

## A Convenient Synthesis of ( $\pm$ )-Occidol

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A new approach to the sesquiterpene ( $\pm$ )-occidol [1-methyl-1-(1,2,3,4-tetrahydro-5,8-dimethyl-2-naphthyl)-ethanol] (1) is described. This synthesis involves, as an intermediate, 1,4-dihydro-5,8-dimethylnaphthalene, which was prepared from the butadiene-*p*-benzoquinone adduct.

DURING the past few years, we<sup>1,2</sup> have been interested in the synthesis of occidol (1), the major sesquiterpene isolated from *Thuja occidentalis*. We recognised that the ring system of occidol is symmetrical except for the presence of a propan-2-ol system at C-2, and that this characteristic could be exploited in design of its synthesis. Another simple route is reported here.

In essence, it was intended to construct a completely symmetrical intermediate and then to affix to it the C-2 side chain. The dihydronaphthalene derivative (2) meets this requirement; and it was hoped that this might be obtained readily from the well-known butadiene-*p*-benzoquinone adduct (3).

Treatment of (3) with an excess of methyl-lithium in ether readily furnished an oily mixture of the diols (5) which was dehydrated without further purification to

observed that cyclohexanecarboxylic acid is obtainable in good yield from a photoreaction of nickel carbonyl with cyclohexene. The relatively mild conditions for such a process suited our purpose; accordingly (2) was subjected to the reaction and gave the product (4), after esterification with diazomethane, in 63% yield.

Since (4) has been previously converted into ( $\pm$ )-occidol by reaction with methyl-lithium,<sup>2</sup> the synthesis of the sesquiterpene was then formally complete.

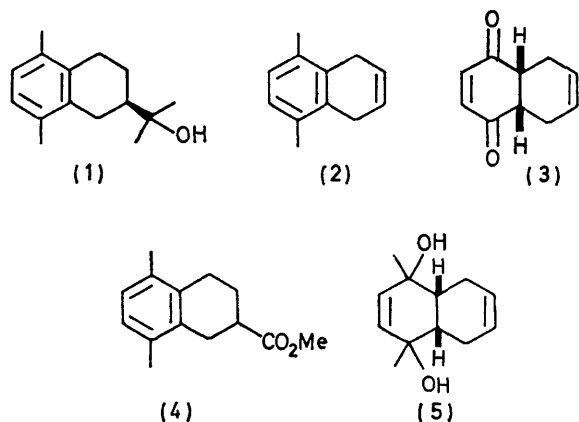
### EXPERIMENTAL

**1,4-Dihydro-5,8-dimethylnaphthalene (2).**—To a stirred solution of the diketone (3) (4.05 g, 25 mmol) in anhydrous ether (50 ml), methyl-lithium (1.9M-solution in ether; 40 ml) was added at such a rate that gentle refluxing was maintained without external heating. The mixture was then warmed at 50° for 2 h, cooled, and poured into aqueous ammonium chloride. The layers were separated and the aqueous phase was extracted with ether (2 × 30 ml). The combined ethereal solution was dried (MgSO<sub>4</sub>) and evaporated *in vacuo* to give the oily diols (5).

This mixture was dissolved in pyridine (5 ml), cooled in an ice-bath, treated with phosphoryl chloride in small portions, and finally left at room temperature for 1 h. Quenching with ice-water and extraction with ether yielded a product which was distilled *in vacuo* to afford the *dihydronaphthalene* (2) (2.07 g, 52%), b.p. 110–112° at 1.0 Torr; m.p. 29–31°;  $\nu_{\max}$  (CH<sub>2</sub>Cl<sub>2</sub>) 1675 and 1600 cm<sup>-1</sup>;  $\tau$  (CCl<sub>4</sub>) 3.25 (2H, s, ArH), 4.20 (2H, t, *J* 1.5 Hz, =CH), 6.83 (4H, d, *J* 1.5 Hz, CH<sub>2</sub>), and 7.87 (6H, s, ArCH<sub>3</sub>) (Found: C, 91.3; H, 8.75. C<sub>12</sub>H<sub>14</sub> requires C, 91.1; H, 8.9%).

**Methyl 1,2,3,4-Tetrahydro-5,8-dimethyl-2-naphthoate (4).**—A mixture of (2) (1.58 g, 10 mmol), nickel carbonyl (1.5 ml, 11.5 mmol), water (3.6 ml), concentrated hydrochloric acid (2 ml), and acetone (30 ml), in a quartz tube carrying a reflux condenser, was irradiated under nitrogen with a Hanovia 450 W mercury arc. After 10 h the solution was evaporated to dryness and the residue was distributed between water and chloroform. The chloroform solution was treated with an excess of ethereal diazomethane, then evaporated; the residue was distilled to give the methyl ester (4) (1.37 g, 63%), b.p. 130–133° at 1.0 Torr;  $\nu_{\max}$  (CHCl<sub>3</sub>) 1730 cm<sup>-1</sup>;  $\tau$  (CDCl<sub>3</sub>) 3.05 (2H, s, ArH), 6.25 (3H, s, CO<sub>2</sub>Me), and 7.79 (6H, s, ArCH<sub>3</sub>), identical with an authentic sample.

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give the desired product (2) in 52% overall yield. The <sup>1</sup>H n.m.r. spectrum of (2) is definitive and unambiguous, showing a singlet at  $\tau$  3.25 for the aromatic protons, a vinylic proton triplet at  $\tau$  4.20 (*J* 1.5 Hz), exhibiting coupling to the benzyl methylene protons at  $\tau$  6.83 (*J* 1.5 Hz), and a singlet for the methyl groups attached to the aromatic ring at  $\tau$  7.87, the ratio of these signals being 1 : 1 : 2 : 3.

The most direct way of introducing the remaining side chain appeared to be addition of a formic acid unit (or a derivative) across the double bond; this was effected by transition metal catalysis. Fell and Tetteroo<sup>3</sup> have

<sup>1</sup> T.-L. Ho, *Chem. and Ind.*, 1971, 487.

<sup>2</sup> T.-L. Ho, *Canad. J. Chem.*, 1972, **50**, 1098.

<sup>3</sup> B. Fell and J. M. J. Tetteroo, *Angew. Chem. Internat. Edn.*, 1965, **4**, 790.