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5,8-Diacetyl-1,3-dimethyl-5,8-dihydrolumazine*

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Abstract. $C_{12}H_{14}N_4O_4$, $M_r = 278{\cdot}30$, synthesized by an electrochemical method; orthorhombic, space group $Pc2_1n$, $Z = 4$, $a = 12{\cdot}848$ (5), $b = 12{\cdot}862$ (5), $c = 7{\cdot}898$ (3) Å, $V = 1305{\cdot}2$ Å^3, $D_x = 1{\cdot}417$ g cm^{-3}. The final R value was 0·069. The molecule represents the first known type of stable 5,8-dihydropteridine derivative which has, however, lost its potential antiaromatic character through acylation at positions 5 and 8.

Introduction. Naturally occurring pteridines are derivatives of pterin and lumazine (Pfleiderer, 1963) possessing various substituents at 6 and/or 7 positions (Fig. 1). The presence of an unsubstituted or monofunctionally substituted pyrazine ring offers a reactive 1,4-diazadiene system open to catalytical and electrochemical reductions leading to a 5,8-dihydro structure of potential antiaromatic character. According to these properties 5,8-dihydropteridines are unstable compounds which tautomerize to the energetically more favoured 7,8-dihydro isomers (Lund, 1975). Since all attempts to synthesize, by analogy with previous investigations (Pfleiderer & Zondler, 1966), the corresponding 5,8-dialkyl blocked derivatives have as yet been unsuccessful, we decided to concentrate on the 5,8-diacyl-5,8-dihydro analogues. The stability of such compounds will be increased substantially since π electrons of the formal 8π antiaromatic system are localized in the amide functions.

The present compound is completely stable, can be handled without difficulty and crystallizes nicely from various organic solvents (Gottlieb & Pfleiderer, 1977). The unusual and new type of pteridine structure of this molecule caused us to determine its fine structure and geometry by X-ray analysis in order to confirm the 5,8-dihydro constitution and the decreased antiaromaticity of the dihydropyrazine moiety.

The crystals were massive hemimorphic. The lattice parameters were determined from the angles of 10 reflexions measured on a Philips PW 1100 diffractometer. Intensities were collected on the diffractometer using a crystal of about 0·2 × 0·2 × 0·15 mm with Cu $K\alpha$ radiation monochromated by a graphite plate. The θ–2θ scanning technique was used with a scan speed of 4° min^{-1} in θ. The scans were repeated twice when the total number of counts during a single scan was less than 3000. The background was measured at each end of the scan for half the total scan time. 1109 independent reflexions were measured within $\theta = 3 \sim 65°$ as above the $2\sigma(I)$ level. No absorption correction was applied. The crystal structure was solved by the multi-solution method with *MULTAN* (Germain, Main & Woolfson, 1971) based on 158 reflexions with $E \geq 1{\cdot}4$.

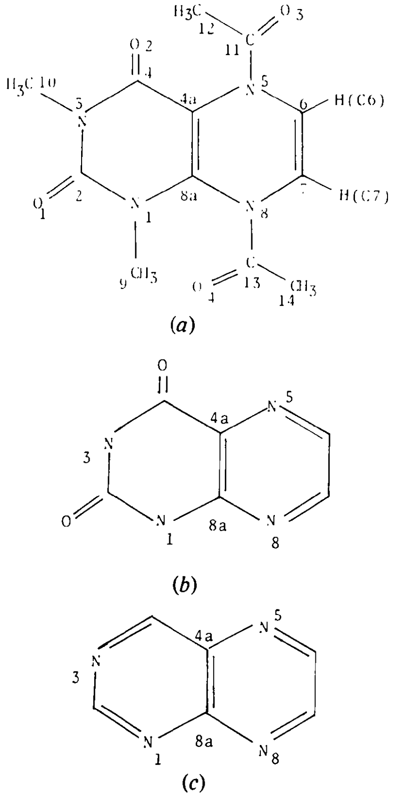

Fig. 1. Schematic drawings of (*a*) 5,8-diacetyl-1,3-dimethyl-5,8-dihydrolumazine, (*b*) lumazine and (*c*) pteridine.

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* Pteridines. LXIII. Part LXII: Rokos & Pfleiderer (1975).

The positions of all the heavier atoms were obtained from the E map. The H atoms bonded to C(6) and C(7) were located on a difference electron density map but those of the methyl groups could not be found. The final refinement was carried out by the block-diagonal least-squares method with the weights: $F_o \le 2$: $\sqrt{w} = 0{\cdot}5$; $F_o \le 20$: $\sqrt{w} = 1$; $F_o > 20$: $\sqrt{w} = 20/F_o$.

The R value was reduced to 0·069. The final atomic positional parameters are listed in Table 1.*

Discussion. A stereoscopic drawing of the molecule is given in Fig. 2 (*ORTEP*; Johnson, 1965). The bond lengths and angles are given in Fig. 3; the values for lumazine hydrate (Norrestam, Stensland & Söderberg, 1972) and pteridine (Shirrell & Williams, 1975) are shown in Fig. 4 for comparison. The bond lengths found in the pyrimidine ring have reasonable values compared with those for lumazine hydrate, except for the C(4a)–C(8a) bond. The conformation of the pyrazine ring in the present compound is characterized by the boat form with N(5) and N(8) as the bow and the stern respectively. In Tables 2 and 3 are listed the distances from the least-squares plane consisting of C(6), C(7), C(4a), C(8a) and the endocyclic torsion angles of the pyrazine ring. The pyrimidine ring is almost but not strictly planar. C(4) deviates 0·21 Å from the least-squares plane formed by N(1), C(2), N(3), C(4a) and C(8a) (Table 2). C(4) and N(1) and hence the C(4)=O(2) and N(1)–C(9) bonds are oriented in the opposite direction from N(5) and N(8)

Table 1. *Positional parameters* (×10⁴ *for* C, N, O *and* ×10³ *for* H)

	x	y	z
N(1)	−2314 (4)	3620 (5)	2167 (6)
C(2)	−2583 (6)	4546 (6)	2989 (9)
N(3)	−1762 (4)	5205 (4)	3378 (7)
C(4)	−731 (5)	5037 (5)	2970 (8)
C(4a)	−509 (5)	3977 (5)	2469 (7)
N(5)	537 (3)	3632 (4)	2195 (6)
C(6)	672 (5)	3030 (5)	692 (8)
C(7)	−89 (5)	2428 (5)	209 (7)
N(8)	−1040 (4)	2384 (4)	1217 (6)
C(8a)	−1287 (4)	3336 (5)	2028 (7)
C(9)	−3188 (5)	3003 (7)	1450 (10)
C(10)	−2041 (7)	6222 (6)	4194 (13)
C(11)	1330 (4)	3674 (5)	3370 (8)
C(12)	1116 (5)	4132 (7)	5079 (10)
C(13)	−1422 (5)	1438 (5)	1845 (8)
C(14)	−1086 (6)	478 (6)	896 (10)
O(1)	−3486 (4)	4756 (5)	3290 (9)
O(2)	−79 (4)	5729 (4)	3106 (7)
O(3)	2176 (3)	3318 (4)	2990 (6)
O(4)	−1991 (4)	1428 (4)	3067 (6)
H(C6)	137 (6)	307 (7)	7 (11)
H(C7)	−6 (6)	203 (7)	−88 (10)

Table 2. *Deviations of the atoms from the least-squares planes*

Pyrazine ring		Pyrimidine ring	
C(4a)	−0·013Å	N(1)	−0·044Å
C(6)	0·013	C(2)	0·044
C(7)	−0·013	N(3)	−0·023
C(8a)	0·013	C(4a)	0·001
N(5)*	0·394	C(8a)	−0·022
N(8)*	0·354	C(4)*	−0·214

The dihedral angle between the pyrazine ring and pyrimidine ring is 18·8°.

* Omitted from the calculations of the least-squares plane.

Table 3. *Endocyclic torsion angles of the pyrazine ring*

C(4a)–N(5)–C(6)–C(7)	−33·7°
N(5)–C(6)–C(7)–N(8)	−0·5
C(6)–C(7)–N(8)–C(8a)	32·5
C(7)–N(8)–C(8a)–C(4a)	−29·5
N(8)–C(8a)–C(4a)–N(5)	−4·1
C(8a)–C(4a)–N(5)–C(6)	36·3

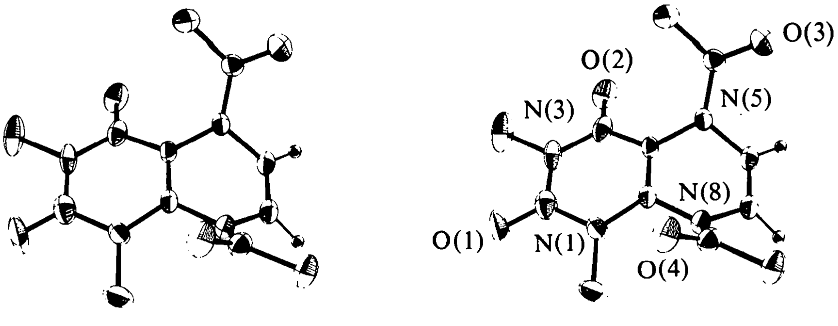

Fig. 2. Stereoscopic drawing of the molecule.

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* The temperature factors and $F_o - F_c$ tables have been deposited with the British Library Lending Division as Supplementary Publication No. SUP 32678 (7 pp.). Copies may be obtained through The Executive Secretary, International Union of Crystallography, 13 White Friars, Chester CH1 1NZ, England.

and the N(5)—C(11) and N(8)—C(13) bonds with respect to the plane of the molecule. It has been reported that in lumazine the electrons in the pyrazine ring are delocalized (Norrestam *et al.*, 1972) whereas in pteridine itself they are localized on the C(7)—N(8), N(5)—C(6) and C(4a)—C(8a) bonds (Hamor & Robertson, 1956; Shirrell & Williams, 1975). In both cases the pyrazine ring is planar. In the present molecule, the C(4a)—C(8a) and C(6)—C(7) bonds (1·341, 1·304 Å respectively) are both much shorter than the other bonds in the pyrazine ring (mean value 1·432 Å). This suggests that the π electrons in the pyrazine ring are not delocalized but are localized on these two short bonds. This is the first time that this type of pyrazine-ring structure has been found in pteridines.

The two *N*-acetyl groups at N(5) and N(8) are oriented so that the methyl group of one comes into proximity with the carbonyl O atom of the other. This must occur in order to avoid repulsion between the methyl groups or between the carbonyl O atoms. The pteridine ring system is reported to be planar but in the present compound the dihedral angle between the least-squares planes of the pyrazine ring [C(6), C(7), C(8a) and C(4a)] and the pyrimidine ring [N(1), C(2), N(3), C(4a) and C(8a)] is found to be 18·8°, the molecule adopting a roof shape with the C(4a)—C(8a) bond situated at the ridge.

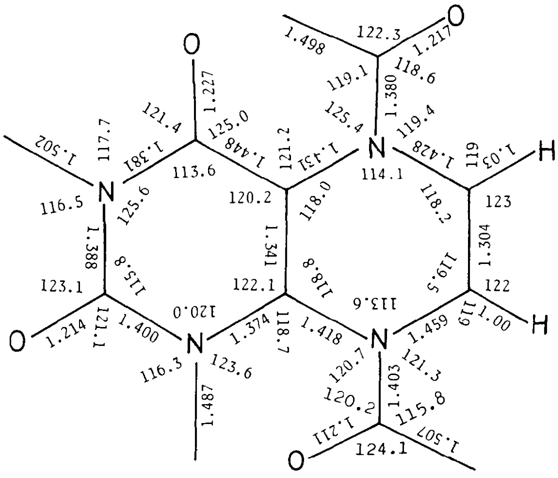

Fig. 3. Bond lengths and angles of the molecule. The average standard deviations are 0·008 Å and 0·6°; values of 0·08 Å and 5° are estimated for lengths and angles involving H atoms.

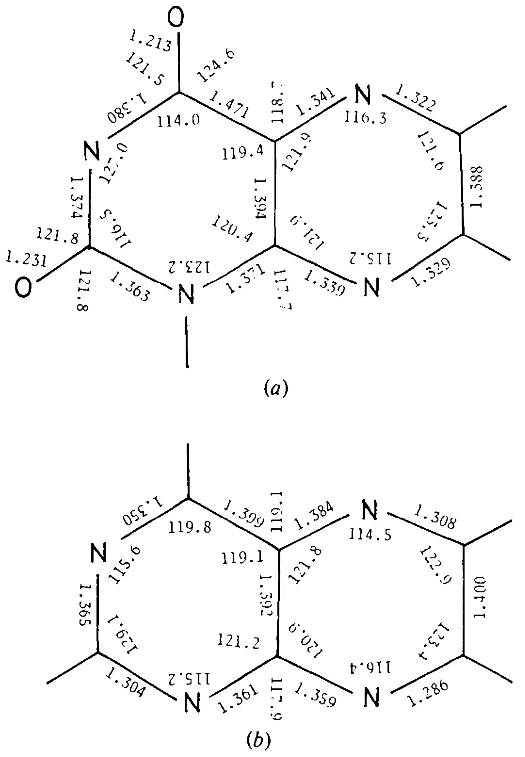

Fig. 4. Bond lengths and angles of (*a*) lumazine (the values are averaged over the two molecules) (Norrestam, Stensland & Söderberg, 1972) and (*b*) pteridine (Shirrell & Williams, 1975).

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