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1′-Benzyl-3-(2,6-dichlorophenyl)-1″-methyl-4,4″-diphenyloxazole-5(4*H*)-spiro-3′-piperidine-5′-spiro-3″-pyrrolidine-2″-spiro-3‴-1*H*-indole-2‴(3‴*H*),4′-dione benzene hemisolvate

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Key indicators

Single-crystal X-ray study
T = 293 K
Mean σ(C–C) = 0.005 Å
R factor = 0.047
wR factor = 0.128
Data-to-parameter ratio = 13.6

For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

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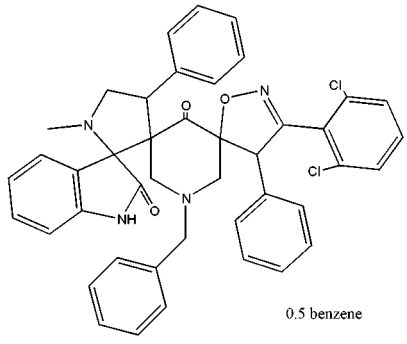
In the title compound, $C_{43}H_{36}Cl_2N_4O_3\cdot0.5C_6H_6$, there exists a trispiro ring system, which consists of a planar 2-oxindole ring, an envelope pyrrolidine ring, an envelope isoxazoline ring and a boat-shaped piperidone ring. The crystal structure is stabilized by N—H···N intermolecular interactions.

Comment

Spiro-compounds represent an important class of naturally occurring substances characterized by highly pronounced biological properties (Kobayashi *et al.*, 1991; James *et al.*, 1991). 1,3–Dipolar cycloaddition reactions are important for the construction of spiro-compounds (Caramella & Grunanger, 1984). The title compound, (I), was synthesized by a double dipolar cycloaddition. Azomethine ylide, derived from isatin and sarcosine by a decarboxylative route, was first reacted with 1-benzyl-3,5-dibenzylidenepiperidin-4-one. The resulting cycloaddition product was then reacted with 2,6-dichlorobenzonitrile oxide to give (I). The molecular structure of (I) (Fig. 1) revealed the presence of a ring system with spiro junctions at atoms C8, C11 and C14. It consists of a 2-oxindole ring, a pyrrolidine ring, an isoxazoline ring and a piperidone ring.



(I)

The bond lengths and angles in (I) are normal within experimental error. Those involving the spiro centers, atoms C8, C11 and C14, are given in Table 1. The pyrrolidine ring (N2/C9/C10/C11/C8) has an envelope conformation with atom C9 displaced by 0.600 (2) Å from the mean plane through atoms N2/C8/C11/C10 [planar to within 0.053 (3) Å]. The dihedral angle between plane N2/C9/C10 and mean plane N2/C8/C11/C10 is 40.9 (4)°. The C19–C24 phenyl ring is inclined to mean plane N2/C8/C11/C10 by 90.4 (3)°.

The 2-oxindole ring (C8/C7/C6/C5/C4/C3/C2/N1/C1) is planar to within 0.018 (3)Å. The dihedral angle between the 2-oxindole ring mean plane and mean plane N2/C8/C11/C10 is 93.1 (3)°.

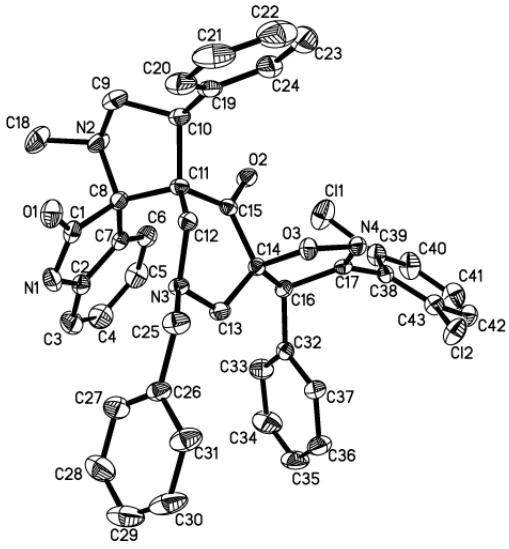


Figure 1
The molecular structure of (I), drawn with 30% probability ellipsoids. H atoms have been omitted for clarity.

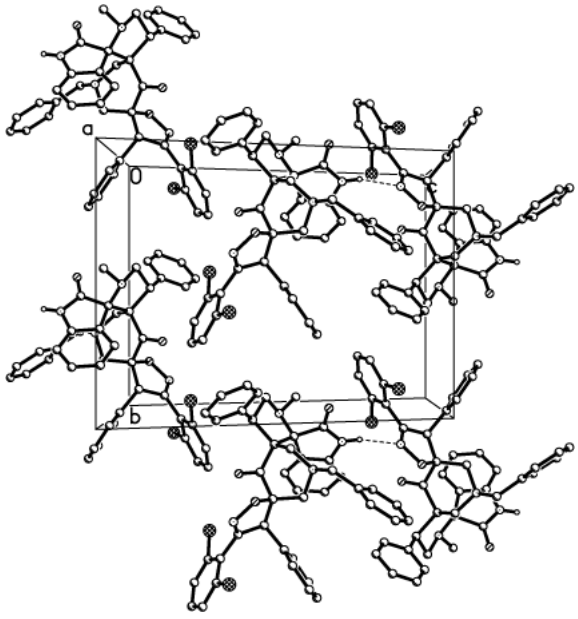


Figure 2
The crystal structure of (I), viewed along the *a* axis. The dashed lines indicate the N—H···N intermolecular hydrogen bonds. The benzene molecule of crystallization and the C—H H atoms have been omitted for clarity.

The isoxazoline ring O3/N4/C17/C16/C14 has an envelope conformation, with atom C14 displaced by 0.240 (2) Å from the mean plane through atoms O3/N4/C17/C16 [planar to within 0.006 (2) Å]. Phenyl rings C38–C43 and C32–C37 are inclined by 57.9 (4) and 84.9 (2)°, respectively, to the mean plane O3/N4/C17/C16.

The piperidone ring has a boat conformation with atoms C12 and C14 displaced by 0.713 (3) and 0.341 (3) Å, respectively, from the mean plane through atoms N3/C13/C15/C11.

In the crystal structure, the molecules are linked by an intermolecular N—H···N hydrogen bond, involving atoms N1 and N4 (Table 2 and Fig. 2), so forming a hydrogen-bonded polymer extending in the *c* direction. A benzene molecule of crystallization, disordered about a center of symmetry, is located between centrosymmetr-cally related molecules of (I).

Experimental

A mixture of 1-benzyl-3,5-dibenzylidenepiperidin-4-one (2 mmol), isatin (2 mmol) and sarcosine (2 mmol) was refluxed in methanol (80 ml) until the disappearance of the starting material, as evidenced by thin-layer chromatography. After the reaction was complete the solvent was removed *in vacuo* and the residue separated by column chromatography (silica gel, petroleum ether/ethyl acetate = 5:1) to give the intermediate compound. This was then reacted with 2,6-dichlorobenzonitrile oxide in refluxing dry benzene for 24 h. The mixture was then cooled and filtered. Recrystallization from benzene–THF gave the title compound, (I). Further synthetic and other details are given in the CIF. Colorless crystals, suitable for X-ray analysis, were obtained by slow evaporation of a solution of (I) in chloroform–benzene.

Crystal data

$C_{43}H_{36}Cl_2N_4O_3\cdot0.5C_6H_6$	D_x = 1.314 Mg m^{-3}
M_r = 766.71	Mo $K\alpha$ radiation
Monoclinic, $P2_1/c$	Cell parameters from 1017 reflections
a = 19.005 (7) Å	θ = 2.4–22.6°
b = 12.611 (4) Å	μ = 0.22 mm^{-1}
c = 17.986 (6) Å	T = 293 (2) K
β = 115.937 (5)°	Plate, colorless
V = 3877 (2) Å^3	0.38 × 0.22 × 0.20 mm
Z = 4	

Data collection

Bruker SMART CCD area-detector diffractometer	6770 independent reflections
φ and ω scans	3692 reflections with $I > 2\sigma(I)$
Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)	R_{int} = 0.055
T_{min} = 0.945, T_{max} = 0.958	θ_{max} = 25.0°
15 867 measured reflections	$h = -22 \rightarrow 20$
	$k = -8 \rightarrow 14$
	$l = -16 \rightarrow 21$

Refinement

Refinement on F^2	H-atom parameters constrained
$R[F^2 > 2\sigma(F^2)]$ = 0.047	$w = 1/[\sigma^2(F_o^2) + (0.084P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2)$ = 0.128	$(\Delta/\sigma)_{max}$ = 0.001
S = 1.02	$\Delta\rho_{max}$ = 0.19 e Å^{-3}
6770 reflections	$\Delta\rho_{min}$ = −0.27 e Å^{-3}
497 parameters	

Table 1
Selected geometric parameters (Å, °).

N2—C8	1.475 (3)	C11—C12	1.526 (4)
O3—C14	1.482 (3)	C11—C15	1.527 (4)
C1—C8	1.559 (4)	C13—C14	1.512 (4)
C7—C8	1.520 (4)	C14—C15	1.540 (4)
C8—C11	1.585 (4)	C14—C16	1.547 (3)
C10—C11	1.571 (4)		
N2—C8—C7	110.8 (2)	C12—C11—C8	112.8 (2)
N2—C8—C1	110.9 (2)	C15—C11—C8	108.8 (2)
C7—C8—C1	101.5 (2)	C10—C11—C8	104.0 (2)
N2—C8—C11	103.1 (2)	O3—C14—C13	108.8 (2)
C7—C8—C11	118.7 (2)	O3—C14—C15	99.82 (19)
C1—C8—C11	112.1 (2)	C13—C14—C15	115.2 (2)
C12—C11—C15	106.3 (2)	O3—C14—C16	104.0 (2)
C12—C11—C10	113.9 (2)	C13—C14—C16	115.8 (2)
C15—C11—C10	111.0 (2)	C15—C14—C16	111.3 (2)

Table 2
Hydrogen-bonding geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N1—H1···N4^{i}	0.86	2.25	3.017 (3)	149

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

The H atoms were introduced at calculated positions as riding atoms, with bond lengths of 0.93 (CH aromatic), 0.98 (CH), 0.98 (CH_3), and 0.86 Å (N—H). The displacement parameters were 1.2 (CH, NH) or 1.5 (CH_3) times thoses of the parent atoms.

Data collection: *SMART* (Bruker, 1997); cell refinement: *SMART*; data reduction: *SAINT* (Bruker, 1997); program(s) used to solve structure: *SHELXS*97 (Sheldrick, 1997); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics: *SHELXTL* (Bruker, 1997); software used to prepare material for publication: *SHELXTL*.

References

Bruker (1997). *SMART*, *SAINT* and *SHELXTL*. Versions 5.10. Bruker AXS Inc., Madison, Wisconsin, USA.

Caramella, P. & Grunanger, P. (1984). *1,3-Dipolar Cycloaddition Chemistry*, edited by A. Padwa, Vol. 1, pp. 291–312. New York: Wiley.

James, D. M., Kunze, H. B. & Faulkner, D. J. (1991). *J. Nat. Prod.* **54**, 1137–1140.

Kobayashi, J., Tsuda, M., Agemi, K., Shigemori, H., Ishibashi, M., Sasaki, T. & Mikamiy, Y. (1991). *Tetrahedron*, **47**, 6617–6622.

Sheldrick, G. M. (1996). *SADABS*. University of Göttingen, Germany.

Sheldrick, G. M. (1997). *SHELXS*97 and *SHELXL*97. University of Göttingen, Germany.