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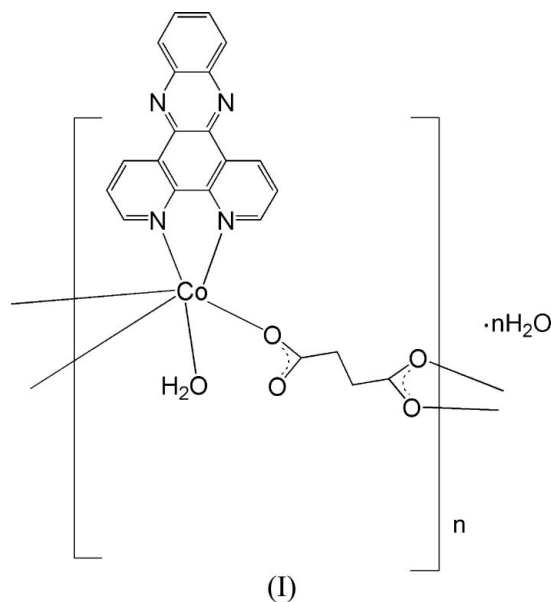
## Key indicators

Single-crystal X-ray study  
 $T = 292$  K  
Mean  $\sigma(\text{C}-\text{C}) = 0.008$  Å  
 $R$  factor = 0.074  
 $wR$  factor = 0.211  
Data-to-parameter ratio = 15.3For details of how these key indicators were  
automatically derived from the article, see  
<http://journals.iucr.org/e>.*catena*-Poly[[[aqua(dipyrido[3,2-*a*:2',3'-*c*]-  
phenazine)cobalt(II)]- $\mu$ -succinato] monohydrate]Received 28 October 2006  
Accepted 29 October 2006

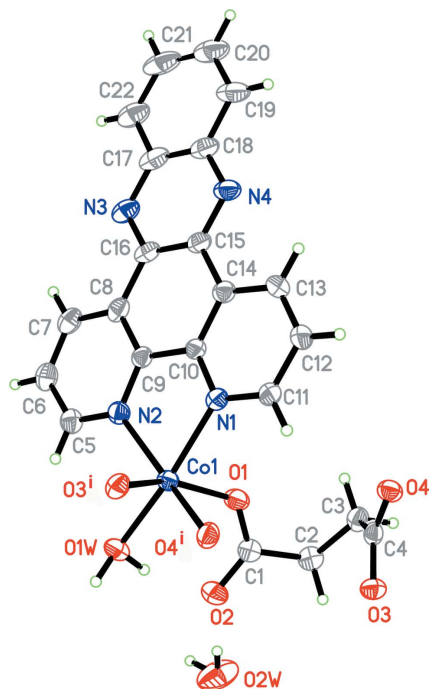
In the title compound,  $\{[\text{Co}(\text{C}_4\text{H}_4\text{O}_4)(\text{C}_{18}\text{H}_{10}\text{N}_4)(\text{H}_2\text{O})] \cdot \text{H}_2\text{O}\}_n$ , each  $\text{Co}^{\text{II}}$  atom is six-coordinated by two N atoms from one dipyrido[3,2-*a*:2',3'-*c*]phenazine ligand, and by four O atoms from two succinate anions (one chelating bidentate and one monodentate) and one water molecule in a distorted *cis*- $\text{CoN}_2\text{O}_4$  octahedral coordination. The  $\text{Co}^{\text{II}}$  atoms are bridged by the succinate ligands to generate a helical chain structure. The chain motif is consolidated into a layer structure by  $\text{O}-\text{H} \cdots \text{O}$  hydrogen bonds involving the water molecules and carboxylate O atoms.

## Comment

The rational design and synthesis of metal-organic coordination polymers is of great current interest (Eddaoudi *et al.*, 2001). 1,10-Phenanthroline (phen) or its derivatives, as one type of important organic ligands, have been widely used as components in the construction of metal-organic coordination polymers (Chen & Liu, 2002). The phen derivative dipyrido[3,2-*a*:2',3'-*c*]phenazine, *L*, possesses an extended aromatic system and its coordination polymers have recently been studied (Zhang & Sun, 2006). As a continuation of this work, we have prepared the polymeric title compound,  $[\text{Co}(\text{suc})(L)(\text{H}_2\text{O})] \cdot \text{H}_2\text{O}$ , (I) (Fig. 1), from a combination of  $\text{Co}^{2+}$  ions, succinic acid ( $\text{H}_2\text{suc}$ ) and *L* as a secondary chelating ligand.



Selected bond lengths and angles for (I) are given in Table 1. Each  $\text{Co}^{\text{II}}$  atom is six-coordinated by two N atoms from one *L* ligand, and by four O atoms from two  $\text{suc}^{2-}$  anions (one


**Figure 1**

The asymmetric unit of (I), expanded to show the metal coordination. Displacement ellipsoids are drawn at the 30% probability level (arbitrary spheres for the H atoms). [Symmetry code: (i)  $1 - x, y - \frac{1}{2}, \frac{3}{2} - z$ .]

monodentate and one chelating bidentate) and one water molecule, resulting in a very distorted octahedral coordination. Compound (I) also incorporates an uncoordinated water molecule (Fig. 1). The C—O bond lengths of both carboxylate groups of the  $\text{suc}^{2-}$  dianion suggest delocalization of the bonding and its carbon backbone adopts a *gauche* conformation.

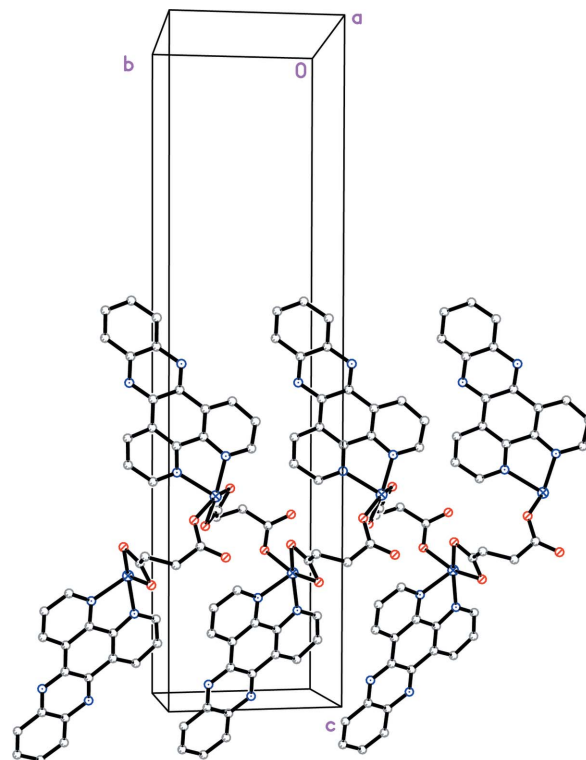
The  $\text{Co}^{\text{II}}$  atoms are bridged by the  $\text{suc}^{2-}$  ligands to generate a helical chain structure propagating along [010] (Fig. 2) generated by the  $2_1$  screw axis. This chain motif is consolidated into a layer structure by O—H...O hydrogen bonds involving the water molecules and carboxylate O atoms (Table 2).

## Experimental

The ligand *L* was synthesized according to the method of Che *et al.* (2006). An ethanolic solution (24 ml) of *L* (0.5 mmol) was added slowly to an aqueous solution (20 ml) of  $\text{CoCl}_2 \cdot 2\text{H}_2\text{O}$  (0.5 mmol) and  $\text{H}_2\text{suc}$  (1 mmol) with stirring at refluxing temperature. The resulting solution was filtered and the filtrate was allowed to stand in air at room temperature for one week, yielding red crystals of (I) (61% yield based on Co).

### Crystal data

$[\text{Co}(\text{C}_4\text{H}_4\text{O}_4)(\text{C}_{18}\text{H}_{10}\text{N}_4)(\text{H}_2\text{O})] \cdot \text{H}_2\text{O}$	$V = 2088.9$ (7) $\text{\AA}^3$
$M_r = 493.33$	$Z = 4$
Monoclinic, $P2_1/c$	$D_x = 1.569$ $\text{Mg m}^{-3}$
$a = 8.6818$ (17) $\text{\AA}$	Mo $K\alpha$ radiation
$b = 7.8022$ (16) $\text{\AA}$	$\mu = 0.87$ $\text{mm}^{-1}$
$c = 30.968$ (6) $\text{\AA}$	$T = 292$ (2) K
$\beta = 95.27$ (3)°	Block, red
	$0.31 \times 0.27 \times 0.24$ mm


**Figure 2**

A view of the one-dimensional chain structure of (I). Uncoordinated water molecules and H atoms have been omitted.

### Data collection

Rigaku R-Axis RAPID diffractometer	18973 measured reflections
$\omega$ scans	4741 independent reflections
Absorption correction: multi-scan (ABSCOR; Higashi, 1995)	3215 reflections with $I > 2\sigma(I)$
$T_{\min} = 0.759, T_{\max} = 0.816$	$R_{\text{int}} = 0.074$
	$\theta_{\max} = 27.5^\circ$

### Refinement

Refinement on $F^2$	$w = 1/[\sigma^2(F_o^2) + (0.11P)^2 + 1.9763P]$
$R[F^2 > 2\sigma(F^2)] = 0.074$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.211$	$(\Delta/\sigma)_{\max} = 0.001$
$S = 1.04$	$\Delta\rho_{\max} = 3.08$ $\text{e \AA}^{-3}$
4741 reflections	$\Delta\rho_{\min} = -0.43$ $\text{e \AA}^{-3}$
310 parameters	
H atoms treated by a mixture of independent and constrained refinement	

**Table 1**

Selected geometric parameters ( $\text{\AA}, ^\circ$ ).

C1—O2	1.250 (5)	Co1—N2	2.126 (4)
C1—O1	1.267 (5)	Co1—O1	2.067 (3)
C4—O3	1.258 (5)	Co1—O1W	2.061 (3)
C4—O4	1.277 (6)	Co1—O3 <sup>i</sup>	2.177 (3)
Co1—N1	2.115 (4)	Co1—O4 <sup>i</sup>	2.147 (3)
N1—Co1—N2	77.57 (14)	O4 <sup>i</sup> —Co1—O3 <sup>i</sup>	60.43 (12)
C1—C2—C3—C4	67.6 (5)		

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

**Table 2**  
Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O1W—H11W $\cdots$ O2	0.93 (4)	1.75 (3)	2.612 (5)	154 (5)
O1W—H12W $\cdots$ O4 <sup>ii</sup>	0.92 (4)	1.76 (2)	2.678 (4)	172 (5)
O2W—H21W $\cdots$ O1 <sup>iii</sup>	0.92 (7)	2.14 (8)	3.041 (6)	165 (9)
O2W—H22W $\cdots$ O2	0.92 (7)	1.90 (6)	2.815 (6)	173 (10)

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

All C-bound H atoms were generated geometrically and refined as riding atoms, with  $C-H = 0.93 \text{ \AA}$  and  $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C})$ . The H atoms of the water molecules were located in a difference map and refined with an O—H distance restraint of  $0.90(2) \text{ \AA}$ . The highest residual electron-density peak is located  $0.92 \text{ \AA}$  from atom H6.

Data collection: *PROCESS-AUTO* (Rigaku, 1998); cell refinement: *PROCESS-AUTO*; data reduction: *PROCESS-AUTO*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997);

molecular graphics: *SHELXTL-Plus* (Sheldrick, 1990); software used to prepare material for publication: *SHELXL97*.

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## References

- Che, G.-B., Li, W.-L., Kong, Z.-G., Su, Z.-S., Chu, B., Li, B., Zhang, Z.-Q., Hu, Z.-Z. & Chi, H.-J. (2006). *Synth. Commun.* **36**, 2519–2524.
- Chen, X.-M. & Liu, G.-F. (2002). *Chem. Eur. J.* **8**, 4811–4817.
- Eddaoudi, M., Moler, D. B., Li, H., Chen, B., Reineke, T. M., O'Keeffe, M. & Yaghi, O. M. (2001). *Acc. Chem. Res.* **34**, 319–330.
- Higashi, T. (1995). *ABSCOR*. Rigaku Corporation, Tokyo, Japan.
- Rigaku (1998). *PROCESS-AUTO*. Version 1.06. Rigaku Corporation, Tokyo, Japan.
- Sheldrick, G. M. (1990). *SHELXTL-Plus*. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.
- Sheldrick, G. M. (1997). *SHELXS97* and *SHELXL97*. University of Göttingen, Germany.
- Zhang, S.-C. & Sun, J. (2006). *Acta Cryst. E* **62**, m3107–m3109.