

LANTHANIDE INDUCED CHEMICAL SHIFTS IN NATURAL CYCLOPROPANES;  
STEREOCHEMISTRY OF CHRYSANTHEMYL AND PRESQUALENE ALCOHOLS AND ESTERS.

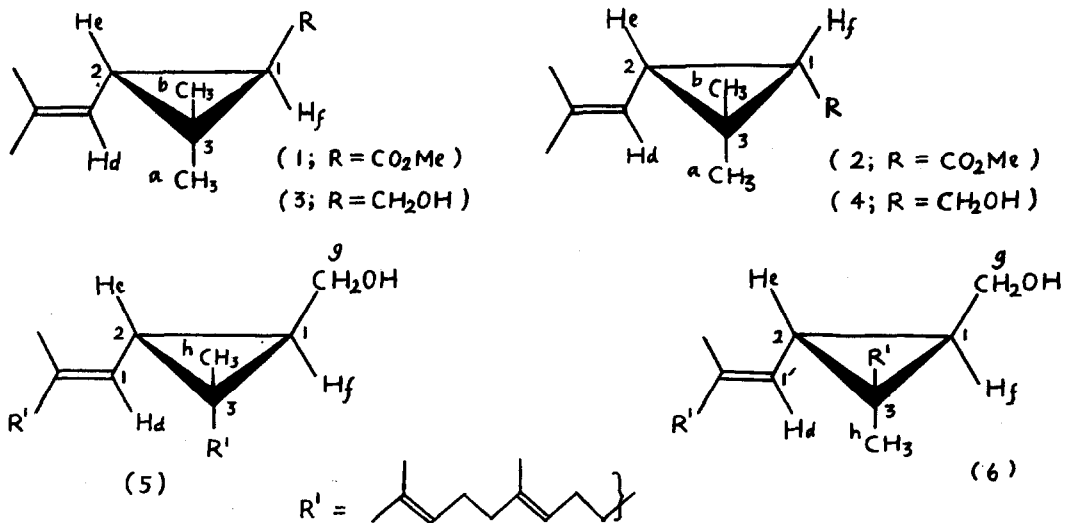
By L. Crombie, D.A.R. Findley and D.A. Whiting

(Department of Chemistry, The University, Nottingham NG7 2RD)

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Much current interest in natural cyclopropanes centres on their role in monoterpenoid,<sup>1</sup> triterpenoid,<sup>2</sup> and carotenoid<sup>3,4</sup> biosynthesis. Stereochemical assignments, rarely completely straight forward, are readily amenable to analysis in terms of n.m.r. lanthanide shift plots, expressed as gradient (nearest 0.5) of shift (ppm) vs mol ratio {Eu(FOD)<sub>3</sub>/substrate}, as illustrated below.

Comparing data for trans (t) and cis (c) methyl chrysanthemates (1) and (2), the response of H<sub>f</sub> to shift reagent is similar for both compounds {gradients, H<sub>f</sub>(t)8.5, (c)7.5}, but H<sub>e</sub> and H<sub>b</sub> are more affected in the trans-ester {H<sub>e</sub>(t)8.5, (c)3.5; H<sub>b</sub>(t)5.0, (c)1.5}, whilst H<sub>d</sub> and H<sub>a</sub> are more affected in the cis-ester {H<sub>d</sub>(t) 2.5, (c) 7.5; H<sub>a</sub> (t) 2.5, (c) 4.5}. These effects are concordant with the stereochemistry shown, and the geometric relationship of the C(3) methyls to the C(1) carbomethoxy is readily deduced.



In the 1,2-trans ester the methyl cis to carbomethoxy appears at lower  $\tau$  (Hb 8.75, Ha 8.89). This correlation is valuable in stereochemical assignment in the presqualene<sup>2</sup> and prephytoene<sup>4</sup> series.

Similar results are obtained for trans- and cis- chrysanthemyl alcohols, shifts being generally larger (increased coordination). Thus H<sub>f</sub>(t) and H<sub>f</sub>(c) plots have the same gradient (19.5) while H<sub>e</sub> and H<sub>b</sub> are more shifted, and H<sub>a</sub> and H<sub>d</sub> are less shifted, in the trans- alcohol than in the cis- alcohol {H<sub>e</sub>(t) 11.5, (c) 8.5; H<sub>b</sub>(t) 9.5, (c) 5.0; H<sub>d</sub>(t) 5.5, (c) 10.5; H<sub>a</sub>(t) 5.5, (c) 9.0}

The stereoisomeric presqualene alcohols (5) and (6) are those predominating in synthesis<sup>2</sup> (low  $R_f$  and high  $R_f^*$  respectively). The present data show that the shift response of protons H<sub>f</sub>, H<sub>d</sub>, and H<sub>g</sub> are the same (within experimental error) in both compounds as expected from the stereochemistries shown {H<sub>f</sub> 21, H<sub>d</sub> 6.0, H<sub>g</sub> 33.5}, although H<sub>e</sub> ( $LR_f$ ) (10) and H<sub>e</sub> ( $HR_f$ ) (13) are not in such close agreement. On comparing these values with those for H<sub>d</sub> and H<sub>e</sub> in alcohols (3) and (4), a 1,2- trans geometry is indicated for both (5) and (6). This is supported by the coupling constant  $J_{1,2}$  in the two esters corresponding to alcohols (5) and (6), which is 5.1 Hz in both (cf.  $J_{1,2}$ (1) 5.1 Hz,  $J_{1,2}$ (2) 8.8 Hz). The multiplicity of H<sub>e</sub> and H<sub>f</sub> are clearly observed in the spectra of the esters when clarified by Eu (FOD)<sub>3</sub>. The 3-CH<sub>3</sub> signal is more affected by shift reagent in (5) (H<sub>h</sub>) than in (6) {H<sub>h</sub> ( $LR_f$ ) 9.0, ( $HR_f$ ) 5.5}. This methyl is therefore 1,3-cis to the CH<sub>2</sub>OH in (5) and 1,3-trans in (6). The stereochemistry about the ring is thus fully defined in both natural presqualene alcohol (5) and its isomer.

\* Low  $R_f$  and high  $R_f$  alcohols previously obtained<sup>2</sup> contained cis double bond isomers, the stereoselectivity of cyclopropane formation being much higher than originally thought.

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