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A New Antibiotic, Mimosamycin*

By Tadashi Hata, Hiroshi Fukumi, Sadao Sato, Kimie Aiba and Chihiro Tamura

Central Research Laboratories, Sankyo Co. Ltd, Hiromachi, Shinagawa-ku, Tokyo 140, *Japan*

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Abstract. $C_{12}H_{11}NO_4$, M_r = 233·2, monoclinic, $P2_1/c$, Z = 4, a = 10·799 (4), b = 14·302 (4), c = 6·898 (2) Å, β = 100·25 (2)°. The final R and weighted R were 0·099 and 0·105 respectively. The structural formula established corresponds to 2,6-dimethyl-7-methoxy-3,5,8-isoquinolinetrione. The planar isoquinoline rings are stacked at intervals of 3·41 Å.

Introduction. Mimosamycin, a new antibiotic active mainly against mycobacteria, was first isolated from *Streptomyces lavendulae* No. 314 (Arai, Yazawa, Mikami, Kubo & Takahashi, 1976; Mikami, Yokoyama, Ômi & Arai, 1976). Crystals were obtained as yellow needles from benzene solution. The oscillation and Weissenberg photographs showed that all crystals were twinned and had nearly equal amounts of twin components. Crystals grown from various solvents gave the same results, indicating that this compound has a strong tendency for twinning. We could not obtain a single crystal in this experiment. Therefore, a twinned crystal (approximately 0·7 × 0·2 × 0·1 mm) was used for the measurements.

614 independent reflections within the limiting sphere 2θ = 45° were collected on a Rigaku four-circle diffractometer using LiF-monochromated Mo $K\alpha$ radiation. The θ–2θ scan mode was employed, with scans of 2°.

A sharpened Patterson map, $P(u,v,w)$, had salient peaks only in the three sections w = 0, w = 0·1 and w = 0·5, suggesting that the planar molecules are approximately parallel to the (001) plane. The major peaks on the $P(u,v,0·1)$ section could be readily assigned to multiple vectors from the naphthalene-like skeleton with the 2,3,6,7 substituents related by the screw axis. This located the center of the naphthalene-like skeleton at x = 0·55 and z = 0·05 relative to the screw axis. Since the y coordinates had not yet been determined, the structure factor calculation in space group $P2_1$ was carried out. In a subsequent Fourier map, another naphthalene-like skeleton related by c glide symmetry was revealed. Further structure factor calculations and Fourier syntheses based on space group $P2_1/c$ showed the positions of all 17 non-hydrogen atoms. Eight cycles of block-diagonal least-squares refinement with individual isotropic thermal parameters resulted in an R of 0·216. Considerable discrepancy between F_o and F_c in the $hk2$ zone was observed. This may be due to the superposition of the twinned reciprocal lattice in this layer.

Thus, new intensity data were collected on the same apparatus using a receiving slit of 2·5 mm ⌀ and graphite-monochromated Cu $K\alpha$ radiation. The θ–2θ scanning method was used within a 2θ limit of 128°. Intensities of 998 reflections with $F \geq 3\sigma(F)$ were recorded and used for further refinement. No absorption correction was applied.

Block-diagonal least-squares refinement with anisotropic thermal parameters reduced the R value to 0·172 for the new reflection data. A difference Fourier map revealed all the H atoms. Four additional cycles of least-squares refinement of all positional and thermal parameters (individual isotropic temperature factors for H) gave final R and R_w values of 0·099 and 0·105 respectively. The weighting scheme $w = 1/[1 + (F_o - 18)^2/24^2]$ was employed. Five reflections with very large structure amplitudes were rejected from the final data set, since they appeared to be strongly affected by

Table 1. *Fractional positional parameters* (×10^4) *of the non-hydrogen atoms, with e.s.d.'s in parentheses*

	x	y	z
C(1)	4280 (6)	3855 (4)	2983 (12)
N(2)	3205 (6)	3368 (4)	2871 (11)
C(3)	3161 (8)	2379 (5)	2867 (14)
C(4)	4378 (7)	1939 (4)	2965 (12)
C(5)	5444 (7)	2435 (4)	3091 (11)
C(6)	6684 (7)	1965 (4)	3231 (12)
C(7)	7820 (7)	2529 (5)	3306 (13)
C(8)	7746 (7)	3472 (5)	3247 (13)
C(9)	6543 (7)	3988 (5)	3293 (12)
C(10)	5405 (7)	3430 (4)	3102 (12)
C(11)	1978 (7)	3841 (5)	2677 (15)
O(12)	2157 (5)	1982 (3)	2798 (11)
O(13)	6751 (5)	1102 (3)	3301 (9)
C(14)	9054 (8)	2030 (5)	3396 (15)
O(15)	8826 (5)	3953 (3)	3359 (9)
C(16)	8870 (8)	4847 (5)	2401 (15)
O(17)	6552 (5)	4830 (3)	3601 (10)

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* Studies of Mimosamycin. II. A preliminary report has already been published (Fukumi, Kurihara, Hata, Tamura, Mishima, Kubo & Arai, 1977).

Table 2. *Fractional positional parameters* ($\times 10^3$) *and isotropic thermal parameters* (Å^2) *for the hydrogen atoms, with e.s.d.'s in parentheses*

	x	*y*	*z*	*B*
H(1)	420 (6)	454 (4)	287 (10)	4·0 (1·6)
H(4)	445 (6)	124 (5)	289 (10)	4·1 (1·7)
H(11*A*)	213 (7)	441 (5)	262 (12)	5·7 (2·0)
H(11*B*)	158 (6)	368 (5)	378 (10)	4·0 (1·6)
H(11*C*)	149 (8)	364 (6)	155 (13)	7·4 (2·3)
H(14*A*)	896 (6)	162 (4)	233 (10)	3·2 (1·5)
H(14*B*)	925 (8)	157 (6)	429 (13)	6·8 (2·3)
H(14*C*)	966 (7)	237 (6)	377 (13)	6·4 (2·2)
H(16*A*)	828 (6)	505 (5)	137 (11)	4·1 (1·6)
H(16*B*)	874 (7)	526 (5)	350 (11)	5·2 (1·9)
H(16*C*)	941 (7)	488 (5)	166 (11)	5·2 (1·9)

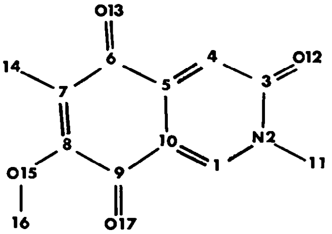

Fig. 1. Atomic numbering of mimosamycin. Unaccompanied numbers indicate C atoms.

secondary extinction. Scattering factors were taken from *International Tables for X-ray Crystallography* (1974). The N and O atoms were identified unequivocally from the thermal parameters and bond distances. The final positional parameters of the non-hydrogen atoms are listed in Table 1.[*] Table 2 gives the positions of the H atoms.

Discussion. Fig. 1 shows the structural formula established and the numbering scheme. The bond lengths and angles are listed in Tables 3 and 4 respectively.

The C(5), C(6), C(7), C(8), C(9), C(10), O(13), O(17) skeleton may be compared with *p*-benzoquinone, except for the C(5)–C(10) bond. C(7)–C(8) is 1·351 Å, the average of C(6)=O(13) and C(9)=O(17) is 1·229 Å and that of C(5)–C(6), C(6)–C(7), C(8)–C(9) and C(9)–C(10) is 1·475 Å. These are close to the corresponding values in *p*-benzoquinone (Trotter, 1960) and its resorcinol complex (Ito, Minobe & Sakurai, 1970).

Table 3. *Bond lengths* (Å)

C(1)–N(2)	1·344 (8)	C(6)–C(7)	1·461 (9)
C(1)–C(10)	1·347 (8)	C(6)–O(13)	1·236 (8)
N(2)–C(3)	1·415 (8)	C(7)–C(8)	1·351 (9)
N(2)–C(11)	1·473 (8)	C(7)–C(14)	1·504 (9)
C(3)–C(4)	1·447 (9)	C(8)–C(9)	1·500 (9)
C(3)–O(12)	1·218 (8)	C(8)–O(15)	1·344 (8)
C(4)–C(5)	1·341 (8)	C(9)–C(10)	1·451 (9)
C(5)–C(6)	1·486 (9)	C(9)–O(17)	1·222 (8)
C(5)–C(10)	1·425 (8)	O(15)–C(16)	1·444 (10)
C(1)–H(1)	0·99 (6)	C(14)–H(14*B*)	0·90 (9)
C(4)–H(4)	1·00 (7)	C(14)–H(14*C*)	0·82 (7)
C(11)–H(11*A*)	0·82 (8)	C(16)–H(16*A*)	0·91 (7)
C(11)–H(11*B*)	0·97 (7)	C(16)–H(16*B*)	0·99 (8)
C(11)–H(11*C*)	0·90 (9)	C(16)–H(16*C*)	0·84 (7)
C(14)–H(14*A*)	0·94 (7)		

Table 4. *Bond angles* (°)

N(2)–C(1)–C(10)	122·1 (5)	C(6)–C(7)–C(8)	120·4 (6)
C(1)–N(2)–C(11)	121·4 (4)	C(6)–C(7)–C(14)	118·2 (4)
C(1)–N(2)–C(3)	123·1 (5)	C(8)–C(7)–C(14)	121·4 (6)
C(3)–N(2)–C(11)	115·5 (4)	C(7)–C(8)–C(9)	122·5 (6)
N(2)–C(3)–C(4)	113·9 (5)	C(7)–C(8)–O(15)	117·6 (6)
N(2)–C(3)–O(12)	119·7 (7)	C(9)–C(8)–O(15)	119·5 (5)
C(4)–C(3)–O(12)	126·4 (6)	C(8)–C(9)–C(10)	116·8 (4)
C(3)–C(4)–C(5)	122·3 (5)	C(8)–C(9)–O(17)	120·5 (6)
C(4)–C(5)–C(6)	121·2 (4)	C(10)–C(9)–O(17)	122·5 (6)
C(4)–C(5)–C(10)	120·2 (5)	C(1)–C(10)–C(9)	119·9 (4)
C(6)–C(5)–C(10)	118·6 (5)	C(5)–C(10)–C(9)	121·6 (6)
C(5)–C(6)–C(7)	119·6 (4)	C(1)–C(10)–C(5)	118·5 (5)
C(5)–C(6)–O(13)	120·0 (6)	C(8)–O(15)–C(16)	121·8 (6)
C(7)–C(6)–O(13)	120·4 (6)		

The C(1)–N(2) bond length of 1·344 Å is 0·030 to 0·045 Å shorter than the corresponding bonds in *N*-methyl-2-pyridone (in its complex with 5,5-diethylbarbituric acid) (Hsu & Craven, 1974), 1-(2′,6′-dichlorobenzyl)-2-pyridone (Wheeler & Ammon, 1974) and *N*-methoxycarbonylamino-3,6-dimethyl-4,5-diphenyl-2-pyridone (Mathew & Palenik, 1975). The C(3)=O(12) bond is also shorter but N(2)–C(3) is longer than those of the above 2-pyridone derivatives. C(1)–C(10) and C(4)–C(5) are close to the normal C=C double-bond length. C(3)–C(4) and C(5)–C(10) (1·477 and 1·425 Å) are shorter than the C–C single-bond length, indicating extensive delocalization in the C(1), N(2), C(3), C(4), C(5), C(10) ring system. The aromaticity index (Wheeler & Ammon, 1974) of these six atoms is calculated to be 0·71 – at the lower end of the aromaticity scale.

Among the three C=O bond lengths and the CCC angles opposite C=O bonds, a certain correlation can be observed: the longer the C=O bond length is, the larger the CCC angle. Such an observation is reported for 1,4-naphthoquinone derivatives (Phillips & Trotter, 1976, 1977). A similar correlation has also been found

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[*] Lists of structure factors and anisotropic thermal parameters have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 33589 (9 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

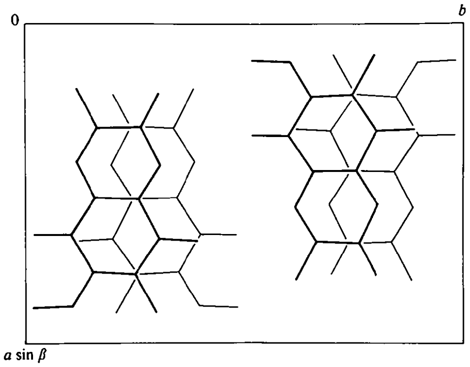

Fig. 2. The crystal structure projected down c.

between the C=C bond length and the CCC angle opposite the C=C bond (Coppens, 1973).

The isoquinoline ring is approximately planar with the largest deviation from the least-squares plane being 0·055 Å. C(16) and O(17) are definitely out of this plane, the deviations being 0·714 and 0·258 Å respectively. The methoxy group is inclined by 33·0° to this plane.

As shown in Fig. 2, the molecules are stacked in infinite columns along the *c* axis and the mean separation between the molecular planes is 3·41 Å. C(9) and O(13) of the carbonyl group are located just above O(13) and C(9), respectively, in the molecule related by the *c* glide plane. Intermolecular distances between these atoms are 3·424 and 3·493 Å respectively. These observations suggest that there is appreciable dipole–dipole interaction between the carbonyl groups.

References

ARAI, T., YAZAWA, K., MIKAMI, Y., KUBO, A. & TAKAHASHI, K. (1976). *J. Antibiot.* **29**, 398–407.
COPPENS, P. (1973). *Acta Cryst.* B**29**, 1359–1360.
FUKUMI, H., KURIHARA, H., HATA, T., TAMURA, C., MISHIMA, H., KUBO, A. & ARAI, T. (1977). *Tetrahedron Lett.* pp. 3825–3828.
HSU, I.-N. & CRAVEN, B. M. (1974). *Acta Cryst.* B**30**, 998–1001.
International Tables for X-ray Crystallography (1974). Vol. IV. Birmingham: Kynoch Press.
ITO, T., MINOBE, M. & SAKURAI, T. (1970). *Acta Cryst.* B**26**, 1145–1151.
MATHEW, M. & PALENIK, G. J. (1975). *Acta Cryst.* B**31**, 1965–1967.
MIKAMI, Y., YOKOYAMA, K., ÔMI, A. & ARAI, T. (1976). *J. Antibiot.* **29**, 408–414.
PHILLIPS, S. E. V. & TROTTER, J. (1976). *Acta Cryst.* B**32**, 3104–3106.
PHILLIPS, S. E. V. & TROTTER, J. (1977). *Acta Cryst.* B**33**, 984–990.
TROTTER, J. (1960). *Acta Cryst.* **13**, 86–95.
WHEELER, G. L. & AMMON, H. (1974). *Acta Cryst.* B**30**, 680–687.

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1,2-Diphenylbenzene (*o*-Terphenyl)

BY SEIKO AIKAWA AND YUSEI MARUYAMA

Department of Chemistry, Ochanomizu University, Otsuka, Bunkyo-ku, Tokyo 112, *Japan*

AND YUJI OHASHI AND YOSHIO SASADA

Laboratory of Chemistry for Natural Products, Tokyo Institute of Technology, Nagatsuta, Midori-ku, Yokohama 227, *Japan*

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Abstract. $C_{18}H_{14}$, M_r = 230·31, orthorhombic, $P2_12_12_1$, a = 18·582 (4), b = 6·024 (2), c = 11·729 (2) Å, Z = 4, V = 1313·0 (6) Å^3, D_x = 1·165 g cm^{-3}; λ(Mo $K\alpha$) = 0·71069 Å, μ(Mo $K\alpha$) = 0·77 cm^{-1}. The structure was solved by direct methods and refined by the block-diagonal least-squares method. The final R was 0·080 for 1139 reflections. The two phenyl groups are twisted in the same direction with respect to the central ring; the dihedral angles between the mean plane of the central ring and those of the two phenyl rings are 62·1 and 42·5°.

Introduction. It has been found that *o*-terphenyl can easily form a stable glassy structure when it is supercooled below 240 K (Chang & Bestul, 1972). We have studied the physical properties of this compound in the glassy state. Although the crystal structure of *o*-terphenyl has been argued from magnetic susceptibility