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# THE CRYSTAL STRUCTURE OF SUPRASTEROL II

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The molecular structure of suprasterol II has been investigated through the X-ray analysis of its 4-iodo-5 nitrobenzoate. This derivative was prepared and kindly supplied by Dr. J. W. Cornforth. Crystals for photography were obtained by recrystallization from hot benzene solution and occur as yellow plates with (100) the dominating face. They are monoclinic, with space-group C 2 and cell dimensions

a = 39.14 Å, b = 10.34 Å, c = 8.21 Å, and $\beta$ = 94° 51'

The observed density is $1.32_5$ gm.cm.$^{-3}$, corresponding with four molecules in the unit cell, for which the calculated density is 1.347 gm.cm.$^{-3}$.

The crystals were first examined in 1951 by M. Curzon[1] who measured the intensities of the hol and hko reflections, found the positions of the iodine atoms from Patterson projections based on these, and calculated trial electron density projections. These showed so much overlapping of

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[1] M. Curzon, Chemistry Part II, Thesis, Oxford University, (1951).

atomic positions that they could not be interpreted in any detail. Further work on the molecule was, therefore, deferred until a three-dimensional investigation could be more easily undertaken.

The present investigation began with the collection of three-dimensional data from equi-inclination Weissenberg photographs; the intensities of 1991 reflections were estimated visually and corrected for Lorentz and polarization factors; the reflections faded out at sin $\theta$ values of about 0.7. A three-dimensional Patterson synthesis was then computed from the derived $F^2$ values modified to correspond approximately with those from point atoms at rest, and from this synthesis the positions of the iodine atom, the benzene ring and the carboxyl group were determined. Structure factors were computed using these atomic positions, and were followed by the calculation of a three-dimensional Fourier synthesis based on the phase angles so derived. This electron-density map showed over eighty peaks of approximately one electron per $\text{Å}^3$ in height, plus ten much higher peaks corresponding to those atoms included in the structure factor calculation. Most of the low peaks consisted of mirror-image pairs, the mirror planes occurring at $y = 0$ and $y = \frac{1}{2}$. This doubling was caused by the iodine positions being related by a mirror plane perpendicular to the y axis. It was possible to select one peak from each of 22 mirror-image pairs, using only the criteria of reasonable interatomic distances and angles. In most of these cases the peak selected was slightly higher than its related peak.

A second set of structure factors was then computed using the positions of 32 atoms, and followed by a second Fourier synthesis. From this map five more atomic positions were determined in a similar manner, and a difference map based on a third set of structure factors showed the last four atoms. Least squares refinement is now proceeding and the R factor is at present 13.0%. It seems clear that the atoms have been placed well enough to define the outline molecular structure though not with high precision; at the present stage of the analysis carbon-carbon bond distances in the benzene ring vary between 1.29 and 1.60 Å, average 1.43 Å while single carbon-carbon bonds in the molecule as a whole vary from 1.26 to 1.73 Å, with an average of 1.53 Å.

The structure found, shown in Fig. 1 and Fig. 2,

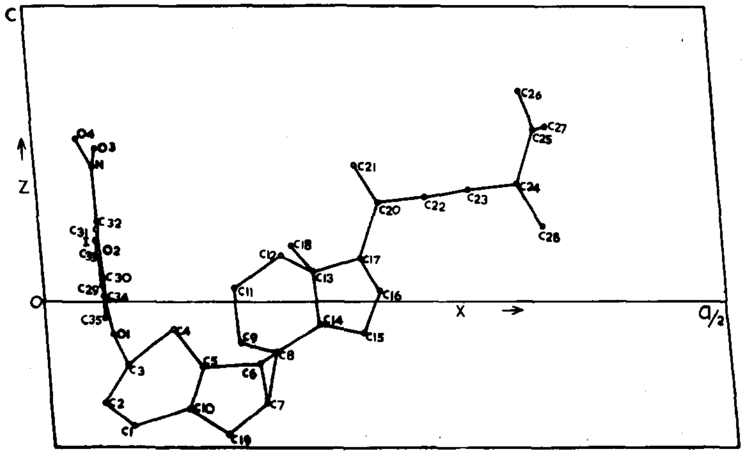

FIG. 1. Suprasterol II: projection of the molecule on (010).

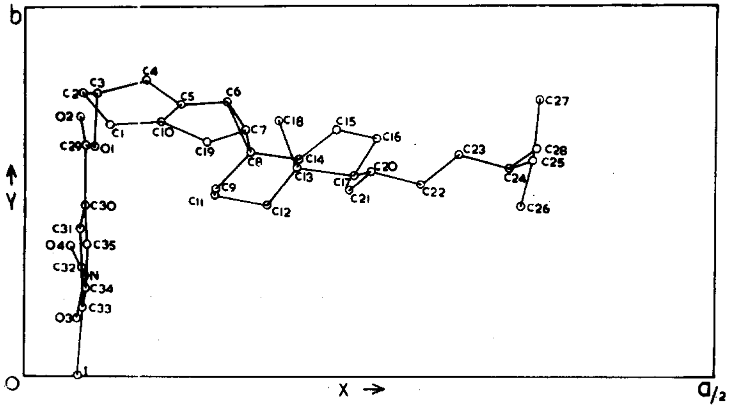

FIG. 2. Suprasterol II: projection of the molecule on (001).

agrees with that put forward by Dauben and Baumann[2] and formulated as I. In the suprasterol molecule a three-membered ring, fused to a five-membered ring, is attached through a spiro junction to ring C and replaces ring B of the original sterol skeleton. The five-membered ring is planar within the limits of experimental error, and carbon atoms 1 and 4 also lie in the plane of the ring as would be expected if C5 and C10 are joined by a double bond. Ring C and D of the sterol skeleton and the attached side chain appear in the same configuration as that found in calciferol, ring D being non-planar, with C17 deviating

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[2] Preceding letter, compare W. G. Dauben, I. Bell, T. W. Hutton, G. F. Laws, A. Rheiner, Jr. and H. Urscheler, J. Am. Chem. Soc. 80, 4116 (1958).

most from the plane of the remaining atoms. As a whole, the structure can be derived by comparatively small changes from that of calciferol itself[3] (II), where already C19 and C7 are so close that they impose a twisted form on the

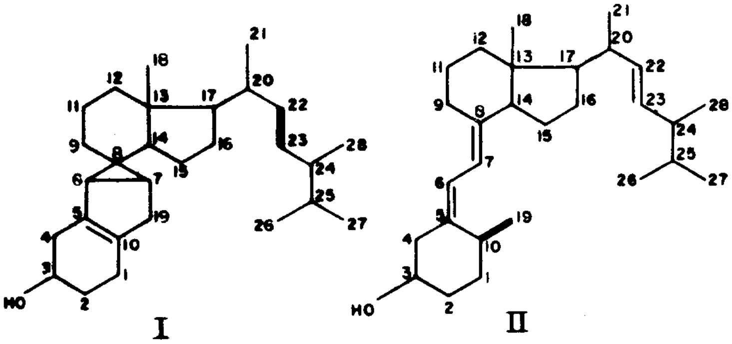

FIG. 3

cis butadiene group in the molecule. The movement of the double bond to link C5 and C10 flattens the molecule in this region of ring A in suprasterol, as described above, and this flattening is accompanied by a further conformational change. The hydroxyl group in this particular derivative of suprasterol II is in the erect, not equatorial, orientation and this carries the attached benzene ring into a position nearly perpendicular to the main planes of the

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[3] D. C. Hodgkin, M. S. Webster and J. D. Dunitz, Chem. and Ind. 1957, 1148.

steroid rings. This arrangement does not seem to be a necessary consequence of the changed stereochemical form of ring A and may result from packing conditions within the molecule and crystal structure. It has the effect of imposing a compact, rather than extended, shape on the molecule as a whole.

All computations were performed on the Oxford University MERCURY Computer. We wish to thank Dr. J. S. Rollett for his structure factor and least squares program, Dr. O. S. Mills for the use of his Fourier synthesis program, and the Oxford Computing Laboratory staff for their help and co-operation. One of us also wishes to thank the National Research Council of Canada for the award of a Special Scholarship.