BULLETIN OF THE CHEMICAL SOCIETY OF JAPAN VOL. 43 2640—2641 (1970)

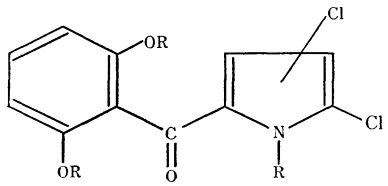
The Crystal and Molecular Structure of *O,O',N*-Trimethylpyoluteorin, $C_{14}H_{13}O_3NCl_2$

Yoshihisa UTSUMI,*1 Akio FURUSAKI and Yujiro Tomiie*2

Faculty of Science, Kwansei Gakuin University, Nishinomiya

(Received March 26, 1970)

Pyoluteorin, $C_{11}H_7O_3NCl_2$, mp 174—175°C (dec.), is an antibiotic produced by *Pseudomonas aeruginosa* it has been found to be efficacious against cholera germs, *etc.* For this antibiotic, the following structural formula (I) has been proposed on the basis of chemical evidence:[1]



I: R=H II: R=CH_3

However, the position of one of the chlorine atoms in the pyrrole ring has remained uncertain. Using single crystals of *O,O',N*-trimethylpyoluteorin (II) kindly supplied by Dr. Masao Nishikawa, Chemical Research Laboratories, Research and Development Division, Takeda Chemical Industries, Ltd., an X-ray-crystal structural analysis of the derivative has been undertaken in order to determine the chlorine position and in order to obtain more detailed information about the stereostructure of the molecule.

O,O',N-Trimethylpyoluteorin, $C_{14}H_{13}O_3NCl_2$, crystallizes in yellow needles and gives the crystal data shown in Table 1. The reflection intensities were visually measured from equi-inclination integrating Weissenberg photographs taken with Cu$K\alpha$ radiation for 0—5 layers around the *b* axis and for 0—10 layers around the *a* axis. To these intensities, the usual Lorentz and polarization corrections were applied. Thus, the structure factors of 1363 independent reflections were obtained.

TABLE 1. CRYSTAL DATA

Monoclinic	
	$a = 14.51 \pm 0.04$ Å
	$b = 7.71 \pm 0.03$
	$c = 14.60 \pm 0.04$
	$\beta = 116.5 \pm 0.3°$
Space group	$P2_1/a$
Z	4

The positions of the two independent chlorine atoms could be easily found from a three-dimensional Patterson function. These coordinates were refined by the diagonal-matrix least-squares method. As a result of five cycles of this refinement, the *R* factor dropped only a little from the initial value, 0.50, while the temperature factor converged into a value of about 6 Å^2 for either one of the chlorine atoms. The approximate coordinates of all the light atoms were obtained from the first Fourier map, calculated with the sign based on only the chlorine atoms. The coordinates of the two chlorine and eighteen light atoms thus obtained were refined at first by the diagonal-matrix least-squares method with individual isotropic temperature factors, and then by the block-diagonal-matrix least-squares method with anisotropic temperature factors. The final *R* factor thus obtained was 0.137. The atomic parameters obtained are given in Table 2, while the molecular framework is further shown in Fig. 1.

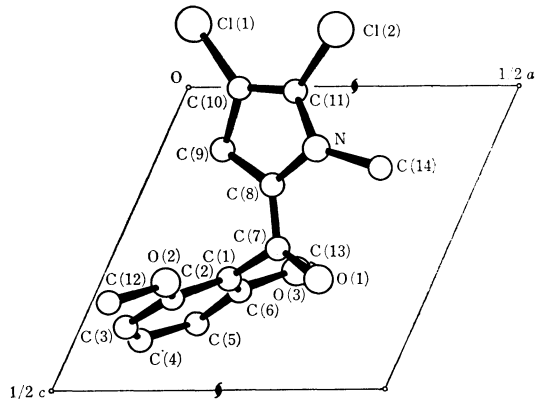


Fig. 1. The molecular framework viewed along the *b* axis.

As is shown in Fig. 2, the bond lengths and angles calculated with the final coordinates are all reasonable considering the mean standard deviations of the coordinates (0.007 Å for Cl, 0.014 Å for O, 0.016 Å for N, and 0.021 Å for C); for example, as to the benzene ring, they are 1.36—1.47 Å and 113—125° respectively. The molecular structure

*1 Present address: Fujitsu, Ltd., Marunouchi, Chiyoda-ku, Tokyo.

*2 Deceased May 31, 1967.

1) R. Takeda, *J. Amer. Chem. Soc.*, **80**, 4749 (1958).

Table 2. The atomic parameters

Atom	x/a	y/b	z/c	B_{11}	B_{22}	B_{33}	B_{12}	B_{23}	B_{31}
Cl(1)	−0.0384	0.2541	−0.1046	830	3062	495	−306	181	−99
Cl(2)	0.1800	0.4397	−0.0948	1377	2035	547	−832	245	1125
O(1)	0.3408	0.3175	0.3248	364	1084	577	−175	−4	487
O(2)	0.1129	0.3873	0.3287	460	962	909	440	102	966
O(3)	0.2998	−0.0889	0.3107	544	1004	700	288	71	888
N	0.2381	0.3604	0.1040	449	661	469	−138	142	594
C(1)	0.2052	0.1463	0.3233	299	649	397	306	266	422
C(2)	0.1345	0.2217	0.3553	306	854	440	−39	14	392
C(3)	0.0877	0.1182	0.4046	338	1512	301	−281	−12	289
C(4)	0.1184	−0.0511	0.4266	429	1776	400	−391	432	162
C(5)	0.1899	−0.1376	0.3983	226	1704	389	−520	0	206
C(6)	0.2299	−0.0240	0.3436	246	1407	383	104	−68	243
C(7)	0.2547	0.2509	0.2719	337	555	448	239	80	507
C(8)	0.1991	0.2784	0.1646	390	641	379	170	293	417
C(9)	0.0985	0.2269	0.1055	571	1128	556	−137	−49	689
C(10)	0.0764	0.2787	0.0016	547	1064	459	269	191	169
C(11)	0.1628	0.3555	0.0072	746	925	528	−355	−46	767
C(12)	0.0427	0.4738	0.3623	490	1606	1127	314	−157	1126
C(13)	0.3199	−0.2726	0.3149	720	768	879	918	541	987
C(14)	0.3481	0.4165	0.1375	595	2689	707	−1151	−298	856

The thermal parameters are given in values multiplied by 10^5.

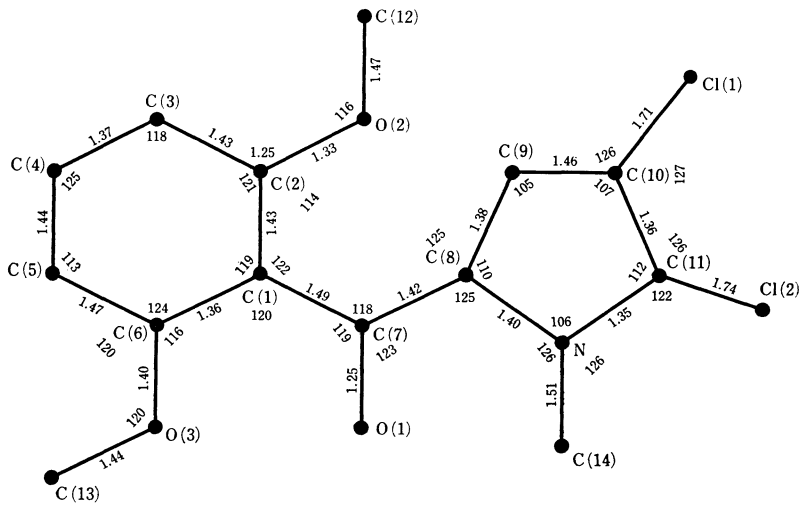


Fig. 2. The bond lengths (Å) and angles (°).

found in the present experiment corresponds exactly to Formula II, as may be seen from Fig. 1. One of the two chlorine atoms is situated at the 5′-position of the pyrrole ring, as was expected on the basis of chemical evidence, while the other is located at the 4′-position, the distance between them being about 3.41 Å. The pyrrole ring plane makes a dihedral angle of only about 7° with the carbonyl plane, while the benzene plane makes an angle of no less than 83° with it. This shows that the carbonyl group is considerably conjugated with the pyrrole ring, but is little conjugated with the benzene ring. Further, it is noteworthy that the *N*-methyl carbon atom, C(14), deviates to a considerable extent from the pyrrole ring plane, the distance being about 0.16 Å. Though one of the two methoxyl carbon atoms, C(12), lies almost on the benzene plane, the other, C(13), deviates from the plane by about 0.24 Å.

In conclusion, the authors would like to express their thanks to Professor Isamu Nitta of this university for his valuable discussions. The authors also wish to express their thanks to Dr. Masao Nishikawa, Chemical Research Laboratories, Research and Development Division, Takeda Chemical Industries, Ltd., for providing them with the sample.