

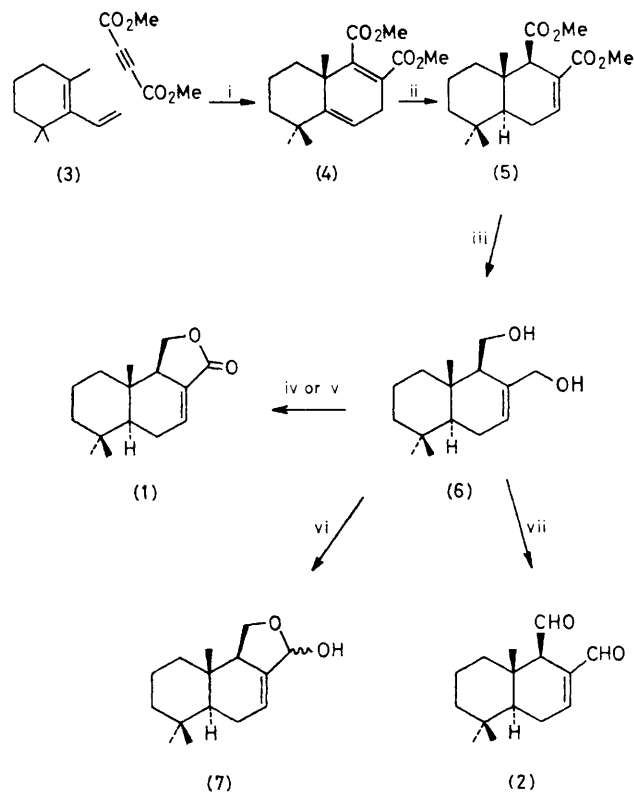
## Synthesis of Cinnamolide and Polygodial

By S. CHRISTOPHER HOWELL, STEVEN V. LEY,\* and MICHAEL MAHON  
(*Department of Chemistry, Imperial College, London SW7 2AY*)

and PAUL A. WORTHINGTON  
(*I.C.I. Plant Protection, Jealott's Hill, Bracknell, Berks., RG12 6EY*)

*Summary* Starting from 2,6,6-trimethyl-1-vinylcyclohex-1-ene a short synthesis of the sesquiterpenes cinnamolide and polygodial has been achieved with 60% and 57% overall yields, respectively.

PREVIOUS synthetic routes to cinnamolide (**1**)<sup>1</sup> and the potent insect antifeedant polygodial (**2**)<sup>1b,2</sup> are unattractive, especially if reasonable quantities of material are required. Here we report a short, highly efficient synthesis



SCHEME. i, 110 °C, 24 h; ii, 1 atm of H<sub>2</sub>, Pd/C 10%, trace of HCl, dil. methanol; iii, LiAlH<sub>4</sub>; iv, 10–20 equiv. of BaMnO<sub>4</sub>, CH<sub>2</sub>Cl<sub>2</sub>, 24 h; v, Ag<sub>2</sub>CO<sub>3</sub>/Celite; vi, 1–2 equiv. of BaMnO<sub>4</sub>, CH<sub>2</sub>Cl<sub>2</sub>, 4 h; vii, dimethyl sulphoxide/(COCl)<sub>2</sub> 4 equiv., –50 °C, 1 h, and then 6 equiv. of NEt<sub>3</sub>.

† Prepared in 95% yield from β-cyclocitral by treatment with trimethylsilylmethyl magnesium chloride in ether at room temperature followed by toluene-*p*-sulphonic acid in tetrahydrofuran at room temperature or in 90% yield according to ref. 1b.

‡ This structure has been confirmed by X-ray crystallographic determination. We thank Dr. D. J. Williams, Imperial College, for this result.

<sup>1</sup> (a) T. Suzuki, M. Tanemura, T. Kato, and Y. Kitahara, *Bull. Chem. Soc. Jpn.*, 1970, **43**, 1268; (b) S. P. Tanis and K. Nakanishi, *J. Am. Chem. Soc.*, 1979, **101**, 4398; (c) H. Yanagawa, T. Kato, and Y. Kitahara, *Synthesis*, 1970, 257.

<sup>2</sup> T. Kato, T. Suzuki, M. Tanemura, A. S. Kumanireng, N. Ototani, and Y. Kitahara, *Tetrahedron Lett.*, 1971, 1961.

<sup>3</sup> P. N. Rylander, *Aldrichimica Acta*, 1979, **12**, 53.

<sup>4</sup> H. Firouzabadi and E. Ghaderi, *Tetrahedron Lett.*, 1978, 839.

<sup>5</sup> M. Fetizon and M. Golfier, *C. R. Acad. Sci., Ser. C*, 1968, **267**, 900.

<sup>6</sup> K. Omura and D. Swern, *Tetrahedron*, 1978, **34**, 1651.

of these natural products starting from the readily available diene (3).† Our route employs a similar strategy to that of Nakanishi;<sup>1b</sup> however, by a careful choice of reagents we can avoid the use of protecting groups.

Diels-Alder reaction of (3) with dimethyl acetylenedicarboxylate readily affords (4) in 83% yield (Scheme). Hydrogenation of (4) under isomerising conditions<sup>3</sup> (1 atm of H<sub>2</sub>, Pd/C, trace of HCl, methanol) led directly to the *trans*-fused decalin<sup>†1b</sup> (5) in high yield (80%). Reduction of (5) with lithium aluminium hydride gave the key drimane diol (6) (90%), m.p. 73–74 °C (lit.<sup>1b</sup> 73–74 °C). Oxidation of this diol with an excess of barium manganate<sup>4</sup> gave cinnamolide (1) in 94% yield, or quantitatively using Fetizon's reagent.<sup>5</sup> Compound (1) was identical in all respects to the previously prepared material.<sup>1b</sup> Oxidation of (6) using only 1–2 equiv. of barium manganate gave the known lactol (7) (92%) (m.p. 95–98 °C, lit.<sup>1c</sup> 95–97 °C).

In order to achieve specific oxidation of (6) to polygodial (2) as opposed to (1) or (7), special reaction conditions were required. Thus, it was found that the Swern method<sup>6</sup> (dimethyl sulphoxide/oxalyl chloride) uniquely effected this transformation in 95% yield. The polygodial produced was identical to authentic material {<sup>1</sup>H n.m.r. δ 0.93 (s, 6H), 0.95 (s, 3H), 1.1–2.0 (m, 7H), 2.4 (m, 2H), 2.8 (m, 1H), 7.1 (m, 1H), 9.45 (s, 1H), and 9.5 (d, 1H); m.p. 91.0–92.5 °C; lit.<sup>1b</sup> 93–94 °C}.

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