen ligands transferred from Ag(I) to Cu(II). The main driving force for this exchange reaction is presumably the great affinity of Ag(I) toward the halide ion. The Hg(II) assisted exchange reaction was also used for the preparation of a dimeric complex containing $(bipy)_2CuCl_2$ units and linear, neutral $HgCl_2$ building blocks; the Hg(II) center in this compound increases structural dimension by accepting chloride ligand from the Cu(II) center in a bridging fashion (Leznoff *et al.*, 2003). Recently, we reported the crystal structure of Tris(1,10-phenanthroline)copper(II) di-μ-iodo-bis(diiodomercurate) dimethyl sulfoxide monohydrate which is produced from the Hg^{II} ion assisted exchange reaction between $Cu(phen)I_2$ and $Hg(phen)I_2$ (Oh, *et al.*, 2006).

In this work, we tested the reaction of $Cu(bipy)Br_2$ with $Hg(bipy)Br_2$ with a hope to observe a similar type of tris-chelated Cu^{II} complex to be produced since the Hg^{II} has stronger affinity toward the halide ion and is softer Lewis acid than Cu^{II}. As expected, the transfer of the bipy ligand is observed in this reaction. However, the complete transfer of Br atoms from Cu^{II} to Hg^{II} does not occur; a bimetallic and bridged complex $(bipy)_2Cu—Br\text{-}HgBr_3$(I) was produced instead of the formation of an ion pair complex $[Cu(bipy)_3][HgBr_4]$.

The Cu—Hg distance is 4.196 (2) Å, indicating there is no metal-metal interaction between the two metal centers. The coordination geometry around Cu^{II} atom can be described as distorted trigonal bipyramidal with the axial positions occupied by the N12 and N13 atoms of bipy ligands (N12—Cu—N13 177 (4) °) (Fig. 1). The τ value, which is an angular structural parameter as an index of trigonality, is calculated to be 0.83, which means this is closer to trigonal bipyramidal than square pyramidal structure (Addison *et al.*, 1984). One of the equatorial positions is occupied by Br1 atom which then bridges Cu and Hg metals. The Cu—N bond distances range from 1.977 (9) to 2.052 (10) Å which are well within the reported bond distances in Cu—Hg oligomers (1.961 − 2.139 Å) containing bipy ligands (Song *et al.*, 2004). The equatorial Cu—N distances are a little longer than those in the axial Cu—N as usual in trigonal bipyramidal complexes. N24—Cu—Br1 angle (127.8 (3) °) is opened by $HgBr_3$ group from normal angle 120 ° to reduce the steric hindrance. On the other hand, N1—Cu—Br1 angle is closed to 101.3 (3) °. The bridging Hg—Br1 distance in (I) is longer than three terminal Hg—Br bonds by more than 0.15 Å (2.7503 (15) Å for bridging bromide and 2.5512 − 2.6008 Å for terminal bromide). This kind of enlongation has been also observed in $[Cu(en)_2][HgBr_4]$ complex (Schunk & Thewalt, 2001) and Cu—Hg oligomers, $[Cu_2(bipy)_4HgBr_4][Hg_2Br_6]$ and $[Cu_2(bipy)_4Hg_2Br_6][Hg_4Br_{10}]$ (Song *et al.*, 2004).

There is weak slipped π-π interaction between the pyridine ring (N1) and its symmetry related one with an interplanar distance of 3.438\%A and a centroid to centroid distance of 3.699\%A resulting in an offset of 21.6\%. Such π-π interactions

between pyridine rings have been known in various Cu^{II} complexes containing bipy and phen ligands (Song *et al.*, 2004; Zheng *et al.*, 2002).

Experimental

The precursor compounds 2,2'-bipyridinedibromomercury(II), $Hg(bipy)Br_2$, and 2,2'-bipyridinedibromocopper(II), $Cu(bipy)Br_2$, were prepared as following; mercuric bromide (1.08 g; 3.00 mmol) was dissolved in 50 ml of ethanol and then, to this solution, 2,2'-bipyridine (0.484 g; 3.10 mmol) was added. The white crystallines of $Hg(bipy)Br_2$ produced were immediately filtered, washed with cold ethanol and dried under vacuum; the yield was 88.9%. Analysis calculated for $C_{10}H_8N_2HgBr_2$: C 23.25; H 1.56; N 5.42%; found C 23.19; H 1.60; N 5.49%. Cupric bromide (0,670 g; 3.00 mmol) was dissolved in 50 ml of ethanol and then, to this solution, 2,2'-bipyridine (0.484 g; 3.10 mmol) was added. The mixture reacted at room temperature with stirring for 5 hrs. The dark orange precipitates produced were filtered, washed with cold ethanol and then dried under vacuum. The yield was 89.6%. Analysis calculated for $C_{10}H_8N_2CuBr_2$: C 31.65; H 2.12; N 7.38%; found C 31.49; H 2.23; N 7.31%.

$Hg(bipy)Br_2$ (0.431 g; 1.14 mmol) and $Cu(bipy)Br_2$ (0.578 g; 1.14 mmol) were dissolved in 10 ml of dimethylsulfoxide respectively, and then two solutions were mixed and stirred for 2 hrs. at room temperature. The dark green crystals of the title compound produced were collected, washed with cold ethanol and dimethylsulfoxide successively and then dried under vacuum. Analysis calculated for $C_{20}H_{16}N_4CuHgBr_4$: C 27.67; H 1.86; N 3.23%; found C 27.12; H 2.04; N 3.44%.

Refinement

All H atoms were fixed geometrically and treated as riding with C—H = 0.93 Å with $U_{iso}(H) = 1.2U_{eq}(C)$.

Figures

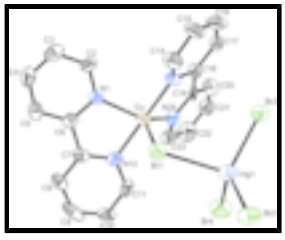


Fig. 1. Molecular structure of (I), showing the atom-numbering scheme. Ellipsoids are drawn at the 30% probability level. H atoms have been omitted for clarity.

Bis(2,2'-bipyridine-1κ^2*N*,*N*')-\-*m*-bromido-1:2κ^2*Br*-tribromido-2κ^3*Br*-\ copper(II)mercury(II)

Crystal data

$[CuHgBr_4(C_{10}H_8N_2)_2]$	F_{000} = 1652
M_r = 896.14	D_x = 2.487 Mg m^{-3}
Monoclinic, $P2_1/n$	Mo $K\alpha$ radiation λ = 0.71073 Å
Hall symbol: -P 2yn	Cell parameters from 25 reflections
a = 8.5510 (6) Å	θ = 11.3–14.1º

b = 15.522 (4) Å	μ = 13.99 mm^{-1}
c = 18.056 (2) Å	T = 295 (2) K
β = 92.784 (8)º	Block, green
V = 2393.8 (7) Å^3	0.23 × 0.2 × 0.2 mm
Z = 4	

Data collection

Enraf-Nonius CAD-4 diffractometer	θ_{max} = 26º
non–profiled ω/2θ scans	θ_{min} = 2.3º
Absorption correction: ψ scan (North *et al.*, 1968)	h = −10→10
T_{min} = 0.050, T_{max} = 0.059	k = −2→19
6320 measured reflections	l = −2→22
4705 independent reflections	3 standard reflections
2406 reflections with $I > 2\sigma(I)$	every 400 reflections
R_{int} = 0.057	intensity decay: none

Refinement

Refinement on F^2	Secondary atom site location: difference Fourier map
Least-squares matrix: full	Hydrogen site location: inferred from neighbouring sites
$R[F^2 > 2\sigma(F^2)]$ = 0.060	H-atom parameters constrained
$wR(F^2)$ = 0.110	$w = 1/[\sigma^2(F_o^2) + (0.0352P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
S = 0.99	$(\Delta/\sigma)_{max} < 0.001$
4705 reflections	$\Delta\rho_{max}$ = 0.93 e Å^{-3}
271 parameters	$\Delta\rho_{min}$ = −1.13 e Å^{-3}
156 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.

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

	x	y	z	U_{iso}*/U_{eq}
C2	−0.0322 (14)	0.6419 (8)	0.5219 (7)	0.040 (3)
H2	0.0485	0.6813	0.5306	0.048*
C3	−0.0552 (13)	0.5794 (9)	0.5747 (7)	0.045 (4)
H3	0.0087	0.5763	0.6178	0.054*

C4	−0.1743 (14)	0.5227 (9)	0.5618 (7)	0.048 (4)
H4	−0.1925	0.4804	0.5968	0.057*
C5	−0.2686 (13)	0.5265 (8)	0.4980 (7)	0.041 (3)
H5	−0.3483	0.4866	0.4889	0.049*
C6	−0.2414 (12)	0.5917 (8)	0.4475 (6)	0.032 (3)
C7	−0.3341 (12)	0.6042 (8)	0.3783 (7)	0.033 (3)
C8	−0.4543 (12)	0.5510 (8)	0.3537 (7)	0.040 (3)
H8	−0.4795	0.5019	0.3801	0.049*
C9	−0.5376 (13)	0.5729 (9)	0.2877 (9)	0.055 (4)
H9	−0.6222	0.5392	0.2711	0.066*
C10	−0.4967 (12)	0.6420 (9)	0.2481 (7)	0.047 (4)
H10	−0.5510	0.6557	0.2037	0.056*
C11	−0.3745 (13)	0.6917 (8)	0.2739 (7)	0.038 (3)
H11	−0.3454	0.7393	0.2464	0.046*
C14	0.2304 (13)	0.7503 (8)	0.4252 (7)	0.048 (3)
H14	0.2351	0.6909	0.4188	0.057*
C15	0.3632 (14)	0.7934 (10)	0.4513 (7)	0.052 (4)
H15	0.4544	0.7637	0.4652	0.062*
C16	0.3563 (14)	0.8814 (10)	0.4561 (7)	0.052 (4)
H16	0.4452	0.9117	0.4725	0.062*
C17	0.2216 (13)	0.9257 (8)	0.4375 (6)	0.040 (3)
H17	0.2174	0.9855	0.4410	0.048*
C18	0.0911 (13)	0.8779 (8)	0.4130 (7)	0.035 (3)
C19	−0.0611 (13)	0.9174 (8)	0.3890 (7)	0.035 (3)
C20	−0.0916 (14)	1.0046 (8)	0.3924 (7)	0.047 (4)
H20	−0.0146	1.0431	0.4093	0.057*
C21	−0.2390 (16)	1.0331 (9)	0.3702 (7)	0.053 (4)
H21	−0.2623	1.0915	0.3729	0.064*
C22	−0.3525 (15)	0.9762 (9)	0.3440 (8)	0.060 (4)
H22	−0.4511	0.9955	0.3275	0.072*
C23	−0.3154 (14)	0.8895 (9)	0.3432 (7)	0.047 (4)
H23	−0.3922	0.8501	0.3278	0.057*
Br1	0.04425 (13)	0.64128 (9)	0.27693 (8)	0.0433 (4)
Br2	0.23547 (15)	0.67094 (9)	0.06716 (8)	0.0511 (4)
Br3	0.28973 (14)	0.86587 (9)	0.24357 (8)	0.0483 (4)
Br4	−0.15949 (15)	0.82029 (10)	0.12790 (9)	0.0634 (5)
Cu1	−0.10161 (15)	0.73448 (10)	0.37395 (9)	0.0432 (4)
Hg1	0.11158 (6)	0.76093 (3)	0.17075 (3)	0.04758 (19)
N1	−0.1207 (10)	0.6482 (6)	0.4588 (5)	0.032 (2)
N12	−0.2952 (10)	0.6737 (7)	0.3379 (5)	0.036 (3)
N13	0.0957 (10)	0.7909 (7)	0.4088 (5)	0.041 (3)
N24	−0.1725 (11)	0.8604 (6)	0.3640 (5)	0.036 (3)

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
C2	0.053 (7)	0.035 (8)	0.031 (8)	−0.001 (7)	−0.013 (6)	0.004 (7)
C3	0.045 (8)	0.059 (9)	0.032 (8)	0.014 (7)	0.008 (7)	0.001 (8)

C4	0.048 (8)	0.048 (9)	0.048 (9)	−0.002 (7)	0.013 (7)	0.013 (8)
C5	0.046 (8)	0.028 (7)	0.050 (9)	0.003 (6)	0.008 (7)	0.003 (7)
C6	0.034 (6)	0.036 (7)	0.026 (7)	0.007 (6)	0.009 (6)	−0.005 (6)
C7	0.018 (6)	0.044 (8)	0.036 (8)	0.005 (6)	−0.001 (6)	−0.005 (7)
C8	0.027 (6)	0.040 (8)	0.055 (9)	−0.006 (6)	0.008 (7)	−0.012 (8)
C9	0.021 (6)	0.053 (10)	0.090 (12)	−0.004 (7)	−0.004 (8)	−0.026 (9)
C10	0.024 (6)	0.069 (10)	0.045 (9)	−0.008 (7)	−0.015 (6)	−0.005 (8)
C11	0.037 (7)	0.037 (8)	0.041 (8)	0.005 (6)	0.002 (6)	0.019 (7)
C14	0.049 (7)	0.035 (8)	0.058 (8)	0.000 (7)	−0.013 (7)	0.001 (8)
C15	0.029 (7)	0.072 (11)	0.054 (9)	−0.012 (7)	−0.007 (7)	−0.007 (9)
C16	0.032 (7)	0.081 (11)	0.042 (8)	−0.005 (8)	−0.007 (7)	−0.010 (9)
C17	0.058 (8)	0.031 (8)	0.033 (8)	−0.012 (7)	0.011 (7)	−0.005 (7)
C18	0.045 (7)	0.028 (7)	0.033 (7)	−0.012 (6)	0.002 (6)	−0.003 (7)
C19	0.046 (7)	0.022 (7)	0.037 (8)	−0.014 (6)	0.009 (6)	0.012 (7)
C20	0.048 (8)	0.041 (9)	0.054 (9)	0.000 (7)	0.009 (7)	0.000 (8)
C21	0.075 (9)	0.034 (8)	0.051 (9)	−0.004 (8)	0.003 (8)	0.002 (8)
C22	0.045 (8)	0.060 (10)	0.075 (11)	0.020 (8)	0.001 (8)	0.016 (9)
C23	0.049 (8)	0.047 (9)	0.045 (9)	0.008 (7)	−0.007 (7)	0.007 (8)
Br1	0.0431 (7)	0.0393 (8)	0.0472 (9)	−0.0010 (6)	−0.0027 (7)	0.0004 (7)
Br2	0.0544 (8)	0.0526 (9)	0.0454 (9)	0.0121 (7)	−0.0085 (7)	−0.0070 (8)
Br3	0.0541 (8)	0.0498 (9)	0.0405 (8)	−0.0093 (7)	−0.0039 (7)	−0.0001 (8)
Br4	0.0496 (8)	0.0680 (11)	0.0706 (11)	0.0113 (8)	−0.0187 (8)	0.0091 (10)
Cu1	0.0354 (8)	0.0371 (10)	0.0552 (11)	−0.0115 (8)	−0.0170 (7)	0.0115 (9)
Hg1	0.0466 (3)	0.0477 (4)	0.0472 (3)	0.0045 (3)	−0.0103 (2)	−0.0044 (3)
N1	0.036 (5)	0.024 (6)	0.035 (6)	−0.001 (5)	−0.002 (5)	−0.006 (5)
N12	0.027 (5)	0.044 (7)	0.035 (6)	0.004 (5)	−0.007 (5)	0.007 (6)
N13	0.029 (5)	0.052 (7)	0.041 (7)	−0.012 (5)	−0.009 (5)	0.007 (6)
N24	0.040 (6)	0.029 (6)	0.039 (6)	0.001 (5)	0.002 (5)	0.008 (5)

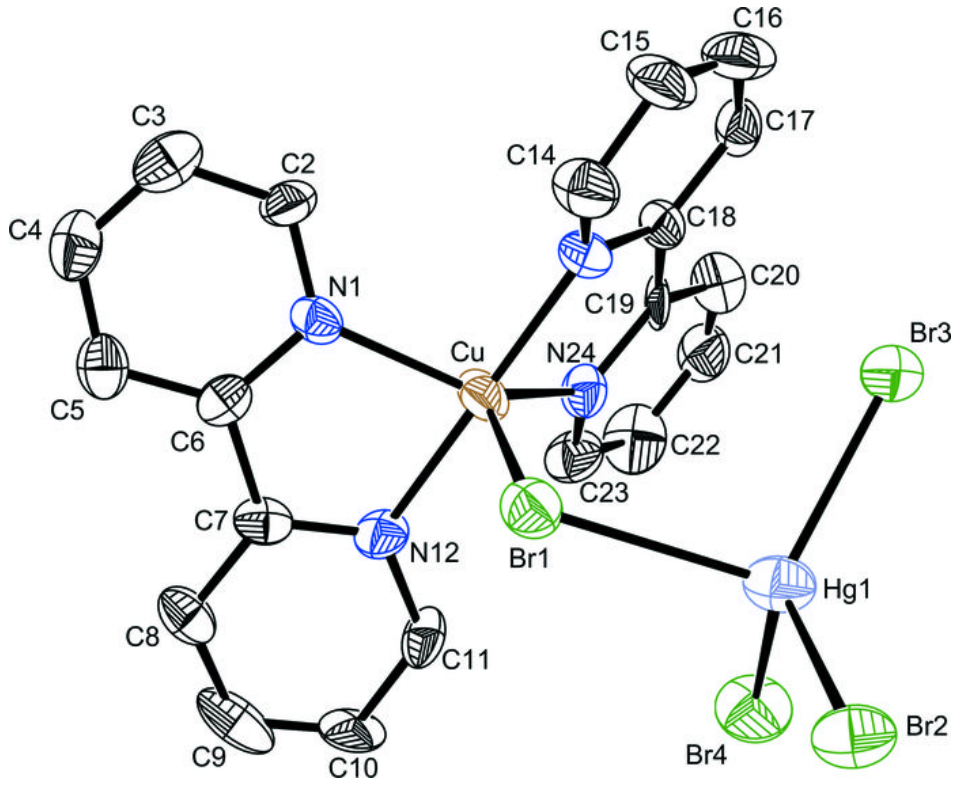
Geometric parameters (Å, °)

C2—N1	1.341 (13)	C16—C17	1.370 (16)
C2—C3	1.380 (16)	C16—H16	0.9300
C2—H2	0.9300	C17—C18	1.394 (14)
C3—C4	1.357 (16)	C17—H17	0.9300
C3—H3	0.9300	C18—N13	1.353 (14)
C4—C5	1.375 (16)	C18—C19	1.484 (15)
C4—H4	0.9300	C19—N24	1.361 (13)
C5—C6	1.388 (16)	C19—C20	1.380 (16)
C5—H5	0.9300	C20—C21	1.377 (16)
C6—N1	1.363 (13)	C20—H20	0.9300
C6—C7	1.460 (15)	C21—C22	1.379 (17)
C7—N12	1.353 (14)	C21—H21	0.9300
C7—C8	1.375 (15)	C22—C23	1.383 (17)
C8—C9	1.399 (17)	C22—H22	0.9300
C8—H8	0.9300	C23—N24	1.339 (13)
C9—C10	1.346 (17)	C23—H23	0.9300
C9—H9	0.9300	Br1—Cu1	2.632 (2)
C10—C11	1.363 (15)	Br1—Hg1	2.7502 (15)

C10—H10	0.9300	Br2—Hg1	2.6008 (15)
C11—N12	1.340 (13)	Br3—Hg1	2.5512 (14)
C11—H11	0.9300	Br4—Hg1	2.5780 (14)
C14—N13	1.334 (13)	Cu1—N13	1.977 (9)
C14—C15	1.382 (15)	Cu1—N12	1.987 (9)
C14—H14	0.9300	Cu1—N1	2.047 (10)
C15—C16	1.370 (18)	Cu1—N24	2.052 (10)
C15—H15	0.9300		
N1—C2—C3	123.0 (12)	N24—C19—C20	121.4 (12)
N1—C2—H2	118.5	N24—C19—C18	114.7 (10)
C3—C2—H2	118.5	C20—C19—C18	123.9 (11)
C4—C3—C2	117.8 (12)	C21—C20—C19	118.4 (13)
C4—C3—H3	121.1	C21—C20—H20	120.8
C2—C3—H3	121.1	C19—C20—H20	120.8
C3—C4—C5	121.4 (13)	C20—C21—C22	120.8 (13)
C3—C4—H4	119.3	C20—C21—H21	119.6
C5—C4—H4	119.3	C22—C21—H21	119.6
C4—C5—C6	118.1 (12)	C21—C22—C23	118.0 (13)
C4—C5—H5	120.9	C21—C22—H22	121.0
C6—C5—H5	120.9	C23—C22—H22	121.0
N1—C6—C5	121.4 (11)	N24—C23—C22	122.1 (13)
N1—C6—C7	114.7 (11)	N24—C23—H23	118.9
C5—C6—C7	123.9 (12)	C22—C23—H23	118.9
N12—C7—C8	120.3 (11)	Cu1—Br1—Hg1	102.40 (6)
N12—C7—C6	115.5 (10)	N13—Cu1—N12	177.8 (4)
C8—C7—C6	124.2 (12)	N13—Cu1—N1	98.6 (4)
C7—C8—C9	118.1 (13)	N12—Cu1—N1	80.8 (4)
C7—C8—H8	121.0	N13—Cu1—N24	81.3 (4)
C9—C8—H8	121.0	N12—Cu1—N24	100.7 (4)
C10—C9—C8	120.8 (12)	N1—Cu1—N24	130.9 (4)
C10—C9—H9	119.6	N13—Cu1—Br1	91.8 (3)
C8—C9—H9	119.6	N12—Cu1—Br1	86.3 (3)
C9—C10—C11	119.0 (12)	N1—Cu1—Br1	101.3 (3)
C9—C10—H10	120.5	N24—Cu1—Br1	127.8 (3)
C11—C10—H10	120.5	Br3—Hg1—Br4	115.60 (5)
N12—C11—C10	121.6 (12)	Br3—Hg1—Br2	117.37 (5)
N12—C11—H11	119.2	Br4—Hg1—Br2	111.58 (5)
C10—C11—H11	119.2	Br3—Hg1—Br1	102.23 (5)
N13—C14—C15	122.2 (13)	Br4—Hg1—Br1	103.59 (5)
N13—C14—H14	118.9	Br2—Hg1—Br1	104.19 (5)
C15—C14—H14	118.9	C2—N1—C6	118.1 (11)
C16—C15—C14	117.9 (13)	C2—N1—Cu1	128.5 (8)
C16—C15—H15	121.1	C6—N1—Cu1	113.4 (8)
C14—C15—H15	121.1	C11—N12—C7	120.2 (10)
C17—C16—C15	121.6 (13)	C11—N12—Cu1	124.2 (9)
C17—C16—H16	119.2	C7—N12—Cu1	115.1 (7)
C15—C16—H16	119.2	C14—N13—C18	119.1 (11)
C16—C17—C18	117.4 (12)	C14—N13—Cu1	125.1 (9)
C16—C17—H17	121.3	C18—N13—Cu1	115.7 (8)

C18—C17—H17	121.3	C23—N24—C19	119.2 (11)
N13—C18—C17	121.6 (12)	C23—N24—Cu1	127.4 (9)
N13—C18—C19	115.0 (10)	C19—N24—Cu1	113.0 (8)
C17—C18—C19	123.3 (11)		

Fig. 1


C16
C15
C3
C17
C2
C14
C4
C18
N1
C20
C19
Br3
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N24
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C5
C6
C22
C23
C7
N12
Br1
Hg1
C8
C11
Br2
C9
C10
Br4