Tetrahedron. Vol. 29, pp. 2553 to 2559. Pergamon Press 1973. Printed in Great Britain

NEW DITERPENOIDS EXTRACTIVES OF *MAYTENUS DISPERMUS*

J. D. MARTÍN*
Department of Chemistry, University of Nottingham, Nottingham NG7 2RD

(*Received in the UK* 31 *October* 1972; *Accepted for publication* 27 *March* 1973)

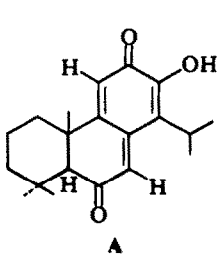
Abstract—The light petroleum extract of *Maytenus dispermus* has been shown to contain, in addition to pristimerin and maytenone, three new diterpenes: Maytenoquinone (1), 12-methoxytotarol (dispermol), and 12-hydroxy-7-oxototarol (dispermone), together with the known compounds: sugiol and β-sitosterol.

The yellow outer root-bark of the tree *Maytenus dispermus* is a source of the pigment pristimerin[1] and the bis-diterpene maytenone,[2] obtained by counter-current distribution of the light petroleum extract. In addition to these compounds we report here the isolation from the same source of a new triterpenoid pigment, dispermoquinone, and three new diterpenes maytenoquinone (1), dispermol (8, 12-methoxytotarol) and dispermone (12, 12-hydroxy-7-oxototarol). The known compounds, β-amyra-11-13(18)-diene-3-one, 7-oxoferruginol (sugiol), and β-sitosterol, were also isolated. The determination of the structure of the new diterpenes is described below, the structure of the new triterpene is described in the following paper.

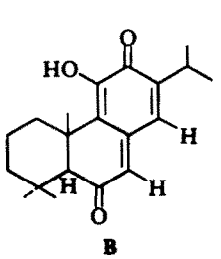
The yellow pigment maytenoquinone (1), which was dextrorotatory, had the molecular formula, $C_{20}H_{26}O_3$, as determined by analysis and mass spectrometry. In the up-field region, the PMR spectrum of the quinone (Table 1), showed two non-equivalent secondary Me group signals at τ 8·60 and 8·65 (J = 7 Hz) and one-proton septet centred at τ 6·90 (J = 7 Hz), which were indicative of an isopropyl group, whose presence was further supported by the loss of 43 mass units from the molecular ion, to give a prominent peak at *m/e* 271 in the mass spectrum.[5] Two singlets at τ 8·71 (6H) and 8·80 (3H) indicated three additional tertiary Me groups. There was also a broad envelope from τ 7·8 to 8·5 arising from six methylene protons. In all signals for 26 protons were found. The above data, together with the co-occurence of the pigment with maytenone and the other diterpenes previously mentioned led us to consider a tricyclic diterpene skeleton for maytenoquinone.

The quinone gave a brown insoluble ferric salt, afforded a highly coloured sodium salt, and formed a green complex when shaken with aqueous copper acetate. It absorbed one mole of hydrogen on catalytic hydrogenation, and the colourless product was converted back to maytenoquinone on standing exposed to air. These properties, together with the infrared spectrum which had bands at 3360 (H-bonded OH) and 1670 (quinonoid carbonyl) and 1620 cm^{-1} (H-bonded quinonoid CO) suggested that maytenoquinone might contain a hydroxybenzoquinone moiety.[6] However, the UV spectrum (λ_{max} 317 (ϵ 16,450), 324 (sh. ϵ 15,700) and 414 nm (ϵ 2140) was more consistent with a *p*-methylenequinone system such as that in taxodione.[7] The PMR spectrum supported this conclusion. In the low-field region three protons appeared, a one proton singlet at τ 2·74 (exchangeable with D_2O) attributable to an enolic OH group, and two one-proton doublets centred at τ 3·37 and 3·75 (J = 1·5 Hz), assigned to protons on the quinone methide system. The splitting (Table 1), due to long range coupling was an example of 5-bond interaction.[8] The one-proton singlet at τ 7·50 was assigned to a tertiary proton α to a CO group.

Only two structures are compatible with the postulated methylenequinone structure and the PMR spectrum of maytenoquinone. These are **A** and **B** below.



A



B

The catechol (2) obtained by catalytic hydrogenation of maytenoquinone gave a negative Gibb's test[9] which suggested that both positions *para* to the OH groups were substituted. Furthermore, compound 2 was found to couple with diazotised

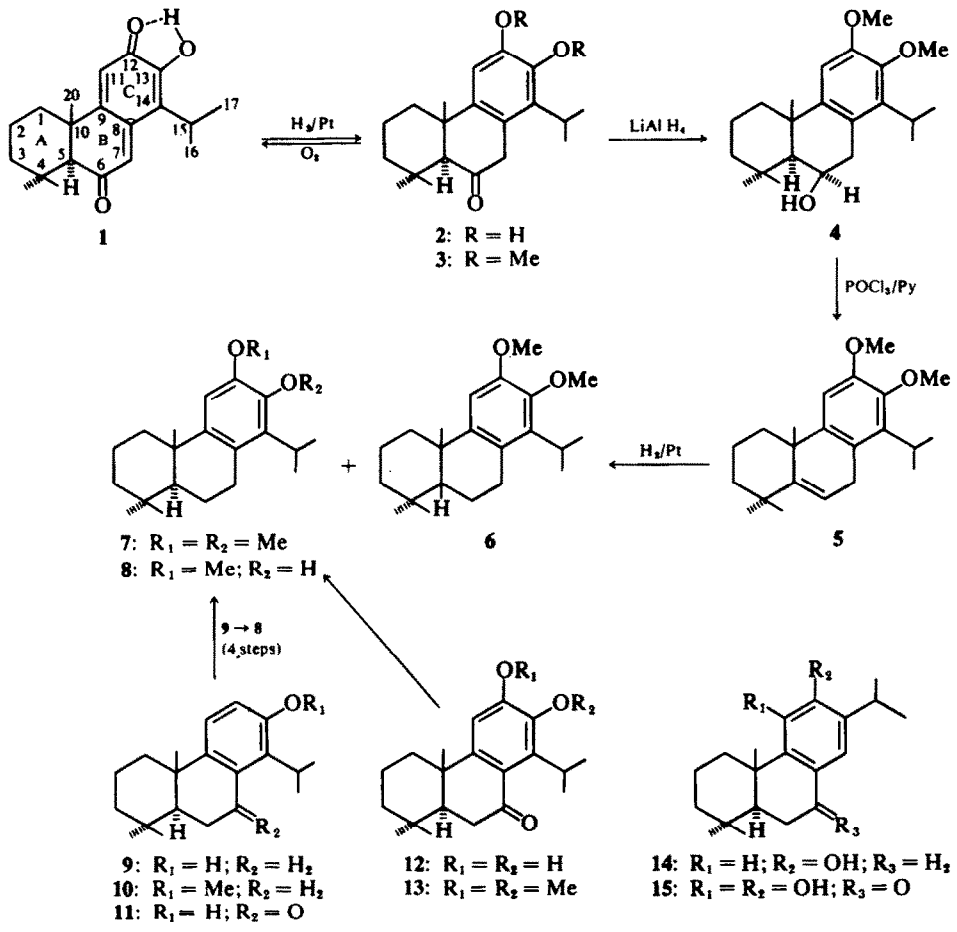
*Present address: Departamento de Química Orgánica, Universidad de La Laguna, Instituto de Investigaciones Químicas, C.S.I.C., Tenerife, Spain.

Table 1. PMR data for maytenoquinone, dispermol and related compounds

Comp.	Solv.	C-5 or C-6	C-7	C-10	C-11	C-15	C-12 & C-13 substituents	C—CH_3
1	$CDCl_3$	7·50 (1H, s)	3·37 (1H, d, J = 1·5 Hz) or 3·58 (1H, d, J = 1·5 Hz)	8·71 (3H, s)	3·58 (1H, d, J = 1·5 Hz) or 3·37 (1H, d, J = 1·5 Hz)	6·90 (1H, septet, J = 7 Hz)	2·74 (1H, s, C-13 OH)	8·60(3H, d, J = 7 Hz) 8·65(3H, d, J = 7 Hz) 8·71(3H, s) 8·80(3H, s)
2	CCl_4	7·57 (1H, s)	6·50 (2H, m)	8·70 (3H, s)	3·36 (1H, s)	7·00 (1H, septet, J = 7 Hz)		8·69(6H, d, J = 7 Hz) 8·95(6H, s)
3	CCl_4	7·64 (1H, s)	6·60 (2H, t)	8·71 (3H, s)	3·32 (1H, s)	7·00 (1H, septet, J = 7 Hz)	6·22 & 6·23 (6H, s, C-12, C-13 OCH_3)	8·72(6H, d, J = 7 Hz) 8·89(3H, s) 8·95(3H, s)
4	CCl_4	5·41 (1H, m, $W_{1/2}$ = 8 Hz)	7·15 (2H, m)	8·46 (3H, s)	3·38 (1H, s)	6·88 (1H, septet, J = 7 Hz)	6·25 (6H, s, C-12 C-13, OCH_3)	8·71(3H, d, J = 7 Hz) 8·74(3H, d, J = 7 Hz) 8·76(3H, s) 8·97(3H, s)
5	CCl_4	4·15 (1H, t, J = 4 Hz)	6·80 (2H, m)	8·76 (3H, s)	3·32 (1H, s)	6·80 (1H, septet, J = 7 Hz)	6·23 (6H, s, C-12 C-13 OCH_3)	8·68(3H, d, J = 7 Hz) 8·71(3H, d, J = 7 Hz) 8·78(3H, s) 8·84(3H, s)
7	CCl_4		7·28 (2H, m)	8·82 (3H, s)	3·41 (1H, s)	6·86 (1H, septet, J = 7 Hz)	6·28 (6H, s, C-12 C-13 OCH_3)	8·73(3H, d, J = 7 Hz) 8·75(3H, d, J = 7 Hz) 9·05(3H, s) 9·09(3H, s)
8	$CDCl_3$		7·20 (2H, m)	8·82 (3H, s)	3·22 (1H, s)	6·65 (1H, septet, J = 7 Hz)	6·23 (3H, s, C-12 OCH_3; 4·73 1H, s, C-13 OH)	8·67(6H, d, J = 7 Hz) 9·06(3H, s) 9·08(3H, s)
12	Acetone-d_6			8·92 (3H, s)	3·24 (1H, s)	6·10 (1H, septet, J = 7 Hz)	1·95 (1H, broad, $W_{1/2}$ = 23 Hz)	8·60(3H, d, J = 7 Hz) 8·69(3H, d, J = 7 Hz) 9·00(3H, s) 9·08(3H, s)
	$CDCl_3$* 1 drop DMSO-d_6		7·35–7·50 (2H, m)	8·92 (3H, s)	3·29 (1H, s)	6·15 (1H, septet, J = 7 Hz)		8·59(3H, d, J = 7 Hz) 8·69(3H, d, J = 7 Hz) 9·01(3H, s) 9·09(3H, s)
16	$CDCl_3$	7·60 (1H, s)	3·29 (1H, s) or 3·49 (1H, s)		3·49 (1H, s) or 3·29 (1H, s)	7·80 (1H, septet, J = 7 Hz)		8·95(3H, d, J = 7 Hz) 9·07(3H, d, J = 7 Hz) 8·70(3H, s) 8·78(3H, s) 8·86(3H, s)
17	CCl_4	6·95 (1H, s)	4·20 (1H, s) 7·98 (3H, s, C-6 $COC\underline{H}_3$		2·90 (1H, s)	6·95 (1H, septet, J = 7 Hz)	7·73 & 7·81 (6H, s, C-12 & C-13 $COC\underline{H}_3$	8·60, 8·63, 8·68, 8·73, 8·76, 8·79, (12H) 9·05 (3H, s)

p-nitroaniline to give an azo-dye, indicating that the sixth position in the catechol ring was unsubstituted. This aromatic proton could be correlated with the signal at τ 3·36 in the PMR spectrum of **2**. The catechol must therefore arise from structure **A** and the taxodione, structure **B**, is excluded since hydrogenation of this would give a catechol containing an aromatic proton *para* to a phenolic OH group. These results led to the tentative assignment of the structures **1** and **2** for maytenoquinone and the dihydro derivative respectively.

In order to confirm the implied maytenoquinone-totarol (**9**) relationship, the following experiments were carried out. Reductive methylation of **1** gave 6-oxo-12-methoxytotarol methyl ether (**3**) as an oil, which was converted to the crystalline alcohol (**4**) by LAH reduction. The configuration of the C-6 OH group in (**4**) was assigned as β axial from its PMR spectrum, which contained a methine signal at τ 5·41 ($W_{1/2}$ = 8 Hz) attributed to the α-equatorial C-6 proton. A tertiary Me signal at τ 8·46 was assigned to the C-10 methyl group, shifted down-

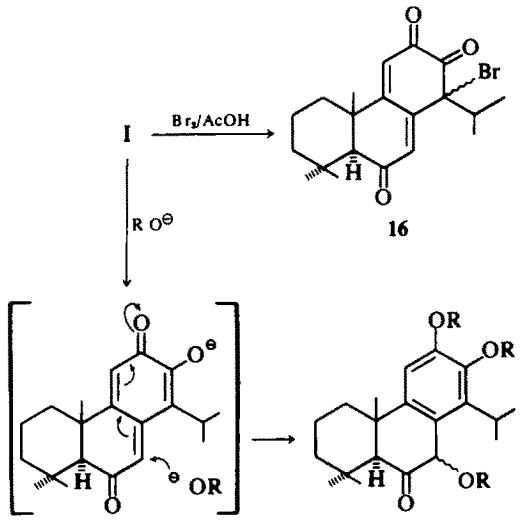


field by 0·25 ppm relative to the corresponding signal of (3).[10] Dehydration of 6-β-hydroxy methyl ether (4) proceeded readily with phosphorus oxychloride and pyridine to give the olefine (5), whose PMR spectrum showed a one-proton triplet at τ 4·15 (J = 4 Hz). This reaction sequence did not establish the stereochemistry at C-5 in maytenoquinone, but the easy dehydration of 4 to 5 supported the α-axial configuration assigned in 1 to the C-5 proton.[7] Catalytic hydrogenation of 5 gave an oil, homogeneous by TLC, but shown by GLC to be a mixture of two compounds, which were separated by preparative GLC. The component with the shorter retention time proved to have the *cis* A/B ring fusion from the fact that the 4α-Me signal appears at τ 9·58 due to a marked shielding by the benzene ring.[11] The other compound isolated should be 12-methoxytotarol methyl ether if maytenoquinone has structure 1. To confirm this, authentic 12-methoxytotarol methyl ether was synthesised.

Treatment of totarol (9) with sodium methoxide and then with *p*-nitrobenzenediazonium chloride yielded 12-*p*-nitrophenylazototarol. Sodium dithionite reduction of the azophenol, followed by diazotisation of the resultant air sensitive 12-aminototarol[12] gave a catechol which on methylation led to 12-methoxytotarol methyl ether (7) identical in all respects with the maytenoquinone degradation product.

Attempted acetylation of maytenoquinone leads to addition of acetic acid to the conjugated system and the formation of a tri-acetate (three acetate methyl peaks in the PMR) to which we assign structure 17. Bromination of the quinone under very mild conditions gave a pale yellow crystalline product (λ_{max} 284 (inf), 293 and 303 nm (sh) which was shown by elemental analysis and mass spectrometry to have the composition $C_{20}H_{25}O_3Br$. The IR spectrum showed bands at 1740 and 1670 cm^{-1} (CO). The PMR spectrum indicated the presence of olefinic protons at C-7 and C-8 but the signal due to the C-13 enolic OH proton in the precursor was absent. On this basis structure 16 is tentatively assigned to the bromo-derivative.

Elementary analysis and mass spectrometry established that the molecular formula of dispermone was $C_{20}H_{28}O_3$. The compound dissolved in dilute sodium hydroxide and gave a strong colour



reaction with alcoholic ferric chloride. Methylation of dispermone gave the dimethyl ether (13) as an oil, two OH groups were thus present. The IR spectrum of dispermone in $CHCl_3$, showed bands at 3300 (intermolecular H-bonded OH), 3560 (intramolecular H-bonded OH), and 3605 cm^{-1} (free OH). When measured at different concentrations, the intensity of the 3560 cm^{-1} remained constant but those of the 3300 and 3605 cm^{-1} bands were concentration dependent. These observations led to the consideration of an *o*-diphenolic system for dispermone.[13] The 1654 cm^{-1} band in the IR spectrum of dispermone was indicative of the presence of a conjugated CO group. The presence of a catechol-ketone moiety in dispermone was indicated also by its UV absorption which in neutral alcoholic solution showed maxima at 241, 285, and 325 nm. The spectrum in 0·1N NaOH/alcohol exhibited maxima at 258 and 353 nm.[14] The tricyclic diterpene skeleton in dispermone was deduced from the molecular formula and the PMR spectrum. In the up-field region the PMR spectrum (in acetone-d_6) showed two non-equivalent secondary Me group signals at τ 8·60 and 8·69 (J = 7 Hz) and a one-proton septet centred at τ 6·10 (J = 7 Hz) which were indicative of an isopropyl group attached to an aromatic ring. The three singlets (3H each) at τ 8·92, 9·01 and 9·08 showed three additional tertiary methyl groups. The signals at τ 7·35 and 7·50 (2H) were attributed to methylene protons α to a CO group. In the low-field region appeared a one-proton singlet at τ 3·24 assigned to the aromatic proton and a broad one-proton signal at τ 1·95 ($W_{1/2}$ = 23 Hz), which disappeared on shaking with D_2O, which was assigned to one of the phenolic hydrogens.

Two structures were compatible with the formula and spectral properties of dispermone, namely 12 and 15 which are related to totarol (9) and ferruginol (14) respectively. The striking downfield position of the isopropyl H signals, and the wide separation of the two secondary Me doublets (7 Hz) in the PMR spectrum of dispermone, indicated that the isopropyl group in this compound was strongly deshielded by the C-7 ketonic oxygen, and that steric requirements cause a preferred conformation where the Me substituents reside in different shielding zones of the benzene ring. These considerations suggested that dispermone was a 7-ketototarol (11) derivative.[15] Furthermore, dispermone gave a negative Gibb's test which precluded structure (15). The structure (12) was fully confirmed when catalytic hydrogenation of dispermone methyl ether afforded 12-methoxytotarol methyl ether (7), previously described.

The phenol dispermol (8), had the molecular formula $C_{21}H_{32}O_2$, as determined by analysis. The IR spectrum of dispermol showed the presence of an OH group and bands attributable to the presence of an aromatic system. The PMR spectrum showed the characteristic pattern for an isopropyl group and there were also signals corresponding to the presence of three further Me groups. A three proton singlet at τ 6·2 could be assigned to a OMe group on an aromatic ring. Two one-proton signals appeared in the low-field region, one at τ 4·73 was shown to disappear in the presence of D_2O and was assigned to a phenolic hydroxy hydrogen and a singlet at τ 3·31 was attributed to an aromatic proton. Methylation of dispermol gave a dimethoxy derivative identical in all respects with 12-methoxytotarol methyl ether (7) previously prepared from totarol. The free phenolic group in the natural product was assigned to position 13 because methylation of totarol (9) shifts the isopropyl signals in the PMR spectrum from the range τ 8·69–8·70 to the range τ 8·75–8·77 in 10. These signals appeared at τ 8·67 in dispermol and at τ 8·73–8·75 in dispermol methyl ether (7).

The known compound 7-oxo-ferruginol (sugiol) was identified by its physical properties and by those of the derived acetate and by direct comparison with a sample of the ketone prepared from ferruginol acetate.

EXPERIMENTAL

M.ps were determined on a Kofler block. UV and visible spectra were measured in EtOH soln with a Unicam S.P. 700 spectrophotometer, IR spectra were determined with a Unicam S.P. 200. PMR spectra were measured in $CDCl_3$ on a Perkin-Elmer R.S. 10 at 60 MHz or on a Varian H.A. 100 at 100 MHz with TMS as an internal reference. Mass spectra were measured with an A.E.I. M.S. 902. Light petroleum refers to the fraction of b.p. 60–80°.

Isolation of the extractives. The residue from the light petroleum extract of the outer root-bark of *Maytenus dispermus* (18 g) after the maytenone and the pristimerin had been removed, was chromatographed on silica gel

(2 Kg) using light petroleum as solvent and light petroleum-benzene followed by benzene and benzene-chloroform mixtures as eluents. The fractions were collected and analysed by TLC. Further elution with chloroform failed to give any further crystalline substances. The fractions collected are listed in Table 2.

Maytenoquinone. The crude solid obtained from the fraction B was purified by crystallisation from mixtures of light petroleum and dichloromethane, sublimation at 125°/10^{-3} mm, and finally by further crystallisation from MeOH to yield large orange needles of *maytenoquinone* (900 mg) m.p. 158–160°; $[\alpha]_D^{21}$ +298° ($CHCl_3$); λ_{max} 317 (ε 16,450), 324 (sh, ε 15,700), 414 nm (ε 2140); ν_{max} 3360, 1670, 1620, 1549, 1422, 1270, 1200, 1140, 995, and 980 cm^{-1}; mass spectrum *m/e* 314 (M^+), 299, 286, 281, 271, 245, 231 and 229. (Found: C, 76·3; H, 8·3; M^+, 314·191. $C_{20}H_{26}O_3$ requires: C, 76·4; H, 8·3%; M^+, 314·188).

12-*Hydroxy*-6-*oxo*-*totarol* (**2**). (A) A soln of maytenoquinone (50 mg) in AcOH (10 ml) was stirred while Zn dust (100 mg) was added portionwise during 15 min, when the soln became colourless. The Zn was filtered off and the filtrate was worked up in the normal way to yield a residue (42 mg) which crystallised from acetone/light petroleum to give colourless plates of the *phenol*, m.p. 135–138°; ν_{max} 3600, 3540, 3400, 1700, 1600, 940 and 880 cm^{-1}. Air oxidation gave a crystalline product, m.p. 157–8°, whose identity with maytenoquinone was confirmed by comparison of IR, m.p., mixed m.p. and TLC behaviour.

(B) A solution of maytenoquinone (50 mg) in MeOH (25 ml) was hydrogenated at room temp and atmospheric pressure over platinum oxide (5 mg) catalyst. After the consumption of H_2 had ceased the catalyst was filtered and the filtrate was evaporated to give a colourless crystalline residue (42 mg). Recrystallisation from acetone/light petroleum gave colourless plates (32 mg), m.p. 134–136°. The compound was identical in all respects with the product of zinc reduction of maytenoquinone.

6-*Oxo*-12-*methoxytotarol methyl ether* (**3**). A soln of 250 mg of maytenoquinone in MeOH (60 ml) was hydrogenated over Adams' catalyst until the soln was colourless. The mixture was left in the H_2 atmosphere at room temp and during a period of 50 hr a total of 20 ml of 30% NaOH aq and 15 ml of dimethyl sulphate was added to it in portions of 1 ml. The soln was shaken for 24 hr after the addition had been completed. The catalyst was filtered, 50 ml of water was added, and the mixture was concentrated under reduced pressure to remove most of the MeOH. The residue was extracted with benzene (100 ml), the extract was washed with water, dried, and passed through a column of silica gel (30 g). Elution of the column with benzene gave the *ether* as a colourless homogeneous (TLC) oil (115 mg) $[\alpha]_D$ +88 ($CHCl_3$); ν_{max} 1715, 1600, 1495, 1470 and 1040 cm^{-1}. (Found: C, 76·3; H, 9·25. $C_{22}H_{32}O_3$ requires: C, 76·7; H, 9·3%).

6-β-*Hydroxy*-12-*methoxytotarol methyl ether* (**4**). A soln of the 6-oxo ether above (810 mg) in dry ether (25 ml) was added dropwise during 15 min to a soln of LAH (500 mg) in dry ether (100 ml) at 0°. The mixture was stirred in an atmosphere of N_2 for 6 hr and then the excess of hydride was destroyed by treatment with EtOAc followed by MeOH. The mixture was then acidified with dil HCl and extracted with ether. Evaporation of the dried ($MgSO_4$) extract furnished a colourless oil (788 mg) which was dissolved in benzene and chromatographed on a silica gel (30 g) column. Benzene eluted 6-β-*hydroxy*-12-*methoxytotarol methyl ether* (**4**) which crystallised from MeOH as long colourless needles m.p. 129–130°; $[\alpha]_D$ +22°, ν_{max} 3460, 1586, 1070, 1030, 1020, 960 and 840 cm^{-1}. (Found: C, 76·65; H, 9·5. $C_{22}H_{30}O_3$ requires: C, 76·3; H, 9·8%).

5,6-*Dehydro*-12-*methoxytotarol methyl ether* (**5**). $POCl_3$ (0·50 mg) was added to a soln of the above alcohol in dry pyridine (6 ml) at 0°. The mixture was allowed to warm to room temp under N_2. After 6 hr the soln was poured into water and extracted with ether. The ethereal extract yielded an oil (80 mg) which was purified by filtration of its light petroleum soln through a column of silica gel (20 g) and elution with benzene-light petroleum mixtures followed by distillation to give (70 mg) of the *olefine* (**5**). (Found: C, 80·5; H, 9·6. $C_{22}H_{32}O_2$ requires: C, 80·5; H, 9·6%).

12-*Methoxytotarol methyl ether* (**7**). A soln of the above olefine (150 mg) in MeOH (20 ml) was hydrogenated in the presence of platinum oxide catalyst (10 mg) at room temp and pressure. The catalyst was filtered and the soln

Table 2.

Fraction	Wt. g.	Eluent	Compound	Formula	M.p.	α_D
A	0·10	Lt. pet.	β-amyra-11, 13(18)diene-3-one	$C_{30}H_{48}O$	239–41°	−56
B	1·10	Lt. pet./benzene 80/20	Maytenoquinone	$C_{20}H_{26}O_3$	158–160°	+298
C	2·00	Lt. pet./benzene 1/1	Maytenone	$C_{40}H_{60}O_3$	195–200°	
D	0·15	Lt. pet./benzene 1/1	Dispermol	$C_{21}H_{32}O_2$	164–166°	+37
E	1·50	benzene	Sugiol	$C_{20}H_{28}O_2$	289–291°	+25
F	0·20	benzene	Dispermoquinone	$C_{30}H_{40}O_5$	255–257°	−263
G	0·30	Ben/Chl (95/5)	β-Sitosterol	$C_{29}H_{50}O$	136–137°	−36
H	0·40	Ben/Chl	Dispermone	$C_{20}H_{28}O_3$	263–265°	−48

evaporated to give an oil which was distilled under reduced pressure. (Found: C, 80·0; H, 10·3. Calc. for $C_{22}H_{34}O_2$: C, 80·1; H, 9·8%). The oil was homogeneous by TLC but was separated into two components by GLC. The compound with the shorter retention time (6) was an oil (10 mg), ν_{max} 1582, 1480, 1460, 1456, 1300, 1245, 1228, 1070, 1010, 972 and 840 cm^{-1}, mass spectrum *m/e* 330 (M^+), 315 (base peak), 287, 281, 273, 245, 233, 219 and 203. The other compound was identified as 12-methoxytotarol methyl ether by IR, mass spectrum, TLC, and GLC comparison with an authentic sample obtained from totarol.

Acetylation of maytenoquinone. Maytenoquinone (30 mg) was allowed to react overnight in a soln of Ac_2O (2 ml) in pyridine (1 ml). The colourless soln was poured into water and the product isolated with ether and purified by elution from silica gel with chloroform, ν_{max} 1780, 1760, 1735, 1210, and 1190 cm^{-1}. PMR see Table 1.

Bromomaytenoquinone. 1 ml of a soln of Br_2 in AcOH (1 ml of Br_2 in 30 ml of acid) was added during 15 min to a soln of maytenoquinone (100 mg) in AcOH with stirring at 0°. The colour of the soln changed from orange to a light yellow. Isolation of the product in the usual way gave the *bromo derivative* (94 mg) which crystallised from light petroleum-dichloromethane as yellow plates, m.p. 129–130° (dec) ν_{max} 1740, 1670, and 1570 cm^{-1}. (Found: C, 61·3; H, 6·4. $C_{20}H_{25}O_3Br$ requires: C, 61·1; H, 6·4%).

12-p-*Nitrophenylazototarol.* A soln of totarol (4·0 g) and NaOMe (20 g) in 400 ml of MeOH was warmed on a steam bath for ½ hr and then cooled in an ice-bath. A soln of *p*-nitrophenyldiazonium chloride prepared by diazotisation of *p*-nitroaniline (1·6 g) was added slowly while stirring. The *azo derivative* was precipitated by water and was collected in ether. The product crystallised from 95% EtOH to give 1·2 g of needles m.p. 195–197°, λ_{max} 268 (inf. ϵ 5910), 368 (ϵ 25,200) and 439 nm (ϵ 9960). (Found: C, 71·6; H, 7·7; N, 9·8. $C_{26}H_{33}N_3O_3$ requires: C, 71·7; H, 7·6; N, 9·6%).

12-*Aminototarol.* A mixture of the above azo compound (800 mg) and 15 g of sodium dithionite in 250 ml of 95% EtOH was refluxed on a steam bath. After 2 hr the soln changed from red to pale yellow and was poured into water and extracted with ether. The *amine* was isolated with ether and crystallised from light petroleum as plates m.p. 165–167° (lit.[12], m.p. 166–167°).

12-*Methoxytotarol methyl ether* (7). The above amine (700 mg) in glacial AcOH (20 ml) containing 10% H_2SO_4 (5 ml) was treated at −5° with $NaNO_2$ aq (1 ml containing 350 mg of nitrite). After 1 hr at 0°, urea was added to destroy the excess of nitrite, and the soln was added gradually to refluxing 20% H_2SO_4 (90 ml) containing Na_2SO_4 (3 g). When the addition was complete the soln was cooled, diluted, and extracted with ether. The residue, after evaporation of the ether distilled at 150–160° (bath)/10^{-4} mm to give a red resin. This was dissolved in dry acetone (100 ml) and 1·0 ml of dimethyl sulphate was added. The mixture was boiled under reflux for 20 hr over anhyd K_2CO_3 (20 g). The filtered soln was then evaporated to give a colourless oily residue, which was purified by elution from silica gel with benzene and then crystallised from MeOH to give plates of 12-*methoxytotarol methyl ether* (7; 43 mg) m.p. 90–92°; $[\alpha]_D$ +33 ($CHCl_3$); ν_{max} 1582, 1470, 1460, 1420, 1300, 1250, 1230, 1070, 1010, 972, 855, 842 and 810 cm^{-1}; mass spectrum, *m/e* 330 (M^+; base peak), 315, 287, 273, 258, 245, 233, 219 and 203. (Found: C, 80·1; H, 10·2. $C_{22}H_{34}O_2$ requires: C, 80·0; H, 10·2%).

Dispermone (12). The fraction H (400 mg) was rechromatographed on silica gel column (30 g) packed in benzene. Elution with benzene-chloroform (1:1) gave a crystalline fraction (320 mg) which was recrystallised from light petroleum-dichloromethane as plates of *dispermone* (12; 250 mg) m.p. 263–265°; λ_{max} 241 (ϵ 12,350), 285 (ϵ 8,950) and 325 nm (ϵ 5,530); ν_{max} 3605, 3560, 3300, 1657, 1600, 1500, 1290, 1085, 1005, and 870 cm^{-1}; mass spectrum, 316 (M^+, base peak), 301, 299, 283, 273, 259, 245, 233, 231, 219, 213, 205, 191, 189, and 179. (Found: C, 75·8; H, 8·7, (M^+ 316·199). $C_{20}H_{28}O_3$ requires: C, 75·9; H, 8·9% (M^+ 316·209)).

Deoxydispermone dimethyl ether (7). A soln of 110 mg of dispermone and dimethyl sulphate (0·5 g) in dry acetone with K_2CO_3 (5 g) was refluxed for 16 hr. The carbonate was filtered off and the soln evaporated to give an oil whose PMR spectrum (Table 1) was compatible with its formulation as dispermone dimethyl ether. The oil (98 mg) without further purification, was dissolved in MeOH (20 ml) with perchloric acid (2 drops, 70%) and hydrogenated over platinum oxide (10 mg) at atm pressure. After two molar equivs of H_2 had been absorbed the reaction was complete (3 hr). The product was isolated by evaporation of the solvent and distillation of the remaining oil. The distillate solidified and then crystallised from MeOH to give *deoxydispermone dimethyl ether* (41 mg), m.p. 89–90°; α_D +35° ($CHCl_3$), whose identity with 7 was confirmed by comparison of IR, m.p., mixed m.p., and TLC behaviour.

Dispermol methyl ether (7). A soln of dispermol was methylated in acetone in the same way as was dispermone. The product, after crystallisation from MeOH had m.p. 90–91° and was identical with 12-methoxytotarol methyl ether.

7-*Oxoferruginol* (15, sugiol). The solid from fraction E (1·5 g) was crystallised from MeOH, sublimed at 210°/10^{-4} mm and crystallised again from MeOH as prisms m.p. 289–291°; $[\alpha]_D$ +25°; λ_{max} 233 (ϵ 14,390), 284 (ϵ 12,560) and 290 nm (sh, ϵ 12,430); ν_{max} 3300, 1640, 1600, 1585, 1570, 1310, 1270, 1085, and 870 cm^{-1}; mass spectrum, *m/e* 300 (M^+), 285 (base peak), 272, 258, 257, 243, 217, 215, 203, 201, 195, 187, 175, 173, and 163. (Found: C, 80·3; H, 9·0. Calc. for $C_{20}H_{28}O_2$: C, 79·9; H, 9·4%). (lit.[4] m.p. 292–294°; $[\alpha]_D$ +26° (EtOH); λ_{max} 232 (ϵ 15,500) and 284 nm (ϵ 13,200).

The acetate prepared by acetylation in pyridine in the usual way, had m.p. 164–165°; $[\alpha]_D$ +21° ($CHCl_3$) (lit. m.p. 165–167°). (Found: C, 77·3; H, 8·5. Calc for $C_{22}H_{30}O_3$: C, 77·2; H, 8·8%). The identity of this derivative was confirmed by direct comparison with a specimen prepared by oxidation of ferruginol acetate.

β-Sitosterol. The crystalline solid from fraction G was crystallised from MeOH, yielding β-sitosterol (0·15 g), m.p. 136–137°; $[\alpha]_D$ −36° ($CHCl_3$). Its acetate crystallised from methanol and had m.p. 129–130, $[\alpha]_D$ −38° ($CHCl_3$).

Acknowledgement—The author thanks Dr. T. J. King for helpful discussions. In am also indebted to Foundation "Juan March" (Spain) and the British Council for grants.

REFERENCES

[1]P. K. Grant and A. W. Johnson, *J. Chem. Soc.* 4079, 4669 (1957); P. K. Grant, A. W. Johnson, P. F. Juby, and T. J. King, *Ibid.* 549 (1960)

[2]A. W. Johnson, T. J. King, and R. J. Martin, *Ibid.* 4420 (1961)
[3]D. H. R. Barton, A. J. Head, and P. J. May, *Ibid.* 935 (1957)
[4]T. Sengupta, S. N. Choudhuri, and H. N. Khastgir, *Tetrahedron* **10**, 45 (1960)
[5]W. L. Parker, and F. Johnson, *J. Am. Chem. Soc.* **90**, 4716 (1968)
[6]B. W. Bycroft, and J. C. Roberts, *J. Org. Chem.* **28**, 1429 (1963)
[7]S. M. Kupchan, A. Karim, and C. Marcks, *Ibid.* **34**, 3915 (1969)
[8]G. J. Karabatsos, and F. M. Vane, *J. Am. Chem. Soc.* **85**, 3886 (1963)
[9]F. E. King, T. J. King and L. C. Manning, *J. Chem. Soc.* 563 (1957)
[10]R. L. Clarke, S. J. Daum, P. E. Shaw, and R. K. Kulling, *J. Am. Chem. Soc.* **88**, 5865 (1966)
[11]W. Nagata, T. Teresawa, and K. Tori, *Ibid.* **86**, 3746 (1964)