X-Ray Determination of the Molecular Structure of a 3-o-Chlorophenylisoxazoline Derivative of Pyrethrosin

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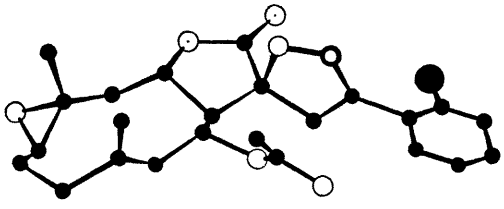
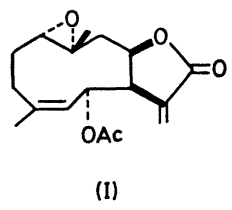
Summary The structure of pyrethrosin is deduced from an *X*-ray study of the adduct formed between pyrethrosin and *o*-chlorobenzonitrile oxide.

THE sesquiterpenoid lactone, pyrethrosin, $C_{17}H_{22}O_5$, was formulated as (I) from chemical studies.[1,2] The carbocyclic system has since been found in other sesquiterpenes, *e.g.* germacratriene[3] and heliangine.[4] The marked reactivity of the 10-membered ring, and the ease of cyclisation, led Barton[1,5] to predict a probably significant biogenetic role for such a skeleton, and this is now accepted. We report an *X*-ray study undertaken [especially in view of the structure (II), suggested by Castille[6]] to check and complete the stereochemistry of (I) and to determine the conformational details of the olefinic ring. The isoxazoline derivative used was prepared by addition of *o*-chlorobenzonitrile oxide at 0 °C in benzene. The *X*-ray study has shown it to be (IV), whence pyrethrosin can be deduced to be (III), a structure similar to that of heliangine(V).[4] This study establishes the general correctness of Barton's proposed structure, but changes the endocyclic double bond to *trans*, and establishes that both the lactone and epoxide rings† are fused *trans* to the 10-membered ring. The acetate is *cis* to the adjacent bridgehead hydrogen atom. These revisions lead to a rather flatter molecule (see Figure). The

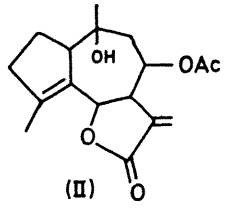


FIGURE

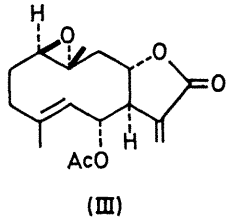
plane of the *trans*-double bond is nearly perpendicular to the general plane of the 10-membered ring as has been found in several 9-, 10-, and 11-membered unsaturated rings. Both methyl groups lie β to the molecule as shown in (III), which is drawn to conform to the absolute configuration deduced by Barton *et al.*[1,2] The addition of the nitrile oxide group across the *exo*-methylene group has occurred *trans* to both the bridgehead hydrogen and the acetyl group; its β approach may have been dictated by the position of the acetyl. Many of the derivatives discussed by Barton and others can now be reformulated *e.g.* cyclopyrethrosin acetate will become (VI).



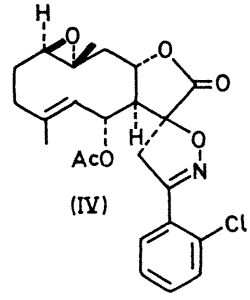
(I)



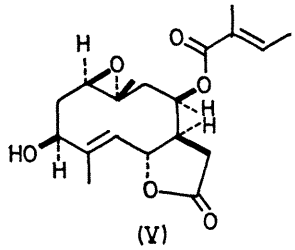
(II)



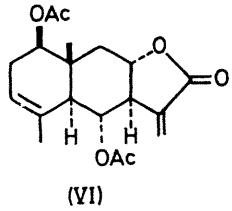
(III)



(IV)



(V)



(VI)

The crystals of $C_{24}H_{26}NO_6Cl$ are monoclinic, $P2_1$, $a = 14{\cdot}62$, $b = 6{\cdot}36$, $c = 13{\cdot}48$ Å, $\beta = 110{\cdot}0$, $Z = 2$. 2323 reflections were estimated visually from photographs taken with Cu-K_α radiation. Solution of the structure was achieved only by means of an image-searching program,[7] which failed to find the chlorophenyl unit, but succeeded with the isoxazolone ring and its three nearest atoms. Refinement,

† Unfortunately, in the structural diagram for pyrethrosin quoted by Barton in ref. 5, the drawing of the epoxide bonds was reproduced incorrectly.

which has reached $R = 0{\cdot}118$, has shown the chlorophenyl group to be disordered.‡

We thank Dr. J. E. Baldwin for supplying the isoxazoline derivative of pyrethrosin.

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‡ Our attention has been drawn to a paper by S. Iriuchijima and S. Tamura (*Agr. Biol. Chem.*, 1970, **34**, 204), who, without apparently having seen Barton's quotation of our formula in ref. 5, have by chemical methods correctly revised both pyrethrosin and cyclopyrethrosin.

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