Tetrahedron Letters No. 40, pp. 3567-3570, 1969. Pergamon Press. Printed in Great Britain.

THERMAL EXCHANGE BETWEEN ACETYL AND METHYL GROUPS IN THE FIVE-MEMBERED RING OF 3-ACETYLGUAIAZULENE

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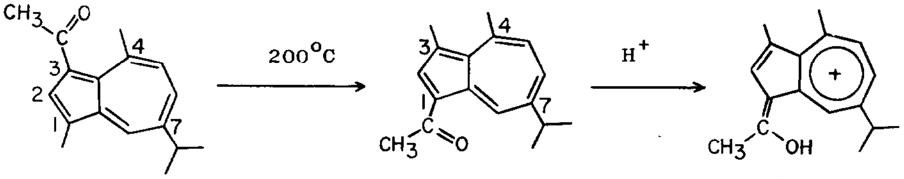
(Received in Japan 14 July 1969; received in UK for publication 31 July 1969)

In the heating of 3-acetylguaiazulene (I), yellowish green crystals, mp 56 - 57°C (picrate; dark red needles, mp 120 - 121°C), were isolated in addition to 2-acetylguaiazulene, and the crystals were determined as 1-acetyl-7-isopropyl-3,4-dimethylazulene (II-a). The result indicates that acetyl and methyl groups in the 5-membered ring moiety of 3-acetylguaiazulene were thermally exchanged.



(I) (II-a) (III)

This crystalline compound had the same molecular weight ($M^+= 240$) as the starting material, 3-acetylguaiazulene. An absorption band $\nu_{C=O}$ 1627 cm^{-1} and the formation of 2,4-dinitrophenylhydrazone, mp 195 - 196°C, indicate the presence of a carbonyl group, which is characterized as an acetyl group by a methyl singlet, δ 2.63 ppm (Fig. 1), and significant peaks, m/e 225 (base peak, $M^+- CH_3$), m/e 197 (18.6 %, $M^+- CH_3CO$), m/e 43 (20.4 %, CH_3CO^+). Besides, the NMR spectrum indicates the presence of an isopropyl (1.36 ppm, d) and two aromatic methyl groups (3.01 and 2.80 ppm). This compound is thus thought to be a positional isomer of 3-acetylguaiazulene, the starting material.

Among the aromatic proton signals, three signals, 10.28 (d, 1H, J = 2.0 cps), 7.48 (dd, 1H, J = 10.5 and 2.0 cps) and 7.15 ppm (d, 1H, J = 10.5 cps), are respectively assigned to H_8, H_6 and H_5 on the basis of the fact that the coupling constants and the signal pattern are similar to those of S-guaiazulene and of

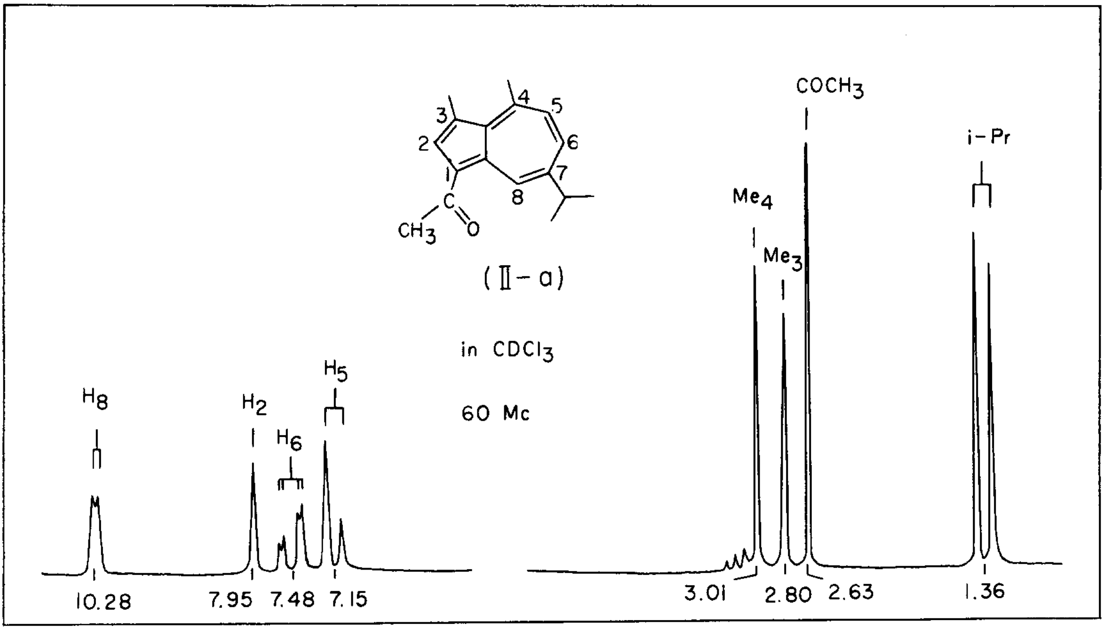


Fig. 1. NMR of 1-acetyl-7-isopropyl-3,4-dimethylazulene.

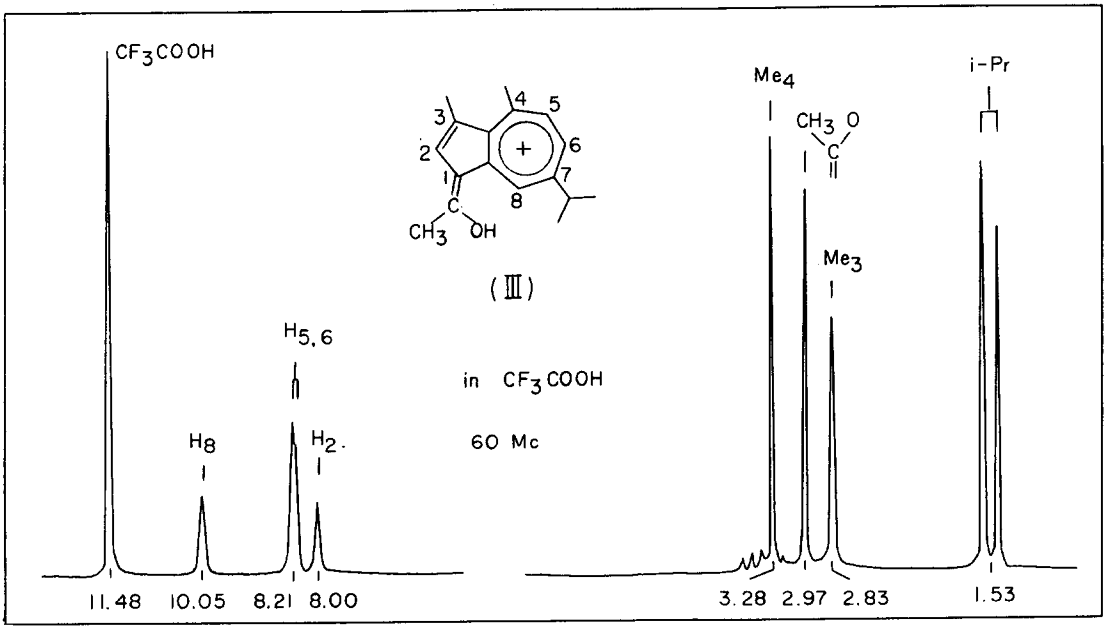


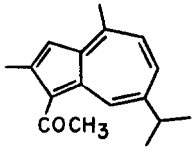
Fig. 2. NMR of conjugate acid of 1-acetyl-7-isopropyl-3,4-dimethylazulene.

3-acetylguaiazulene. It is certain that the 7-membered ring of this compound is of the same 4,7-disubstitution as in the starting material.

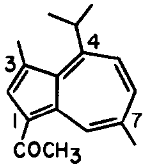
A remarkable low chemical shift of H_8 (10.28 ppm) (cf. S-guaiazulene, 7.98 ppm; 1-acetylazulene, 9.89 ppm; and 1-acetyl-3-methylazulene, 9.68 ppm (1)) shows the acetyl group at the peri position (C_1) of C_8. When NMR was measured in a trifluoroacetic acid solution (Fig. 2), four aromatic proton signals to be correlated to H_8 (10.05), $H_{5,6}$ (8.22 and 8.20), and H_3 or H_2 (8.00 ppm) are observed, but there is no signal to be assigned to a methine or a methylene group. This fact supports the assumption that the protonation of C_1 atom, which carries the acetyl group, in trifluoroacetic acid is prevented by such protonation of the carbonyl group and conjugation of the double bonds as formula (III). In the case of formula (III) the OH proton signal is thought to overlap with that of CF_3COOH (11.48 ppm, sharp singlet) owing to the facile exchange between the both protons.

A broad methyl singlet at 2.83 ppm (s, 3H, half-band width = 2.5 cps) in Fig. 2 is assigned to a methyl group attached to the 5-membered ring moiety, because such broadening of the signal is peculiar to the group spin-coupled with an adjacent olefinic proton (H_2 or H_3, 8.00 ppm). One methyl group is therefore apparent to exist on C_2 or C_3.

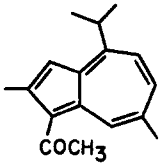
From the above evidences, the structural formulae from (II-a) to (II-d) are possible for the present compound.



(II-b)



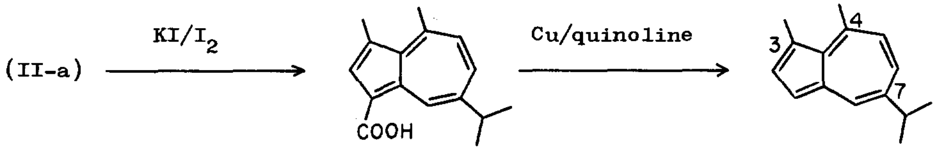
(II-c)



(II-d)

Of these formulae, (II-b) is 1-acetyl-Se-guaiazulene already reported (2). (II-c) is not acceptable because of the large steric interference between alkyl substituents on C_3 and C_4 and the lack of a methine signal in Fig. 2 (the protonation of C_3 is anticipated for the structure (II-c) (1,3)).

The selection between (II-a) and (II-d) was made upon the fact that by hypoiodite oxidation followed by decarboxylation 7-isopropyl-3,4-dimethylazulene (V) was obtained;



(IV) (V)

The visible absorption maximum ($\lambda_{max}^{cyclohexane}$ 611 mμ) of the product does not a with the value 562 mμ of 4-isopropyl-2,7-dimethylazulene, jatazulene (4), to b expected from (II-d); but agrees well with the calculated value (607 mμ) (5) f 3,4,7-trialkylazulene (V) to be derived from (II-a).

The present compound is thus certainly 1-acetyl-7-isopropyl-3,4-dimethyl-azulene (II-a).

The author wishes to thank Professor Tamon Matsuura and Professor Shûichi Hayashi of Hiroshima University for many helpful discussions and suggestions during this work.

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