CHEMISTRY LETTERS, pp. 1129-1132. 1979. Published by the Chemical Society of Japan

A NEW MACROCYCLIC SESTERTERPENE ACID FROM CEROPLASTES CERIFERUS

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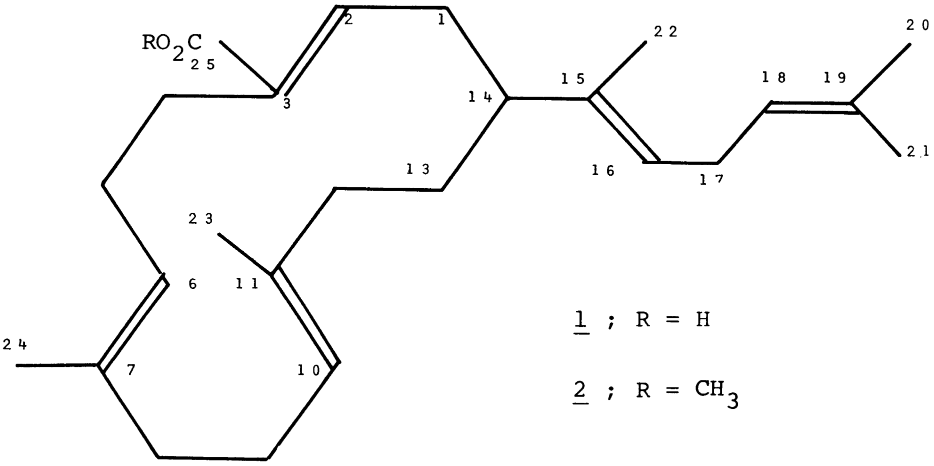
From the wax of Ceroplastes ceriferus, a scale insect, a new macrocyclic sesterterpene, designated as ceriferic acid, was isolated, and its structure was elucidated as albocera-2(E),6(E),10(E),15(E),18-pentaen-25-oic acid.

Insects belonging to the Coccoidea are generally called scale insects, which are harmful especially to fruit plants. These insects secrete a large bulk of waxy substance on their body surface, which is considered to protect scale insect from deleterious effects of weather and enemies. In the course of our investigations on the constituents of the wax[1] of a scale insect, Ceroplastes ceriferus, Tsunoromushi in Japanese, we found a macrocyclic sesterterpene. This paper deals with the structure of the new sesterterpene, which was named ceriferic acid (1).

The wax of C. ceriferus was effectively separated using 'flash chromatography' (hexane : ethyl acetate = 4 : 1), recently developed by Still,[2] affording ceriferic acid (1) contaminated with a small amount of fatty acid. The methyl ester (2) of ceriferic acid, prepared by treatment of 1 with diazomethane, could be obtained in a pure state, after column chromatography on silica gel (hexane), as a colorless and air sensitive oil; $[\alpha]_D$ -93.2° (c 0.91 chloroform); IR (neat) 1705 and 1638 cm^{-1} ($C=C-COOCH_3$). High resolution mass spectrometry allowed assignment of the molecular formula $C_{26}H_{40}O_2$ (M^+, m/e 384.3027) and significant fragmentation ions were observed at m/e 369.2751 (M^+-CH_3), 352.2770 (M^+-CH_3OH), 341.2451 ($M^+-C_3H_7$), 328.2375 ($M^+-C_4H_8$), 325.2849 ($M^+-CO_2CH_3$), 315.2302 ($M^+-C_5H_9$), 247.1665 ($M^+-C_{10}H_{17}$), and 135.1147 ($C_{10}H_{15}$). The ^1H-NMR spectrum of methyl ceriferate (2) revealed five methyls and



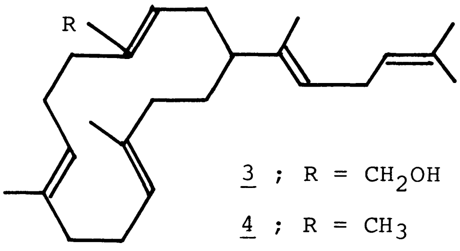
1 ; R = H

2 ; R = CH_3

four vinyl hydrogens by resonances at δ 1.52 (3H), 1.56 (6H), 1.62 (3H), 1.69 (3H), and 5.04 (4H,m), besides a methoxyl and a strongly deshielded olefin proton by resonances at δ 3.65 (3H) and 6.64 (1H,dd,J=6 and 8 Hz) (CH_2-CH=C-$COOCH_3$). The spectrum also exhibited signals appearing at δ 2.67 (2H,t,J=7 Hz) ascribable to the methylene protons (C-17) adjacent to two olefinic protons, since this triplet collapsed into singlet on irradiation at δ 5.04 (vinyl protons).

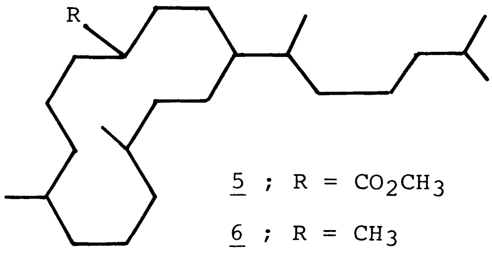
A monocyclic character of methyl ceriferate (2) was evident from its molecular formula and the number of olefinic bonds (^{13}C-NMR, vide infra). The skeleton of 2 was deduced to be the same as that of albocerol (7),[3] on the basis of the mass spectra of 2 and its derivatives (5). The high resolution mass spectrum of 2 exhibited an intense peak at m/e 109.1039, whose composition (C_8H_{13}) corresponded to that of the side chain of 2. The decahydro ester (5), prepared by hydrogenation of 2 over platinum oxide, showed the base peak at m/e 281, due to the fragment produced by the loss of the side chain. The ester (2) was reduced with diisobutylaluminium hydride in toluene at -78°, giving rise to the allyl alcohol (3); NMR($CDCl_3$,δ) 5.5 (1H,br.dd,2-H), 5.1 (4H,m), 4.05 (2H,ABq,J=13 Hz,CH_2-O), 2.72 (2H,t,J=7 Hz,17-CH_2), 1.72 (3H,s,20-CH_3), 1.64 (6H,s), 1.55 (6H,s); m/e 356 (M^+), 338 (M^+-H_2O), 325 (M^+-CH_2OH), 287 (M^+-C_5H_9), 269 (338-C_5H_9). Hydrogenation of 3 over palladium-charcoal produced the hydrocarbon (6), whose mass spectrum was identical with that of albocerane (6).[3]

The ^{13}C-NMR spectrum of 2 showed the signals consistent with the proposed structure: δ($CDCl_3$) 168.4(s,O-C=O), 142.4(d,C-2), 136.4(s), 133.7(s), 132.9(s), 131.3(s), 131.1(s), 125.4(d), 125.3(d), 124.6(d), 123.4(d), 51.3(q,OCH_3), 49.9(d,C-14), 40.3(t), 36.0(t), 31.2(t), 29.8(t), 26.9(t), 26.9(t), 26.0(t), 25.7(q,C-20), 24.5(t), 17.7(q, C-21), 15.6(q,C-23 or 24), 15.3(q,C-24 or 23), 12.3(q,C-22).



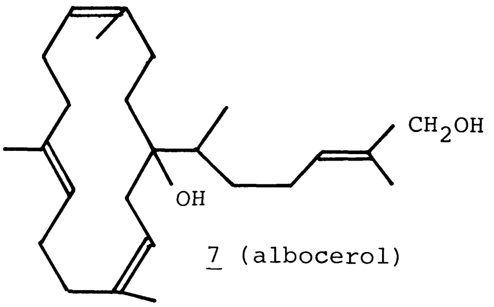
3 ; R = CH_2OH

4 ; R = CH_3

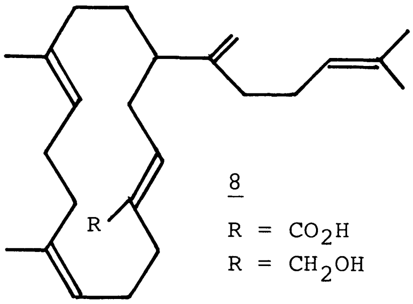


5 ; R = CO_2CH_3

6 ; R = CH_3



7 (albocerol)



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R = CO_2H
R = CH_2OH

In the NMR spectrum of 2, the coupling pattern (dd) between the proton at C-2 and the methylene protons at C-1 suggested that the two protons of this methylene had to be nonequivalent and the methylene group was possibly bonded to an asymmetric center (C-14). This supposition was further verified by SEL (selective decoupling) technique of ^{13}C-NMR spectrometry. In the spectrum of 2, irradiation to the proton at δ 6.64 resulted in remarkable sharpening of the doublet at δ 49.9 due to carbon-14. The presence of the long-range coupling between the C-2 proton and the carbon-14 settled the position of the methoxycarbonyl group as described in the structure 2.

The configurations of the olefinic bonds at C-6, 10, 15 were determined to be all E, by the upfield chemical shifts of the signals due to the allylic methyl groups except 20-methyl, which is cis to the olefinic proton, in the ^{1}H- and ^{13}C-NMR spectra.[4,5] Furthermore, in the off-resonance ^{13}C-NMR spectrum of 2, the quartets due to 23- and 24-methyls were found to be splitted by the large trans long-range coupling[6] with the olefinic protons at C-10 and 6, respectively.

The E-configuration of the double bond at C-2 was obvious from the downfield chemical shift (δ 6.64) of the C-2 proton.[7] This was further confirmed by the following finding. The alcohol (3) was converted into the hydrocarbon (4); NMR (CCl_4,δ) 5.06 (5H,m), 2.66 (2H,t), 1.68-1.62 (12H,4xCH_3), 1.50 (6H,s,2xCH_3), 1.6-1.2 (2H,m,13-CH_2), by treating with SO_3-pyridine followed by lithium aluminium hydride.[8] In the ^{13}C-NMR spectrum of 4, the signal due to the newly formed methyl group at C-25 appeared at δ 22.4. [Other signals appeared at δ 137.1(s), 133.8(s), 133.1(s), 132.9(s), 131.0(s), 125.2(d), 124.9(2xd), 124.5(d), 123.7(d), 46.6(d), 40.2(t), 35.8(t), 31.0(t), 30.4(t), 29.4(t), 26.8(t), 24.5(2xt), 25.6(q), 17.7(q), 15.6(q), 15.4(q), 12.0(q)]. This downfield chemical shift of C-25 supported the assignment of the Z-configuration of the C-2 double bond of 4.

Recently, Naya and her collaborators reported the isolation of ceriferoic acid (8; R=CO_2H) and cericerol-I (8; R=CH_2OH), and related sesterterpenes from C. ceriferus.[9] It should be interested from taxonomical viewpoint that two samples of C. ceriferus, collected in different districts, produce similar but clearly different sesterterpenes.

We thank Dr. L. Quijano of Ciudad Universitaria for the kind supply of the mass spectrum of albocerane (6). The authors also thank Dr. S. Kawai of Tokyo-to Agricultural Experiment Station, Dr. A. Ohtake of Fruit Research Station, and Dr. M. Ono of Sericultural Experiment Station, Tsukuba for identification of C. ceriferus. The authors are grateful to Dr. Y. Naya of The Institute of Food Chemistry for the kind information on the spectral properties of cericerol-I (8) and the related sesterterpenes.

REFERENCES AND NOTES

1) As for the studies on waxy covering of Ceroplastes scale insects, see Y. Tamaki, Bulletin of National Institute of Agricultural Science (Japan) Series C, No. 24, (March, 1970).
2) W.C. Still, M. Kahn, and A. Mitra, J. Org. Chem., 43, 2923 (1978).
3) R. Veloz, L. Quijano, J. S. Calderson, and T. Rios, J. Chem. Soc., Chem. Comm., 191 (1975).
4) R. B. Bates, D. M. Gale. and B. J. Gruner, J. Org. Chem., 28, 1086 (1963).
5) M. J. Pettei, F. G. Pilkiewicz, and K. Nakanishi, Tetrahedron Lett., 2083 (1977).
6) E. Breitmeier and W. Voelter, Monograph in Modern Chemistry, Vol. 5, Carbon-13 NMR Spectroscopy, p 101, Weinheim, New York.
7) K. C. Chan, R. A. Jewell, W. H. Nutting, and H. Rapoport, J. Org. Chem., 33, 3382 (1968).
8) E. J. Corey and K. Achiwa, L. Org. Chem., 34, 3667 (1969).
9) Y. Naya, F. Miyamoto, H. Naoki, and T. Takemoto, ACS/CSJ Chemical Congress, Honolulu, Hawaii, April 1979, Abstracts of Papers, ORGN. 564.

(Received June 13, 1979)