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TERPENOIDS. XIII.
CONVERSION OF CHRYSANTHEMYL ALCOHOL TO A TRIENE WITH THE ARTEMISIA KETONE SKELETON

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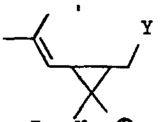
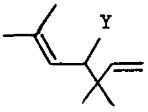
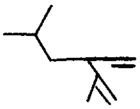
It was recently suggested (1) that the cyclopropylcarbinyl carbonium ion (2) Ia, probably derived from the pyrophosphate Ib of chrysanthemyl alcohol, could be a biogenetic precursor of the natural substances IIb and c of the artemisia series via ring opening in one direction, and a precursor of the natural hydrocarbon III by opening in the other direction. We wish to describe in vitro experiments in which the carbonium ion Ia opens and loses a proton to give IV, a hydrocarbon with the artemisia carbon skeleton.



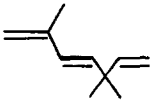
Ia, Y = ⊕
b, Y = OPP
c, Y = OTs
d, Y = OH
e, Y = OAc



IIa, Y = ⊕
b, Y = =O
c, Y = OAc
d, Y = OH
e, Y = H



III



IV (trans)

For ease of synthesis, the tosylate Ic rather than the pyrophosphate Ib was employed as a source of the carbonium ion Ia. When chrysanthemyl alcohol (3) (Id) was heated at 85-90° in pyridine with one equivalent of tosyl chloride, IV, previously prepared by Takemoto and Nakajima (4) by refluxing artemisia alcohol (IId) with iodine, was obtained in 40% yield. The remaining material was a high-boiling viscous oil.

Since both the earlier route to IV and the present route involve carbonium ion conditions, it was considered essential to gain supporting evidence for this structure. Accordingly, some of the triene was hydrogenated, giving 3,3,6-trimethylheptane, identical (infrared, nmr, and vpc) with an authentic sample prepared by hydrogenating the diene IIe. (5) In addition, the nmr spectrum of IV strongly supports the proposed structure, and, from the 17 cps coupling constant between the protons attached to the central double bond, shows this double bond to be trans.

By vpc and nmr, IV, obtained by distillation of the reaction mixture from Id, appeared to be at least 95% pure trans-IV. It is not surprising that less than 5% of cis-IV is formed, since serious nonbonded steric interactions should exist in the cis isomer and in transition states leading to it. The absence of products with the skeleton of III can be rationalized in terms of the greater stability of a transition state leading to the allylic cation of which IIa is a resonance form over a transition state leading to the tertiary carbonium ion which could give III.

In an attempt to obtain artemisia acetate (IIc) from Ia *via* IIa, Ic was heated for 10 hours at 85-90° in HOAc saturated with KOAc. However, the resulting colorless liquid proved to be a mixture of $C_{20}H_{32}$ hydrocarbons (bp, 100°/9 mm. Calcd: C, 88.23; H, 11.77; mol wt, 272. Found: C, 88.17; H, 11.70; mol wt, 285). Below 40°, the predominant reaction product was unrearranged tosylate (Ic), while between 40° and 60°, mainly unrearranged acetate (Ie) was found. A similar $C_{20}H_{32}$ hydrocarbon mixture was prepared in nearly quantitative yield from the triene IV by treatment with a trace of HOTs in HOAc (no reaction in HOAc alone), suggesting that the dimers are formed by reaction between the carbonium ion IIa and the triene IV.

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References:

1. R. B. Bates and S. K. Paknikar, Tetrahedron Letters **20**, 1453 (1965).
2. In this paper, classical carbonium ions are drawn for clarity. For a recent discussion of the detailed structure of cyclopropylcarbinyl and related cations, see M. J. S. Dewar and A. P. Marchand, Ann. Rev. Phys. Chem. **16**, 321 (1965).
3. The experiments starting with Id described herein were carried out with a 60-40 mixture of trans- and cis-Id and with a 95-5 mixture of the same substances. In each case, the yields of isolated products were within experimental error of one another, indicating at most a small degree of stereoselectivity.
4. T. Takemoto and T. Nakajima, Yakugaku Zasshi **77**, 1310 (1957).
5. K. W. Bartz and N. F. Chamberlain, J. Anal. Chem. **36**, 2157 (1964).