

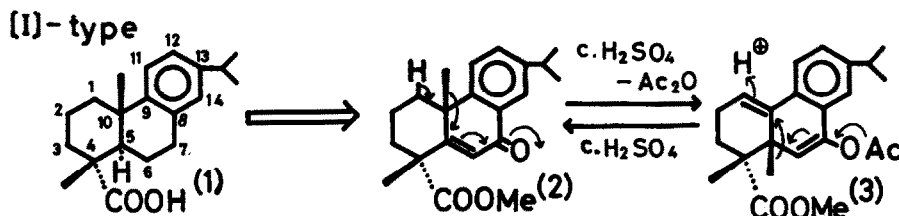
REARRANGEMENT OF BENZONILIDENE TYPE DITERPENES*¹

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(Received in Japan 8 June 1974; received in UK for publication 1 July 1974)

Recently, it was found that an interesting methyl migration occurred in the reaction of benzonilidene ester (2), derived from dehydroabietic acid (1), in the acidic condition ([I]-type: 2 \rightleftharpoons 3).¹⁾ We report herein that the benzonilidene type compounds behave in a completely different manner according to the variation of the reagent and the structure.



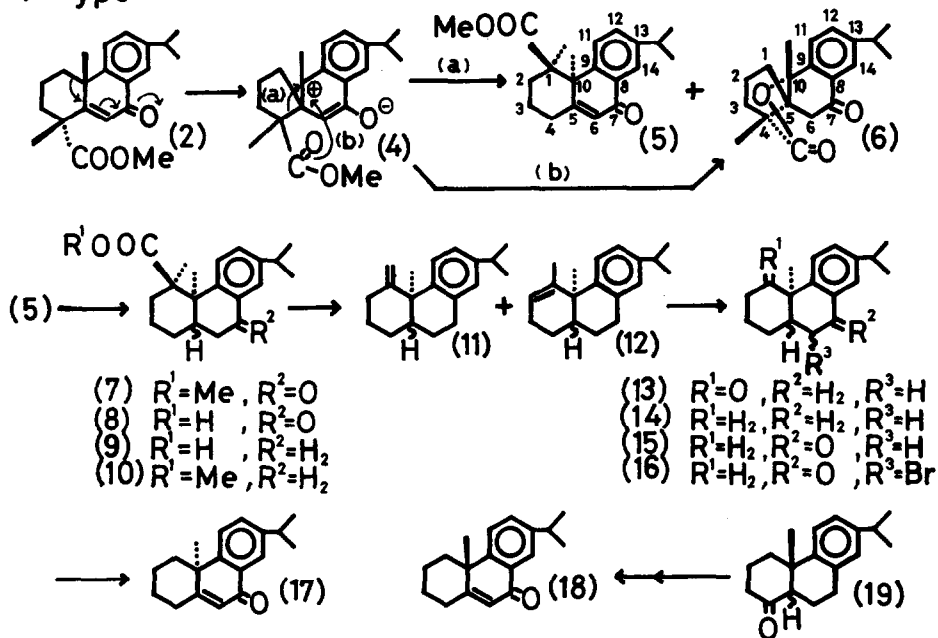
Reaction of the ester (2) using a Lewis acid (AlCl₃, benzene, reflux) gave a major product (5), mp 113-113.5° (51% yield), $\nu_{\text{max}}^{\text{KBr}}$: 1728, 1658 cm⁻¹, δ_{CDCl_3} : 1.27 (d, \underline{J} = 7.2 Hz; isopropyl Me), 1.53, 1.62 (s each; 1- and 10-Me), 3.17 (s; COOMe), 6.39 (s; 6-H), 7.30-7.65 (m; 11- and 12-H), 8.08 (d, \underline{J} = 2 Hz; 14-H) in company with a lactone (6), mp 225-226.5° (4.6% yield), $\nu_{\text{max}}^{\text{KBr}}$: 1767, 1692 cm⁻¹, δ_{CDCl_3} : 1.24 (d, \underline{J} = 7.2 Hz; isopropyl Me), 1.27 (s; 10-Me), 1.54 (s; 4-Me), 2.86

*1 New compounds indicated by physical constants gave satisfactory analytical values. Nmr (δ) spectra were measured at 60 MHz in solvent vs. Me₄Si as internal reference.

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(s; 6-H₂), 7.31-7.53 (m; 11- and 12-H), 7.91 (d, $J=2$ Hz; 14-H) and the starting material (2) (15% yield) ([II]-type).

[II]-type



For the structure of the main product, configuration of 10-methyl group was first determined by a chemical conversion. Successive treatment of 5 by catalytic hydrogenation (H_2 , Pd-C, MeOH), alkaline hydrolysis (10% KOH-MeOH- H_2O , room temp.), and hydrogenolysis (H_2 -3 kg/cm², Pd-C, AcOH) gave an acid (9) (purified as the corresponding methyl ester (10), mp 79-79.5°) via 7 and 8. The acid (9) was treated by the usual methods [oxidation ($Pb(OAc)_4$, benzene-pyridine)²): $9 \rightarrow 11+12$, ozonolysis (O_3 , CH_2Cl_2): $11+12 \rightarrow 13$ as the neutral part, reduction ($KOH-NH_2NH_2 \cdot H_2O$, DEG): $13 \rightarrow 14$, oxidation (CrO_3 , Ac_2O): $14 \rightarrow 15$, bromination (Br_2 , AcOH): $15 \rightarrow 16$ and debromination (1,5-diazabicyclo[5.4.0]undecene-5)] to give a benzonilidene compound (17) (2,4-dinitrophenyl hydrazone, mp 185-187°), $\nu_{max}^{CCl_4}$: 1660, 1610 cm^{-1} , δ^{CDCl_3} 1.26 (d, $J=7.2$ Hz; isopropyl Me), 1.46 (s; 10-Me), 6.28 (s; 6-H), 7.41 (d; 11- and 12-H), 8.06 (br. s; 14-H), ord curve: negative Cotton effect. For the sake of comparison, the antipodal one (18), ord curve: positive Cotton effect, was synthesized from a mixture (cis and trans A/B-ring fusion) of 4-oxo

compound²⁾ (19). As both the compounds (17) and (18) have the same physical constants with the exception of the sign of the Cotton effect, 10-methylgroup of 17 (therefore, 5) is α -configuration.

Nmr analysis of 5 elucidated the position and the configuration of its *gem*-methyl-methoxycarbonyl group. A nuclear Overhauser effect (NOE) was distinctly observed on 11-hydrogen by irradiation at 1-methyl and 10-methyl groups (26.9% increase by irradiation at δ 1.53 and 34.6% increase by irradiation at δ 1.62 at 11-H). In addition to the chemical shift (δ 3.17) of methoxycarbonyl group in higher magnetic field, the nmr observation can be explained fairly by the elucidation of α -methyl (located near 11-H) and β -methoxycarbonyl groups (affected by the diamagnetic effect of the benzene ring) at 1-position.

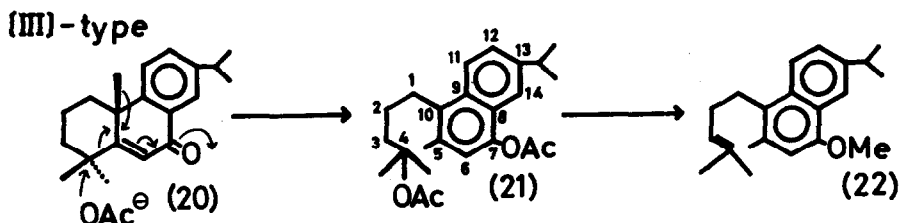
The structure of the minor product (6) is supported by its ir (1692 cm^{-1} for 7-benzyl ketone and 1767 cm^{-1} for 5-membered lactone) and nmr data as follows. The singlet peak (δ 2.86; A_2 -pattern) due to 6-methylene group indicates that 7-oxo group bisects the angles between 6 α - and 6 β -protons and no hydrogen is present at the adjacent 5-position. One of the methyl groups is spatially held in the plane of 7-oxo group and is deshielded (δ 1.54; presumably 4-Me) by its anisotropic effect (10-methyl group of 6 should be equatorial in the B-ring). The molecular model of 6 can only be arranged to satisfy the above physical data.

Rearrangement of 5 and 6 from 2 is understood by the consideration of the process through (a) and (b) routes *via* 4 shown in the above Chart.

The other type of benzonilidene (20), having 4-*gem*-dimethyl group instead of 4-*gem*-methyl-methoxycarbonyl group of 2, was examined under the same condition ($\text{Ac}_2\text{O}-\text{H}_2\text{SO}_4$) as in 2. The reaction gave a diacetate (21) (82% yield), $\nu_{\text{max}}^{\text{CCl}_4}$ 1760, 1725 cm^{-1} , δ^{CCl_4} 1.27 (s; Me x 1), 1.37 (s; Me x 3), 1.86 (s; 4-OAc), 2.37 (s; 7-OAc), 2.45 (s; 5-Me), 7.01 (s; 6-H), 7.39 (q, $J=9.0, 1.0$ Hz; 12-H), 7.56 (d, $J=1.0$ Hz; 14-H), 7.92 (d, $J=9.0$ Hz; 11-H), which is completely different from the products of [I] and [II]-type reactions ([III]-type).

Uv absorption of the product (21), $\lambda_{\text{max}}^{\text{EtOH}}$ (log ϵ) 285 (3.78), 314 (3.24), 322 (3.03), 329 (3.32) μ , shows the characteristic pattern of alkylnaphthalenes. The assumption that 21 has alkylnaphthalene skeleton, is supported by its nmr observation that the peaks due to 6-proton (δ 7.01, cf. the corresponding peak of

20, δ 6.33) and due to 5-methyl group (δ 2.45) appear in the region of the aromatic proton.



Hydrolysis-methylation (Me_2SO_4 - K_2CO_3 - MeCOEt , reflux) of 21 gave a methoxyl compound (22), δ^{CCl_4} 1.33, 1.40 (s each; isopropyl Me), 1.59, 1.71 (s each; 4- Me_2), 2.45 (s; 5-Me), 3.97 (s; 7-OMe), 5.28 (m; 3-H), 6.50 (s; 6-H), 7.30 (q, $J=9.0, 2.0$ Hz; 12-H), 7.81 (d, $J=9.0$ Hz; 11-H), 7.95 (d, $J=2.0$ Hz; 14-H). In the nmr spectrum, absorptions due to one methoxyl group, one olefinic proton, and two olefinic methyl groups newly appear in place of the two acetyl peaks observed in nmr of 21. NOE on aromatic 5-methyl (δ 2.45; 27.0% increase) and 7-methoxy groups (δ 3.97; 25.5% increase) by irradiation at 6-proton (δ 6.50) revealed the relative location (5-Me, 6-H, and 7-OMe). The structure of 22 and 21 are evidently supported by the above examination.

The reactions of the benzonilidene type diterpenes ([I], [II] and [III]-type) strongly depends on their structures and reagents. A more detailed study on this interesting reaction is in progress.

References

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