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Structures of 2-Amino-3,5-dibromo-*N*-cyclohexyl-*N*-methylbenzenemethanamine–Salicylic Acid (1:1)(ABCMBMA–SALA), $C_{14}H_{20}Br_2N_2.C_7H_6O_3$

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Abstract. $M_r = 514{\cdot}27$, triclinic, $P\bar{1}$, $a = 29{\cdot}146$ (34), $b = 9{\cdot}710$ (3), $c = 9{\cdot}719$ (9) Å, $\alpha = 105{\cdot}18$ (5), $\beta = 124{\cdot}18$ (6), $\gamma = 85{\cdot}99$ (6)°, $U = 2185{\cdot}8$ (39) Å^3, $D_x = 1{\cdot}563$, $D_m = 1{\cdot}560$ Mg m^{-3}, $Z = 4$, μ(Mo $K\alpha$) = 4·08 mm^{-1}, $F(000) = 1040$, λ(Mo $K\alpha$) = 0·71069 Å; $R = 0{\cdot}057$ for 4250 observed reflections at 297 K. The two crystallographically independent molecules (ABCMBMA, *A* and *B*; SALA, *C* and *D*) in the asymmetric unit exhibit almost identical shapes and dimensions. The most important intermolecular interactions in this 1:1 adduct are $N^{\oplus}$–H···$O^{\ominus}$···C hydrogen bonds: N(2,ABCMBMA)···O(1,SALA) 2·70 (1) Å (*A*–*C*) and 2·690 (8) Å [*B*–D^{ii}, (ii) = $x, y-1, z$].

Introduction. ABCMBMA is an expectorant drug and the Na salt of SALA is an antipyretic–analgesic–anti-inflammatory agent. This work is a continuation of our investigations on molecular complexes between different drugs [ABCMBMA–1,2-benzisothiazol-3(2*H*)-one 1,1-dioxide(OSBI)(1:1) (Shimizu & Nishigaki, 1983)].

Experimental. A single crystal 0·2 × 0·2 × 0·3 mm was obtained, with some difficulty, from a solution containing equimolar quantities of ABCMBMA and SALA in a mixture of water and ethanol; computer-controlled Rigaku AFC-5 diffractometer, graphite-monochromatized Mo $K\alpha$ radiation, D_m by flotation in *n*-hexane and carbon tetrachloride at 303 K; cell dimensions by least squares with the setting angles of 16 reflections; diffraction data ($2\theta \leq 46°$) collected at 297 K in an ω–2θ scan; 4250 observed independent reflections [$F_o \geq 2{\cdot}5\sigma(F_o)$]; three check reflections measured every 100 reflections showed no decay in intensity; no absorption correction. The phase problem was solved by *MULTAN*78 (Main, Hull, Lessinger, Germain, Declercq & Woolfson, 1978) using 417 refections with $E \geq 1{\cdot}523$; an *E* map calculated for the highest combined figure of merit (2·9360) revealed four Br atoms, and a difference Fourier synthesis gave the positions of all the non-hydrogen atoms. The structure was refined by means of the full-matrix least-squares program *LINUS* (Coppens & Hamilton, 1970) with parameters grouped in four blocks (against F_o, unit weight), including a correction for secondary extinction [$g = 0{\cdot}21\ (2) \times 10^{-4}$], to yield $R = 0{\cdot}057$. In the final cycle all shifts in parameters were less than one-third their e.s.d.'s. H atoms {except those of two hydroxy groups [O(3)*C*, O(3)*D*] in SALA} were included in the structure factor calculations at calculated fixed positions, with temperature factors fixed at those of the parent atoms. A final difference map was devoid of significant features. Scattering factors for all atoms and anomalous-scattering terms for Br were taken from *International Tables for X-ray Crystallography* (1974).

Discussion. Final atomic parameters are in Table 1.* Fig. 1, obtained by the program *ORTEP* (Johnson, 1965), portrays the title compound. Table 2 gives the bonding geometry of the title adduct.

The two crystallographically independent molecules (*A* and *B*, *C* and *D*) in the asymmetric unit exhibit almost identical shapes and sizes. In the ABCMBMA moiety, the bond distances and angles are comparable to those observed in our previous ABCMBMA–OSBI complex. Table 3* shows the planarity of the title compound. The computed χ^2 value for plane (2) is 8·224. The value of χ^2 at 95% for three degrees of freedom is 7·81, showing that 'plane (2)' is nonplanar. All other planes are planar within experimental error (*PARST* 7, Nardelli, Musatti, Domiano & Andreetti,

* Lists of structure factors, H-atom parameters, anisotropic thermal parameters and least-squares planes (Table 3) have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 38446 (16 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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1965). The main torsion angles are given in Table 4. The cyclohexyl group is in a chair form. The torsion angles ψ_1, ψ_2 and ψ_3 in the present *A* and *B* parts are in good agreement with the 97·7 (17), 158·9 (8) and 54·3 (14)° in the ABCMBMA–OSBI (1:1) complex.

In the SALA moiety, the bond lengths and angles are acceptable in comparison with those of uncomplexed SALA (Cochran, 1953; Sundaralingam & Jensen,

Table 1. *Positional parameters and equivalent isotropic thermal parameters with e.s.d.'s in parentheses*

	x	*y*	*z*	B_{eq}(Å²)*		*x*	*y*	*z*	B_{eq}(Å²)*
ABCMBMA									
Br(1)*A*	0·43514 (4)	0·5752 (1)	1·3230 (1)	6·20	C(8)*B*	0·2459 (4)	0·1703 (9)	1·2385 (11)	4·35
Br(2)*A*	0·35140 (5)	0·1127 (1)	0·7292 (2)	6·49	C(9)*B*	0·3346 (3)	0·1179 (8)	1·2610 (10)	3·97
C(1)*A*	0·2860 (3)	0·4853 (8)	0·8423 (10)	3·35	C(10)*B*	0·3723 (3)	0·2461 (9)	1·4064 (11)	4·39
C(2)*A*	0·3278 (3)	0·5566 (8)	1·0115 (11)	3·83	C(11)*B*	0·4314 (4)	0·2038 (11)	1·5128 (14)	6·50
C(3)*A*	0·3770 (3)	0·4884 (8)	1·0924 (11)	4·02	C(12)*B*	0·4529 (4)	0·1445 (11)	1·4018 (16)	6·52
C(4)*A*	0·3852 (4)	0·3610 (9)	1·0102 (12)	4·53	C(13)*B*	0·4150 (4)	0·0159 (10)	1·2566 (15)	6·56
C(5)*A*	0·3433 (4)	0·2941 (8)	0·8473 (12)	4·42	C(14)*B*	0·3547 (3)	0·0531 (8)	1·1462 (11)	4·44
C(6)*A*	0·2931 (3)	0·3532 (8)	0·7570 (11)	3·89					
N(1)*A*	0·3222 (3)	0·6858 (7)	1·0977 (9)	5·03	SALA				
C(7)*A*	0·2306 (3)	0·5396 (9)	0·7417 (10)	3·68	C(15)*C*	0·3682 (4)	0·6557 (9)	0·6229 (11)	4·15
N(2)*A*	0·2252 (3)	0·5992 (6)	0·6047 (8)	3·57	C(16)*C*	0·3880 (4)	0·7745 (9)	0·6051 (12)	4·91
C(8)*A*	0·2545 (4)	0·7462 (8)	0·6802 (11)	4·24	C(17)*C*	0·4410 (5)	0·8394 (11)	0·7359 (19)	7·14
C(9)*A*	0·1661 (3)	0·5897 (9)	0·4506 (10)	3·79	C(18)*C*	0·4739 (5)	0·7916 (14)	0·8815 (19)	8·42
C(10)*A*	0·1274 (4)	0·6609 (10)	0·5018 (13)	5·05	C(19)*C*	0·4549 (5)	0·6747 (15)	0·9007 (17)	8·64
C(11)*A*	0·0687 (4)	0·6505 (12)	0·3409 (15)	6·35	C(20)*C*	0·4021 (5)	0·6065 (11)	0·7697 (14)	6·46
C(12)*A*	0·0467 (4)	0·4943 (13)	0·2372 (12)	6·51	C(21)*C*	0·3116 (4)	0·5840 (9)	0·4852 (11)	4·04
C(13)*A*	0·0862 (4)	0·4274 (12)	0·1885 (12)	6·21	O(1)*C*	0·2932 (2)	0·4859 (6)	0·5074 (8)	4·69
C(14)*A*	0·1454 (4)	0·4361 (10)	0·3439 (11)	4·64	O(2)*C*	0·2847 (3)	0·6284 (7)	0·3534 (8)	6·15
Br(1)*B*	0·06480 (4)	0·4529 (1)	0·7047 (1)	6·27	O(3)*C*	0·3558 (3)	0·8247 (6)	0·4662 (8)	5·76
Br(2)*B*	0·14879 (5)	0·0262 (1)	0·4101 (1)	6·52	C(15)*D*	0·1313 (3)	0·8853 (9)	0·9175 (11)	3·88
C(1)*B*	0·2139 (3)	0·2674 (8)	0·9111 (10)	3·41	C(16)*D*	0·1116 (4)	0·8305 (9)	0·9981 (12)	4·82
C(2)*B*	0·1727 (3)	0·3563 (8)	0·8992 (10)	3·38	C(17)*D*	0·0588 (5)	0·8524 (12)	0·9596 (14)	6·48
C(3)*B*	0·1234 (3)	0·3369 (9)	0·7379 (12)	3·89	C(18)*D*	0·0266 (4)	0·9317 (15)	0·8447 (18)	7·70
C(4)*B*	0·1140 (3)	0·2398 (10)	0·5880 (11)	4·49	C(19)*D*	0·0451 (5)	0·9911 (14)	0·7667 (16)	8·46
C(5)*B*	0·1583 (4)	0·1578 (8)	0·6101 (10)	4·09	C(20)*D*	0·0979 (4)	0·9661 (11)	0·8036 (13)	5·98
C(6)*B*	0·2061 (4)	0·1721 (8)	0·7652 (11)	3·83	C(21)*D*	0·1887 (4)	0·8627 (8)	0·9618 (11)	3·89
N(1)*B*	0·1782 (3)	0·4524 (7)	1·0418 (9)	4·45	O(1)*D*	0·2071 (2)	0·9216 (6)	0·9013 (8)	4·93
C(7)*B*	0·2694 (3)	0·2794 (8)	1·0788 (11)	3·84	O(2)*D*	0·2156 (3)	0·7833 (7)	1·0590 (9)	6·29
N(2)*B*	0·2748 (3)	0·1543 (6)	1·1491 (8)	3·47	O(3)*D*	0·1442 (3)	0·7552 (7)	1·1128 (9)	6·41

* B_{eq} is defined according to Hamilton (1959).

Table 2. *Bond distances* (Å) *and angles* (°) *with e.s.d.'s in parentheses*

ABCMBMA

	A	*B*		*A*	*B*
Br(1)–C(3)	1·884 (7)	1·895 (9)	C(7)–N(2)	1·513 (14)	1·501 (12)
Br(2)–C(5)	1·914 (9)	1·906 (9)	N(2)–C(8)	1·491 (10)	1·491 (17)
C(1)–C(2)	1·392 (9)	1·397 (12)	N(2)–C(9)	1·507 (9)	1·527 (10)
C(1)–C(6)	1·405 (12)	1·378 (13)	C(9)–C(10)	1·529 (17)	1·510 (9)
C(1)–C(7)	1·489 (10)	1·500 (9)	C(9)–C(14)	1·509 (11)	1·516 (16)
C(2)–C(3)	1·409 (10)	1·382 (10)	C(10)–C(11)	1·523 (12)	1·526 (12)
C(2)–N(1)	1·370 (11)	1·382 (12)	C(11)–C(12)	1·529 (15)	1·507 (22)
C(3)–C(4)	1·372 (13)	1·398 (14)	C(12)–C(13)	1·523 (19)	1·513 (12)
C(4)–C(5)	1·349 (11)	1·408 (14)	C(13)–C(14)	1·514 (11)	1·538 (12)
C(5)–C(6)	1·394 (12)	1·338 (10)			
C(2)–C(1)–C(6)	121·4 (7)	120·5 (7)	C(1)–C(6)–C(5)	118·1 (6)	121·2 (10)
C(2)–C(1)–C(7)	123·1 (7)	121·7 (7)	C(1)–C(7)–N(2)	111·6 (9)	111·4 (6)
C(6)–C(1)–C(7)	115·5 (6)	117·6 (8)	C(7)–N(2)–C(8)	111·4 (6)	112·1 (7)
C(1)–C(2)–C(3)	116·5 (7)	116·8 (8)	C(7)–N(2)–C(9)	113·7 (8)	114·2 (7)
C(1)–C(2)–N(1)	122·7 (7)	122·7 (6)	C(8)–N(2)–C(9)	112·9 (6)	111·6 (7)
C(3)–C(2)–N(1)	120·8 (6)	120·3 (8)	N(2)–C(9)–C(10)	112·3 (7)	111·9 (6)
Br(1)–C(3)–C(2)	119·3 (6)	120·7 (7)	N(2)–C(9)–C(14)	110·4 (7)	108·9 (7)
Br(1)–C(3)–C(4)	117·6 (6)	115·3 (5)	C(10)–C(9)–C(14)	112·5 (9)	113·0 (8)
C(2)–C(3)–C(4)	123·0 (7)	123·9 (8)	C(9)–C(10)–C(11)	109·8 (9)	109·5 (7)
C(3)–C(4)–C(5)	118·6 (8)	115·7 (6)	C(10)–C(11)–C(12)	111·0 (9)	111·2 (9)
Br(2)–C(5)–C(4)	120·5 (7)	117·8 (5)	C(11)–C(12)–C(13)	108·9 (10)	110·6 (11)
Br(2)–C(5)–C(6)	117·2 (6)	120·4 (8)	C(12)–C(13)–C(14)	112·8 (9)	111·5 (8)
C(4)–C(5)–C(6)	122·3 (8)	121·8 (9)	C(9)–C(14)–C(13)	110·2 (8)	109·7 (8)

SALA

	C	*D*		*C*	*D*
C(15)–C(16)	1·415 (17)	1·412 (19)	C(17)–C(18)	1·376 (21)	1·376 (19)
C(15)–C(20)	1·395 (15)	1·388 (14)	C(18)–C(19)	1·395 (25)	1·389 (27)
C(15)–C(21)	1·480 (12)	1·490 (15)	C(19)–C(20)	1·388 (15)	1·389 (19)
C(16)–C(17)	1·382 (13)	1·379 (19)	C(21)–O(1)	1·245 (14)	1·238 (16)
C(16)–O(3)	1·341 (12)	1·349 (12)	C(21)–O(2)	1·247 (12)	1·251 (11)
C(16)–C(15)–C(20)	120·0 (8)	119·5 (10)	C(17)–C(18)–C(19)	120·9 (10)	122·8 (13)
C(16)–C(15)–C(21)	119·7 (8)	120·0 (8)	C(18)–C(19)–C(20)	118·8 (13)	118·3 (12)
C(20)–C(15)–C(21)	120·3 (10)	120·4 (11)	C(15)–C(20)–C(19)	120·6 (13)	120·4 (14)
C(15)–C(16)–C(17)	118·4 (10)	120·5 (10)	C(15)–C(21)–O(1)	119·1 (8)	119·3 (8)
C(15)–C(16)–O(3)	120·9 (7)	120·2 (10)	C(15)–C(21)–O(2)	117·0 (10)	117·1 (12)
C(17)–C(16)–O(3)	120·7 (11)	119·4 (13)	O(1)–C(21)–O(2)	123·9 (8)	123·7 (11)
C(16)–C(17)–C(18)	121·3 (14)	118·5 (15)			

1965), cytidine–SALA complex (Tamura, Yoshikawa, Sato & Hata, 1973) and 2,5-piperazinedione–SALA complex (Varughese & Kartha, 1982).

The dimensions of the carboxyl group are in agreement with those of a typical carboxylate ion, and protonation occurs at N(2) atoms of *A* and *B*.

The planar carboxyl groups (*C* and *D*) form angles of 4·3 (7) and 4·6 (6)° with the respective planes of the phenyl ring, which compare well with the corresponding values of 1·1° (Sundaralingam & Jensen, 1965), 11·4° (Tamura *et al.*, 1983) and 9° (Varughese & Kartha, 1982).

Fig. 2 displays the overall packing in the unit cell.

The most dominating intermolecular bonds observed in the complex are the N(2)–H···O(1)=C(21) interactions, and these hydrogen-bond distances are 2·70 (1) Å for the *A*–*C* contact and 2·690 (8) Å for *B*–D^{ii}, where (ii) is *x*, *y*−1, *z*, as shown in Fig. 1; other hydrogen bonds are rather weak (Table 5). All the acidic H atoms and basic acceptor atoms participate in hydrogen bonds. The structure mainly consists of hydrogen-bonded sheets (parallel to the *bc* plane) which are held together by van der Waals forces.

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Table 4. *Torsion angles* (°)

	A	*B*
ψ_1 C(2)–C(1)–C(7)–N(2)	106·6 (10)	108·3 (10)
ψ_2 C(1)–C(7)–N(2)–C(9)	152·2 (8)	151·9 (8)
ψ_3 C(7)–N(2)–C(9)–C(10)	55·0 (11)	54·4 (10)
N(2)–C(9)–C(10)–C(11)	178·9 (9)	−179·6 (8)
C(9)–C(10)–C(11)–C(12)	57·6 (13)	57·1 (12)
C(10)–C(11)–C(12)–C(13)	−58·0 (13)	−58·0 (13)
C(11)–C(12)–C(13)–C(14)	57·3 (13)	56·6 (13)
C(12)–C(13)–C(14)–C(9)	−55·4 (13)	−54·4 (12)
C(13)–C(14)–C(9)–C(10)	54·2 (12)	55·0 (11)

Table 5. *Intermolecular hydrogen bonds and other significant short contacts* (Å)

Donor	Acceptor			
N(1)A^{i}	O(2)D^{i}	3·03 (1)	Br(1)A^{i}···Br(1)A^{vi}	3·938 (4)
N(1)A^{iii}	O(3)C^{i}	3·05 (1)	Br(2)A^{i}···O(3)C^{ii}	3·308 (7)
N(2)A^{i}	O(1)C^{i}	2·70 (1)	C(6)A^{i}···O(1)C^{i}	3·03 (1)
N(1)B^{iii}	O(2)C^{i}	3·033 (9)	Br(1)B^{i}···Br(1)B^{v}	3·934 (5)
N(1)B^{i}	O(3)D^{i}	3·07 (1)	Br(2)B^{i}···O(3)D^{iv}	3·305 (8)
N(2)B^{i}	O(1)D^{ii}	2·690 (8)	C(6)B^{i}···O(1)D^{ii}	3·05 (1)

Symmetry code: (i) *x*,*y*,*z*; (ii) *x*,*y*−1,*z*; (iii) *x*,*y*,*z*−1; (iv) *x*,*y*−1,*z*−1, (v) −*x*,−*y*+1,−*z*+1; (vi) −*x*+1,−*y*+1,−*z*+3.

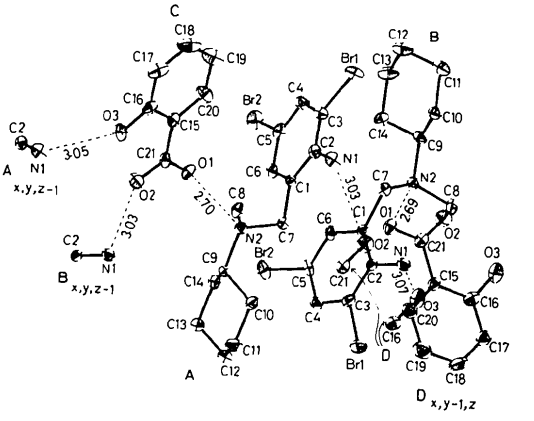

Fig. 1. Atomic numbering in ABCMBMA–SALA (1:1). *A* and *B*: ABCMBMA; *C* and *D*: SALA. (Distances in Å.)

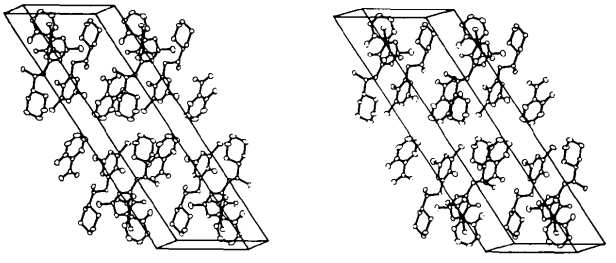

Fig. 2. Packing arrangement in ABCMBMA–SALA (1:1). The axial directions are **a** ↖, **c** → and **b** out of the paper.

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