cm^{-1} (=CH). HRMS: M^+ 428.6654 ($C_{29}H_{48}O_2$); EIMS. *m/z* (rel. int.) 428 $[C_{29}H_{48}O_2]^+$ (15), 413 $[C_{29}H_{48}O_2-Me]^+$ (23), 410 $[C_{29}H_{48}O_2-H_2O]^+$ (18), 287 $[C_{29}H_{48}O_2-C_{10}H_{21}$ (entire substituent at C-17)]$^+$ (32), 269 $[C_{29}H_{48}O_2-C_{10}H_{21}-H_2O]^+$ (25), 245 $[C_{29}H_{48}O_2-C_{10}H_{21}-42]^+$ (43), 227 $[C_{29}H_{48}O_2-C_{10}H_{21}-42-H_2O]^+$ (45), 152 $[C_{29}H_{48}O_2-C_{10}H_{21}-42-93]^+$ (100), ^{1}H NMR: ($CDCl_3$) δ5 780 (*d*, *J* = 1.8 Hz, 4-H), 4.450 (*oct.* $J_{7\alpha,6\beta}$ = 12.1 Hz, $J_{7\beta,6\beta}$ = 4.7 Hz, $J_{6\beta,4}$ = 1.8 Hz, 6β-H), 1 379 (*s*, 19-H_3), 0 905 (*d*, *J* = 6.3 Hz, 21-H_3), 0 847 (*t*, *J* = 7.3 Hz, 29-H_3), 0 827 (*d*, *J* = 6.7 Hz, 27-H_3), 0.803 (*d*, *J* = 6.7 Hz, 26-H), 0 760 (*s*, 18-H); ^{13}C NMR ($CDCl_3$) δ38.66 (C-1), 34.31 (C-2), 200.30 (C-3), 126 59 (C-4), 168.43 (C-5), 73.36 (C-6), 37.17 (C-7), 45.93 (C-8), 53.72 (C-9), 38.08 (C-10), 21.04 (C-11), 39.68 (C-12), 42 59 (C-13), 56.79 (C-14), 24.32 (C-15), 28.22 (C-16), 56.16 (C-17), 11.92 (C-18), 19.84 (C-19), 36 28 (C-20), 18.78 (C-21), 33.99 (C-22), 26.43 (C-23), 46.11 (C-24), 29.01 (C-25), 19.09 (C-26), 19.59 (C-27), 23.16 (C-28), 12.30 (C-29).

Oxidation of procesterol. Procesterol (**1**) (20 mg) was dissolved in Me_2CO (40 ml) and treated with Jones reagent (6 ml). The reaction mixture with stirred at room temp. till the reaction was completed (TLC monitoring). Usual work-up and repeated crystallization from C_6H_6–HOAc (1:1) provided **1a**. (9 87 mg), mp. 98°; $[\alpha]_D$ + 72°, ($CDCl_3$, *c* 0.17), IR ν_{max} 1680 (C=O), 1605 (C=C), and 860 cm^{-1} (=CH); HRMS: M^+ 426.3511 ($C_{29}H_{46}O_2$); ^{1}H NMR ($CDCl_3$) δ6 098 (*s*, 4-H), 1.18 (*s*, 19-H_3), 0 906 (*d*, *J* = 6.3 Hz, 21-H_3), 0.847 (*t*, *J* = 7 3 Hz, 29-H_3), 0.827 (*d*, *J* = 6.7 Hz, 27-H_3), 0.804 (*d*, *J* = 6.7 Hz, 26-H_3), 0.771 (*s*, 18-H_3).

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FORMATION OF THE *ORTHO*-QUINONE MANSONONE C FROM 7-HYDROXYCADALENE ON SILICA GEL

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Key Word Index—*Mansonia altissima*, Sterculiaceae, *Ulmus americana*; Ulmaceae; mansonone C; *ortho*-quinone; 7-hydroxycadalene; oxidation, silica gel.

Abstract—The sesquiterpene β-naphthol, 7-hydroxycadalene, found *inter alia* in the heartwood of a number of *Ulmus* spp., undergoes oxidation on silica gel to mansonone C, one of several related sesquiterpene *ortho*-quinones produced in some *Ulmus* spp. in response to certain stresses. The reaction, which appears to involve oxygen adsorbed on the silica gel, proceeds under an argon atmosphere and is dramatically retarded in the absence of light.

INTRODUCTION

Mansonones, a group of related sesquiterpene *ortho*-quinones originally isolated from the West African tree *Mansonia altissima* Chev. [1–4], were observed to accumulate in the sapwood of *Ulmus americana* and other elm species in response to infection by *Ceratocystis ulmi*, or other stresses [5–8]. Some of these compounds, including mansonone C, **1**, as well as possible biosynthetic precursors such as 7-hydroxycadalene, **2**, occur constitutively in the heartwood of several *Ulmus* species [9–11].

Mansonones C and E (**3**) have been prepared synthetically [9, 12–14], the former independently in two

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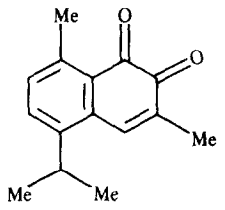

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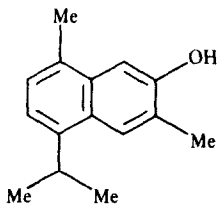

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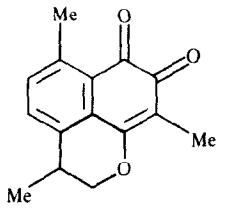

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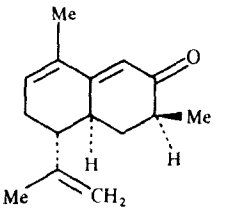

4

laboratories by oxidation of 7-hydroxycadalene, using Fremy's salt [9, 13]

RESULTS AND DISCUSSION

With the object of preparing synthetic mansonone C for a biological study by the Sutherland–Thomson route [15, 9] we have synthesized **4** from *R*(−)-carvone† according to the literature procedure [15] and dehydrogenated it to the naphthol **2**, 7-hydroxycadalene. Diverging from published procedures in which the product was purified by distillation [15, 16], we sought to purify **2** by column chromatography on silica gel (Kieselgel M, 100 mesh, Herrmann). The gradual development of an orange-coloured zone on the column during slow elution of the naphthol with chloroform suggested formation of oxidation product(s) under these conditions [17, 18]. Red-orange crystalline material, mp (from ether–hexane) 138–139° [ref. [1] 134–138 °] eluting in low yield (up to *ca* 3%) behind the naphthol **2**, was identified as mansonone C by comparison of its spectra with those of authentic material [7] and reported data [1].

Similarly, on preparative layer plates of silica gel (Merck, Kieselgel 60, GF 254), a band, $R_F \sim 0.44$ ($CHCl_3$), corresponding to the naphthol **2**, became yellow-orange after several hours, and orange-red after prolonged standing. On subsequent further elution with chloroform, mansonone C separated from the naphthol as a minor product with lower R_F, and several additional minor bands were also evident

Other 2-naphthols have recently been observed to undergo autoxidation on silica gel [18]. Thus, 2-naphthol itself affords a condensation product resulting from initial oxidation to 1,2-naphthoquinone, followed by conjugate addition of a molecule of the parent 2-naphthol and further oxidation An analogous product is formed from 7-methoxy-2-naphthol [18]. In these transformations, the quinone is considered to be derived by autoxidation of the naphthoxide anion via the naphtoxy radical and the corresponding hydroperoxide [18]. Autoxidation of 2,7-dihydroxycadalene on silica gel, which presumably involves the same kinds of intermediates, affords the 1-hydroxy-1-methyl-2-naphthalenone, lacinilene C [19].

A series of experiments was conducted in an effort to optimize formation of mansonone C (**1**) on a preparative scale from 7-hydroxycadalene (**2**) adsorbed on silica gel. The procedure effecting the best conversion of **2** to **1** in these experiments is described below (see Experimental). The yield thus obtained, 35% (45% based on unrecovered 7-hydroxycadalene) is comparable to that realized by oxidation of **2** with Fremy's salt [9]. It is noteworthy that the reaction proceeded readily under an argon atmosphere containing little oxygen, and evidently involves oxygen adsorbed on the silica gel Furthermore, the transformation was dramatically retarded in the absence of light (see Experimental)

Isolation of the simple *ortho*-quinone, mansonone C, as the major oxidation product of the naphthol **2** is probably a consequence of the suppression of further reactions by steric factors and concentration effects

EXPERIMENTAL

Silica gel (Kieselgel M, 100 mesh, Herrman, 15 0 g) in a 100 ml Pyrex round-bottom flask was warmed on a water bath at *ca* 80 ° under vacuum (0 2 Torr) with occasional agitation for 15 min. The flask was removed from the water bath, filled with O_2, and with periodic agitation the system was allowed to return to ambient temp

The flask was then opened and a solution of 7-hydroxycadalene (50 mg, 0 233 mmol) in $CHCl_3$ (35 ml) was added Solvent was removed from the resulting slurry on a rotary vacuum evaporator at *ca* 40° (a plug of glass wool was placed in the neck of the flask as a filter to prevent loss of material during bumping) The flask was subsequently connected to a vacuum pump (0 2 Torr) for 30 min, and then filled with Ar via a balloon reservoir and set aside with periodic agitation under continuous illumination (Sylvania 'Cool White' fluorescent lighting) for 10 days The orange-pink colour that developed on the silica gel increased in intensity during the first 5 or 6 days, after which it was difficult to detect further change by visual inspection Reaction products and unchanged **2** were removed from the silica gel by thorough washing with a mixture of $CHCl_3$ and MeOH (9 1) After removal of solvent *in vacuo*, chromatography of the residue on prep layer plates of silica gel with $CHCl_3$ as eluent, afforded unchanged **2** (11 mg) and mansonone C (19 mg; 35% or 45% based on consumed **2**) Other products, mostly less mobile on plc, were not identified

When 7-hydroxycadalene, adsorbed on silica gel, was set aside in a dark cupboard without exclusion of air for 12 days, the yield of mansonone C was less than 3% and some 90% of unchanged **2** was recovered

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† The product from (+)-carvone, depicted as **4** in ref [15], is the enantiomer of **4**

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LIGNANS FROM *JUNIPERUS THURIFERA*

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Key Word Index—*Juniperus thurifera*, Cupressaceae, deoxypicropodophyllotoxin; (-)*epi*-podorhizol; lignans.

Abstract—The isolation and identification of two new natural lignans, (-)*epi*-podorhizol and deoxypicropodophyllotoxin, and 12 known lignans from a hexane extract of *Juniperus thurifera* is described.

INTRODUCTION

Juniperus thurifera is a tree of variable size native to mountainous zones of the Mediterranean area with cold winters. It is sporadically distributed throughout the western Mediterranean and appears in three varieties: *africana* Maire (in Morocco and Algeria), *hispanica* Mill (Spain) and *gallica* Coiny (in France and Corsica). It belongs to the section *sabina* and in Spain it is known as 'Cedro de España', 'Sabina albar', 'Sabina turifera', and 'Sabina española'.

Crude extracts from leaves have been tested on neoplastic KB celules, showing an appreciable cytostatic activity. They also show a remarkable inhibition on tubulin polymerization (unpublished observations), which is in agreement with other data in the literature reporting these types of activities for some lignans [1, 2].

In the present work, we report the identification of lignans in the hexane extract from *Juniperus thurifera* var. *hispanica* Mill. In previous papers, we have described other components of the plant: phenylpropane derivatives [3], coumarins [4], monoterpenoids [5], sesquiterpenoids and diterpenoids [6], and some two-dimensional NMR studies carried out some lignans [7, 8] and coumarins [4].

RESULTS

Chromatographic separation of the cold insoluble part of the hexane extract afforded 14 lignans with varied structures: (−)-dihydrosesamin(**1**) [9], (−)sesamin (**2**) [10, 11], (−)-hinokinin (**3**) [12, 13], (−)-balactone (**4**) [14, 15], (−)-deoxypodorhizon (**5**) [16–18], nemerosin (**6**) [19, 20], podorhizol (**7**) [19, 20], (−)-*epi*-podorhizol (**8**), deoxypodophyllotoxin (**9**) [21, 22], β-peltatin-A-methylether (**10**) [23], podophyllotoxin (**11**) [21, 22], deoxypicropodophyllotoxin (**12**), picropodophyllotoxin