Long-chain Phenols. Part III.† Identification of the Components of a Novel Phenolic Fraction in *Anacardium occidentale* (Cashew Nut-shell Liquid) and Synthesis of the Saturated Member ‡

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A hitherto undetected phenolic fraction in *Anacardium occidentale* (in the nut-shell liquid and not in the edible kernel) has been shown spectroscopically and chromatographically to comprise the saturated phenol 2-methyl-5-pentadecylresorcinol, its 2-methyl-5-[(8*Z*)-pentadec-8-enyl], 2-methyl-5-[(8*Z*,11*Z*)-pentadeca-8,11-dienyl], and 2-methyl-5-[(8*Z*,11*Z*)-pentadeca-8,11,14-trienyl] analogues, and small amounts of C_{17} components. The unsaturated members are converted by hydrogenation of the side-chain into the saturated phenol, which has been synthesised. The 4-methyl analogue is absent and occurrence of the novel phenol is an instance of specific *C*-methylation. We report *C*-demethylation and isomer formation during the syntheses of the 2- and the 4-methyl saturated phenols.

DURING a comprehensive chromatographic examination [1] § of cashew nut-shell liquid (CNSL) from the widely occurring and industrially useful species *Anacardium occidentale*, two new compounds were noted, and we now report the characterisation of one of these. Originally investigated by Stadeler,[2] and by Ruhemann and Skinner,[3] the chemistry of CNSL was systematised by study [4] of its fully hydrogenated components, and the nature and composition of the unsaturated components

† Part I, ref. 1; Part II, ref. 8.

‡ Presented in part at the 6th IUPAC Symposium on the Chemistry of Natural Products, London, July 1968.

§ The separation was first described by L. J. Morris, in 'New Biochemical Separation,' ed. A. T. James and L. J. Morris, Van Nostrand, New York, 1964, p. 309. G. K. Murthy, M. A. Siva Samban, and J. S. Aggarwal, *J. Chromatog.*, 1968, **32**, 519, have noted the presence of the novel phenol in CNSL.

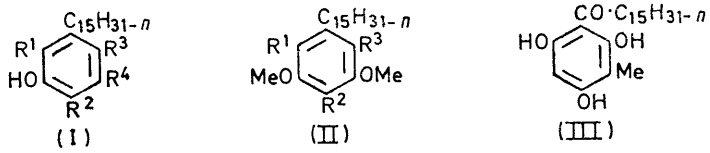
[1] J. H. P. Tyman and L. J. Morris, *J. Chromatog.*, 1967, **27**, 287.

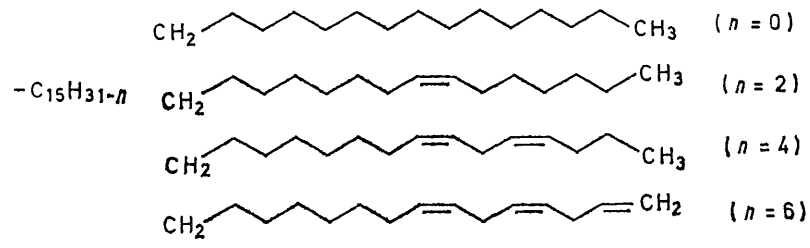
[2] Stadeler, *Annalen*, 1847, **63**, 137.

[3] S. Ruhemann and S. Skinner, *J. Chem. Soc.*, 1887, **51**, 663.

[4] H. J. Backer and N. H. Haack, *Rec. Trav. chim.*, 1941, **60**, 691, 677.

of cardanol (I; $R^1 = R^2 = R^3 = R^4 = H$; $n = 0,2,4,6$),[5] cardol (I; $R^1 = R^2 = R^3 = H$, $R^4 = OH$; $n = 0,2,4,6$),[6] and anacardic acid (I; $R^2 = R^3 = R^4 = H$; $R^1 = CO_2H$; $n = 0,2,4,6$)[7,8] were subsequently elucidated.





RESULTS AND DISCUSSION

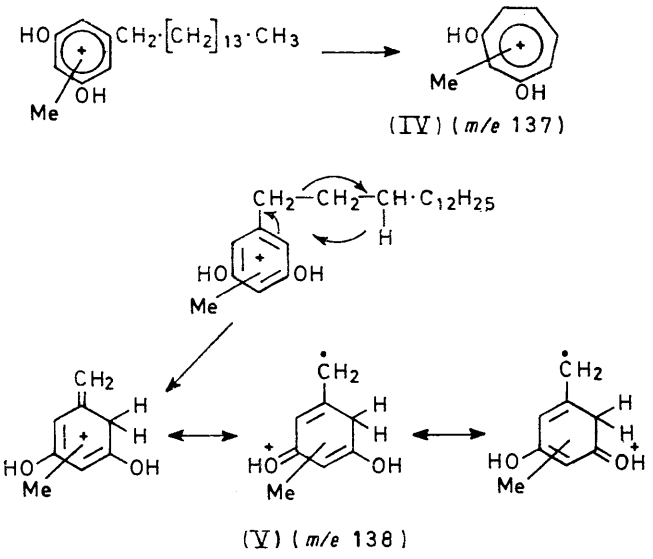
Structure of the Saturated Phenol.—The new substance (isolable only by combined alumina and silica gel column chromatography or by multiple development p.l.c.[8]) contained, like the other phenolic substances, saturated and mono-, di-, and tri-unsaturated components. It proved simpler, on account of autoxidation, to examine its nuclear structure after complete hydrogenation of the side-chain. Elemental analysis did not conclusively establish the empirical formula since the phenol, even after hydrogenation, was more unstable than the other components, became discoloured on exposure to the air, and gave a characteristic purple spot at the base line in t.l.c. experiments. Initially these properties had suggested a pyrocatechol structure distinct from the known 3-pentadecylpyrocatechol,[9] the terminal product of hydrogenation of urushiol from *Rhus toxicodendron*. The only alternative structure, 4-pentadecylpyrocatechol, was synthesised by a different route from that described,[9] but proved to be distinct from the saturated phenol.

The intensity of u.v. absorption was lower than required for a pyrocatechol, and lower than the values for 3-pentadecylphenol (saturated cardanol) and 5-pentadecylresorcinol (saturated cardol), and comparison with spectra of methyl-substituted dihydric phenols suggested a related structure. The ^1H n.m.r. spectrum, unlike that of the other saturated components, showed a CH_3Ar signal at τ 7·83, and signals due to two aromatic and two hydroxylic protons. The mass spectrum of the saturated phenol contained a base peak at *m/e* 138 ($C_8H_{10}O_2$) corresponding to loss of $C_{14}H_{28}$ from a C_{15} side-chain by β-cleavage, a peak at *m/e* 123 ($C_7H_7O_2$) resulting from loss of CH_3, and associated metastable peaks for both stages. The molecular ion peak at *m/e* 334 indicated a molecular formula $C_{22}H_{38}O_2$ ($C_7H_7O_2$–$C_{15}H_{31}$) and a smaller peak at *m/e* 362 the presence of about 11% of a C_{17} side-chain component. 5-Pentadecylresorcinol (saturated cardol) showed corresponding peaks at *m/e* 124, 320, and 348. The mass spectrum of the derived methyl ether exhibited a molecular ion peak at *m/e* 362, showing that the saturated novel phenol was dihydric. The former mass spectroscopic data on the saturated phenol are consistent with predominant β-cleavage of the side-chain and hydrogen transfer (RCH_3^+, *m/e* 138) rather than direct β-cleavage (RCH_2^+, *m/e* 137); the ratios of the peak heights of RCH_3^+ and RCH_2^+ were 3·4 and 5·0 for the saturated phenol and saturated cardol, respectively. Such behaviour is characteristic of long-chain phenols where the long chain is *meta* to one or more oxygen functions.[10,11] In conjunction with the positive mercuric nitrate test, the evidence indicates that the saturated phenol is best represented as a 5-substituted long-chain resorcinol containing a CMe group on the nucleus. The formation of RCH_2^+ (IV) and RCH_3^+ (V) is shown in Scheme 1.

The foregoing considerations, together with the absence of carbonyl absorption in the i.r. spectrum (of the substance prior to hydrogenation), the stability of the compound to lithium aluminium hydride, and the typical benzylic rather than keto-methylene absorption as well as the ratio of hydroxylic to aromatic protons in the n.m.r. spectrum precluded a ' phloroacetophenone ' structure (III) and indicated that the saturated phenol was derived from ' orsellinic acid '. Therefore it was thought to be either 4-methyl or 2-methyl-5-pentadecylresorcinol (I; $n = 0$; $R^1 = Me$, $R^2 = R^3 = H$, $R^4 = OH$) or (I; $n = 0$; $R^2 = Me$, $R^1 = R^3 = H$, $R^4 = OH$)]. Although the ArH signal was a singlet, the two aromatic protons might be expected to give different signals and the fact that they were indistinguishable in the usual solvents ($CDCl_3$ and CCl_4) justified the synthesis

[5] W. F. Symes and C. R. Dawson, *J. Amer. Chem. Soc.*, 1953, **75**, 4952.
[6] W. F. Symes and C. R. Dawson, *Nature*, 1953, **171**, 841.
[7] V. J. Paul and L. M. Yeddanapalli, *J. Amer. Chem. Soc.*, 1956, **78**, 5675.
[8] J. H. P. Tyman and N. Jacobs, *J. Chromatog.*, 1971, **54**, 83; A. A. Durrani and J. H. P. Tyman, *Chem. and Ind.*, 1972, 762.
[9] B. Loev and C. R. Dawson, *J. Amer. Chem. Soc.*, 1956, **78**, 4083.
[10] J. L. Occolowitz, *Analyt. Chem.*, 1964, **36**, 2177.
[11] J. D. Bu'lock and A. T. Hudson, *J. Chem. Soc.* (*C*), 1969, 61.

of both isomers. In view of the high m.p. (higher than that of saturated cardol by 14°), the symmetrical structure of the 2-Me compound appeared to be the more likely for the saturated phenol. The high R_F value, by

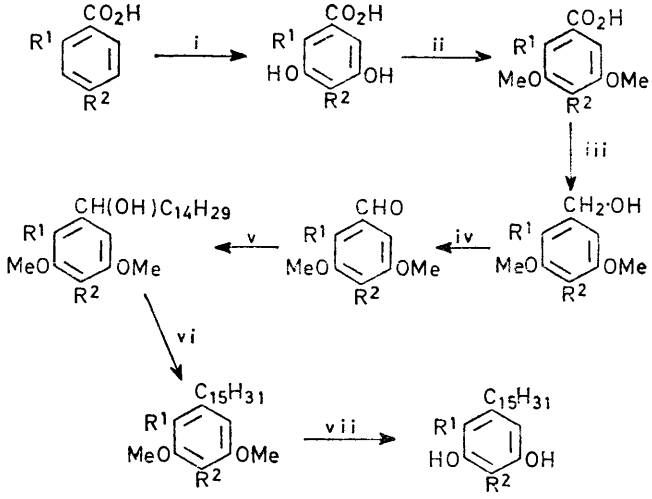


SCHEME 1

analogy with those found for a number of methyl-substituted phenols, suggested the influence of a methyl on two hydroxy-groups and was consistent with the 2-Me rather than the 4-Me isomer (*cf.* also the tocophenols [12]). Both the 4-Me and the 2-Me compounds were however required as part of a general programme of synthetic work [12] and were therefore prepared.,

Synthesis of 2-Methyl- and 4-Methyl-5-pentadecylresorcinol (Scheme 2).—The syntheses [13] were effected by the route shown in Scheme 2 (for the 2-Me compound $R^1 = H$, $R^2 = Me$; for the 4-Me compound $R^1 = Me$, $R^2 = H$).

Reduction of 3,5-dimethoxy-4-methylbenzoic acid with lithium aluminium hydride followed by oxidation of the product, 3,5-dimethoxy-4-methylbenzyl alcohol, with chromium trioxide in pyridine gave the aldehyde in a much higher yield than the direct reduction of 3,5-dimethoxy-4-methylbenzoyl chloride [14] with lithium tri-t-butoxyaluminium hydride. Interaction of 3,5-dimethoxy-4-methylbenzaldehyde with n-tetradecylmagnesium bromide gave 1-(3,5-dimethoxy-4-methylphenyl)pentadecan-1-ol which was hydrogenolysed under mild conditions over palladised charcoal to 1,3-dimethoxy-2-methyl-5-pentadecylbenzene (II; $n = 0$; $R^2 = Me$, $R^1 = R^3 = H$]. Use of a more active catalyst resulted in some demethoxylation and ring reduction. The interaction of 3,5-dimethoxy-4-methylbenzoyl chloride with n-tetradecylmagnesium bromide or di-(n-tetradecyl)cadmium was found to be unsatisfactory. Simultaneous reduction and demethylation of the carbinol with hydriodic acid–phosphorus was also unsatisfactory. In a similar way, 1,3-dimethoxy-4-methyl-5-pentadecylbenzene (II; $n = 0$, $R^1 = Me$, $R^2 = R^3 = H$) was obtained from 3,5-dimethoxy-2-methylbenzoic acid. The 2-methyl and not the 4-methyl compound was identical with the dimethyl ether of the saturated phenol in its m.p., and spectroscopic and chromatographic properties. Although in $CDCl_3$ the aromatic protons in both the compounds exhibited singlets, only those in the 4-Me compound became resolved in C_6D_6.[15] Demethylation of the 2-methyl and the 4-methyl compound with refluxing pyridine hydrochloride gave respectively 2-methyl-5-pentadecylresorcinol (I; $n = 0$, $R^1 = R^3 = H$, $R^2 = Me$, $R^4 = OH$), and 4-methyl-5-pentadecylresorcinol (I; $n = 0$, $R^2 = R^3 = H$, $R^1 = Me$, $R^4 = OH$). The former was identical with the saturated phenol from CNSL. Under more vigorous demethylation conditions (a larger excess of pyridine hydrochloride and a slightly longer reaction time in the case of the 2-methyl dimethyl ether) formation of the *C*-demethylated substance, 5-pentadecylresorcinol, and the isomeric 4-methyl-5-pentadecylresorcinol accompanied the expected product, 2-methyl-5-pentadecylresorcinol. The 4-methyl dimethyl ether likewise yielded the *C*-demethylated compound and 2-methyl-5-pentadecylresorcinol in addition



Reagents: i, H_2SO_4–SO_3, ^-OH; ii, Me_2SO_4, ^-OH; iii, $LiAlH_4$; iv, CrO_3–C_5H_5N; v, n-$C_{14}H_{29}MgBr$, H^+; vi, H_2,Pd–C, H^+; vii, C_5H_5N,HCl

SCHEME 2

to the main product.[16] Since 1,3-dimethoxy-5-pentadecylbenzene, 1,3-dimethoxy-5-nonadecylbenzene,[17] and 1-heneicosyl-3,5-dimethoxybenzene [17] apparently gave the resorcinols without formation of CMe derivatives it seems probable that isomer formation is an intermolecular process. Under unstated conditions believed to

[12] E. V. Truter, 'Thin Film Chromatography,' Cleaver–Hume, London, 1963, p. 113.
[13] J. H. P. Tyman, *Chem. Comm.*, 1967, 982.
[14] H. C. Brown and R. F. McFarlin, *J. Amer. Chem. Soc.*, 1958, **80**, 5372.
[15] R. G. Wilson, J. H. Bowie, and D. H. Williams, *Tetrahedron*, 1968, **24**, 1407.
[16] J. H. P. Tyman, *J.C.S. Chem. Comm.*, 1972, 714.
[17] E. Wenkert, E.-M. Loeser, S. N. Mahapatra, F. Schenker, and E. M. Wilson, *J. Org. Chem.*, 1964, **29**, 435.

be those of ref. 17 but not thought to have given rise to *C*-demethylated and isomeric substances, demethylation of 1-heptadecyl-3,5-dimethoxy-2,6-dimethylbenzene with pyridinehydrochloride gave a 97% yield of the corresponding resorcinol.[11] This product was compared with nor-β-leprosol [18] which had been obtained [18] by hydriodic acid demethylation of methyl-β-leprosol. The small difference in m.p. attributed [11] to the effect of *homologues* and alkenyl impurities in the two substances could however, equally be explained by isomer formation and *C*-demethylation under the known isomerising influence of hydriodic acid.[19-21]

Since 4-methyl-5-pentadecylresorcinol had an identical R_F value with 5-pentadecylresorcinol, it might not have been noticed in a chromatographic separation. Mass spectroscopic examination of saturated cardol isolated by p.l.c. from CNSL showed the complete absence of a peak at *m/e* 334.

The process by which the 2-methyl compound arises is evidently a specific one and possibly indicates the importance of a steric factor as well as nucleophilic reactivity in biological methylations. Attempts to effect *C*-methylation of 5-pentadecylresorcinol at the 2-position were unsuccessful and only traces of the required product were detected. Such methylations are favourably influenced when the hydroxy-groups are part of a 2,4-dihydroxy-carbonyl system [22] and, if *C*-methylation occurs after cyclisation of the polyketide precursor, a hitherto undetected 'orsellinic acid' (I; $n = 0$; $R^1 = R^2 = H$, $R^3 = CO_2H$, $R^4 = OH$) may well be involved in the biosynthetic sequence. Such a compound would undergo reduction of the 3-hydroxy-group to give saturated anacardic acid, decarboxylation to give saturated cardol, methylation and decarboxylation to yield the saturated novel phenol, and reduction of the 3-hydroxy-group and decarboxylation to yield cardanol.

Structure of the Unsaturated Components of the Novel Phenol.—Argentation t.l.c.[13] had indicated that, like the other components of CNSL, monoene, diene, and triene together with a minor proportion of the saturated component were present in the novel phenolic fraction: ^1H n.m.r. spectroscopic examination may be used quantitatively to determine their proportions.[8,23] Apart from olefinic protons in the region τ 4·6—4·8 (coupling constant indicating a *cis* configuration), methylene absorptions [(=CH_2) 4·95—5·2, (–CH_2–CH=CH–) 8·0—8·1, and (–CH=CH–CH_2–CH=CH) 7·20—7·35] show the presence of the expected methylene-interrupted double bond system characteristic of the olefinic components of the CNSL phenols. The i.r. spectrum showed a terminal vinyl group ($\nu_{max.}$ 900 cm^{-1}), and the integration of the absorption peaks shows that the methylene groups between two double bonds occur at the 10′- and 13′-positions in the triene, and at the 10′-position in the diene. From the degradative evidence on the phenols [5,7] and by analogy with unsaturated fatty acids there can be little doubt that the monoene component has 8′-mono-unsaturation. Thus the components are regarded as (8*Z*,11*Z*,14)-$C_{15}H_{25}$-tri-unsaturated, (8*Z*,11*Z*)-$C_{15}H_{27}$-di-unsaturated, and (8*Z*)-$C_{15}H_{29}$-mono-unsaturated.

C-Methyl isomers often occur together with the *O*-methyl compounds and the specific occurrence of the 2-methyl compound in the present case is comparatively rare. They have not been reported as accompanying the related C_{19} and C_{21} resorcinols present in wheat bran. The nearest related compounds appear to be the α- and β-leprosols,[18] which occur in *Mycobacterium leprae*. The latter consists of the monomethyl ether of 4,6-dimethyl-5-pentadecylresorcinol (I; $n = 0$; $R^1 = R^3 = Me$, $R^4 = OMe$, $R^2 = H$) and the corresponding heptadecylbenzene.[11] The pentadecyl compound has been prepared.[24] The function in all these compounds of the CMe group is obscure, although it is of interest that the presence of one or two such groups adjacent to the hydroxy-group as in the α-, β-, and γ-tocopherols confers activity whilst the δ-isomer lacking this feature is biologically inactive.

EXPERIMENTAL

U.v. absorption spectra were determined (for methanolic solution) with a Unicam SP 500 and an Optical 4G spectrophotometer and i.r. spectra with a Unicam SP 200 (for liquids as films and solids as KBr discs). ^1H N.m.r. spectra (with Me_4Si as standard) were determined with a Varian A60 machine through the courtesy of Mr. F. Ellis, Chelsea College of Science and Technology, on a Varian A100 machine by the P.C.M.U., Harwell (100 and 220 MHz), and on a T60 at Brunel University. Mass spectra were determined on A.E.I. MS9 instruments by Mr. F. Bloss, University of Sussex, and through the U.L.I.R.S., School of Pharmacy, University of London.

Column chromatography was carried out on Spence grade H alumina and on Davison Grade silicic acid. All solvents for column chromatography and t.l.c. were redistilled and the light petroleum had b.p. 40—60° unless otherwise stated. Kieselgel G (Merck) was used for t.l.c. Analytical plates [(0·25 mm), 8 × 10 cm] and preparative plates [(1 mm), 20 × 20 cm] were run in solvent A (light petroleum–ether, 70 : 30), solvent B (ethyl acetate–chloroform, 5 : 95), solvent C (chloroform–light petroleum, 30 : 70), and solvent D (light petroleum–ether–formic acid, 49 : 49 : 2). Preparative plates were developed with Rhodamine 6G and analytical plates by treatment with 50% aqueous sulphuric acid followed by charring. Analytical g.l.c. was carried out on a Perkin-Elmer F11 and a Pye 104 apparatus on acid-washed and silanised Celite (100—120) with 5% Carbowax 20M and with 3% Silicone SE30. Microanalyses were performed by Dr. Strauss (Oxford). Whole cashew nuts were obtained with the help of Mr. R. Rogan (British Coco Mills) were from Mozambique.

Chromatographic Separation of Cashew Nut-shell Liquid

[18] J. A. Crowder, F. H. Stodola, and R. J. Anderson, *J. Biol. Chem.*, 1936, **114**, 431.
[19] W. B. Whalley, *J. Chem. Soc.*, 1953, 3366.
[20] W. Baker, I. Dunstan, J. B. Harborne, W. D. Ollis, and R. Winter, *Chem. and Ind.*, 1953, 277.
[21] D. M. Donnelly, E. M. Philbin, and T. S. Wheeler, *Chem. and Ind.*, 1953, 163.
[22] S. K. Mukerjee and T. S. Seshadri, *Chem. and Ind.*, 1955, 271.
[23] J. H. P. Tyman and R. J. Edwards, unpublished data.
[24] J. H. P. Tyman and C. A. Barratt, unpublished data.

(*CNSL*).—Whole cashew nuts (204 g) were cooled in solid carbon dioxide and cracked, and the shells (usually in two pieces), after careful examination to separate the testa and kernel, were placed in ether (0·75 l) containing 4-methyl-2,6-di-t-butylphenol (0·1 g) and left at 0° for 3 days under nitrogen. The ether was decanted, and the shells were disintegrated in a ' Blender ', and re-extracted with ether (0·5 l). The combined filtered ethereal extracts were concentrated *in vacuo* at ambient temperature to constant weight, to give a dark brown concentrate (32·33 g) of CNSL. A third extraction of the spent shells gave a further 0·5 g. The spent shells (92·8 g) had thus originally contained 26·08% CNSL which was therefore present to the extent of 16·04% in the whole cashew nuts. For storage the extract was kept at −20° with only a small air space in a tightly-stoppered conical flask. T.l.c. (solvent A + 2% formic acid) indicated the following components (with decreasing R_F values) (1) a minor ingredient, (2) 4-methyl-2,6-di-t-butylphenol, (3) anacardic acid, (4) cardanol, (5) novel phenol, and (6) cardol.

Separation on alumina alone was unsatisfactory and it was necessary to use an alumina column followed by a subsidiary silica gel column.

CNSL (7·410 g) in light petroleum was added to an alumina column 5 × 10 cm (625 g) prepared by slurrying with ether. The fractions collected, solvents used, and weights and nature of fractions are summarised in Table 1.

TABLE 1

Column chromatographic separation of CNSL on alumina

Fraction	Solvent *	Volume (ml)	Component(s) weight (g)	Nature
1—10	E	250 × 10		Minor ingredient
11—15	E–M (95 : 5)	250 × 6	0·0855	Cardanol and novel phenol
16—18	E–M (95 : 10)	250 × 3	0·7763	Cardanol and novel phenol
19—22	E–M (95 : 10)	250 × 4	0·0189	Novel phenol and cardol
23—26	E–GA (95 : 5)	250 × 4	0·1288	Cardol
27	E–GA (95 : 5)	250	0·6894	Cardol
28, 29	E–GA (95 : 5)		1·6824	Cardol and some anacardic acid

* E = Ether, M = methanol, GA = Glacial acetic acid.

Separation of fractions (11—26) *on silica gel.* Fractions 11—26 (1·3291 g) in ether were added to silica gel (53·7 g) previously slurried in ether–light petroleum in a column (2·5 × 30 cm). Fractions were collected and every fifth fraction was monitored by t.l.c. The results are shown in Table 2.

Fractions 172—212 and 213—246 were separately evaporated and then dissolved and stored in light petroleum at −20° until required.

The novel phenol separated as a solid which redissolved at ambient temperature. The sample (with the exception of a small reference sample) was hydrogenated to obtain the saturated phenol as a characterisable solid. (Attempts to separate the hydrogenated CNSL were generally unsatisfactory.)

The novel phenol (0·075 g) in methanol (5 ml) was hydrogenated at atmospheric pressure and with 10% palladised charcoal (0·07 g). Trituration with and crystallisation from light petroleum (60—80°) gave off-white prisms, m.p. 98—100° with softening at 94°. Satisfactory analyses were not obtained unless the sample was dried *in vacuo* for 24 h [Found: (first analysis) C, 76·7; H, 10·7; (redrying) C, 79·05; H, 11·2. $C_{22}H_{38}O_2$ requires C, 79·05; H, 11·05]. For this reason, until the mass spectrum clearly indicated a molecular weight of 334, erroneous molecular formulae were derived from the early microanalyses. The saturated phenol showed a pronounced electrostatic effect when being transferred to a sample tube. Before hydrogenation, $\nu_{max.}$ (film) 3460 (OH), 2770, 2910 ($-CH_2-$), and 920 cm^{-1} ($=CH_2$).

TABLE 2

Column chromatographic separation of CNSL phenols on silica gel

Fraction	Solvent *	Weight (mg)	Component
1—71	E–P (2 : 98)	17·1	Minor carbonyl component
72—85	E–P (4 : 96)	1·2	
86—96	E–P (6 : 94)	33·5	(Traces) cardanol
97—158	E–P (6—10 : 94—90)	295·9	Cardanol
159—171	E–P (10 : 90)	14·4	Cardanol and novel phenol
172—212	E–P (10—12 : 90—88)	110·1	Novel phenol
213—246	E–P (12 : 88)	72·7	Novel phenol
247—298	E–P (12—14 : 88—86)	22·7	Novel phenol and cardol
298—441	E–P (14 : 86)	678·7	Cardol

* E = Ether, P = light petroleum.

Before hydrogenation (mixture of monoene, diene, and triene) at 100 MHz, τ (CCl_4) 3·95 (2H, s, ArH), 4·6—4·84 (5H, m, $-CH=CH-$), 4·94—5·12 (2H, m, $=CH_2$), 5·2—5·5br (2H, s, ArOH), 7·1—7·4 (4H, m, $=CH-CH_2-CH=$), 7·55—7·75 (2H, t, $ArCH_2-$), 7·9—8·1 (5H, s and m, $ArCH_3$ and $-CH_2-CH=$), 8·4—8·9 (20H, s, $[CH_2]_n$), and 9·05—9·2 (3H, t and m, CH_3). In the 220 MHz spectrum (CCl_4) the above peaks were confirmed, and much improved integration was obtained.

After hydrogenation (the saturated phenol), τ [$(CD_3)_2CO$] 2·25 and 6·93 (2H, s, ArOH), 3·73 (2H, s, ArH), 7·43—7·7 (2H, t, $ArCH_2$), 7·93 (s, $ArCH_3$), and 8·67 [26H, s, $(CH_2)_n$] (the absorption for $ArCH_3$ coincided with the solvent CH_3CO peak); τ (C_6D_6) 2·8 (2H, s, ArOH), 3·85 (2H, s, ArH), 7·4—7·61 (2H, t, $ArCH_2$), 7·81 (3H, s, $ArCH_3$), and 8·66 (26H, s, $[CH_2]_n$); τ [$(CD_3)_2SO$] 1·2br (2H, s, ArOH), 3·80 (2H, s, ArH), 8·1 (3H, s, $ArCH_3$), and 8·75 (26H, s, $[CH_2]_{13}$) (the $ArCH_2$ peak coincided with the solvent CH_3SO peak); τ ($CDCl_3$) 3·83 (2H, s, ArH), 5·33br (2H, s, ArOH, exchangeable with D_2O), 7·4—7·66 (2H, t, $ArCH_2$), 7·9 (3H, s, $ArCH_3$), 8·75 (26H, s, $[CH_2]_{13}$), and 9·0—9·1 (3H, t, CH_3).

Dimethyl ether. The saturated phenol (0·167 g) was refluxed (40 h) in acetone (10 ml) containing dimethyl sulphate (0·78 ml) and potassium carbonate (4·5 g). After work-up, crystallisation (light petroleum) gave white *needles*, m.p. 37—38° (Found: C, 79·55; H, 11·6. $C_{28}H_{46}O_4$ requires C, 79·55; H, 11·6%), τ (CCl_4) 3·8 (2H, s, ArH), 6·23 (6H, s, $ArO\cdot CH_3$), 8·03 (3H, s, $ArCH_3$), 7·33—7·63 (2H, t, $ArCH_2$), and 8·76 (26H, s, $[CH_2]_{13}$).

Diacetate. The saturated phenol (0·0540 g) in pyridine (1 ml) with acetic anhydride (0·5 ml) was warmed on a steam-bath (18 h). After acidification with cold dilute hydrochloric acid, ethereal extraction and crystallisation

(light petroleum) at −20° gave pale buff *needles*, m.p. 60—62° (Found: C, 74·65; H, 10·05. $C_{26}H_{42}O_4$ requires C, 74·6; H, 10·05%), τ (CCl_4) 3·33 (2H, s, ArH), 7·3—7·6 (2H, t, $ArCH_2$), 7·8 (6H, s, 2OAc), 8·1 (3H, s, $ArCH_3$), and 8·75 (26H, s, $[CH_2]_{13}$).

Synthesis of 2-Methyl-5-pentadecylresorcinol.—*3,5-Dimethoxy-4-methylbenzoic acid.* The sulphonation of *p*-toluic acid and succeeding operations were found to proceed differently from the original description [25] and are therefore described. *p*-Toluic acid (14·0 g) and oleum (24% SO_3; 90 ml) were heated at 170—180° (10 h), cooled, and added to water, and the barium salt was isolated in three crops, 26·5, 8·2, and 6·2 g. The first two, from equivalent determinations (Amberlite 120; H^+) were barium 4-methyl-3,5-disulphobenzoate and the first was converted into the potassium salt, which was dried, pulverised, mixed with sodium hydroxide (125 g), and heated at 250—270° in a stainless steel vessel (0·5 h). The product was isolated in the usual way and the acidified filtrate continuously extracted with ether. From t.l.c. with resorcinol, 2-methylresorcinol, 3,5-dihydroxybenzoic acid (all present in the mixture), the proportion of 3,5-dihydroxy-4-methylbenzoic acid could be estimated (yield 0·9 g). The mercuric nitrate test was positive. P.l.c. purification with light petroleum–ether–formic acid (49 : 49 : 2) gave four bands (in descending order), 2-methylresorcinol, 3,5-dihydroxy-4-methylbenzoic acid as a white solid (eluted with methanol), m.p. 240° (lit.,[25] 262°), resorcinol, and 3,5-dihydroxybenzoic acid.

3,5-Dihydroxy-4-methylbenzoic acid was methylated (alternate additions of 12% sodium hydroxide solution and dimethyl sulphate), and hydrolysed to remove methyl ester. Crystallisation (benzene) of the isolated product gave off-white prisms (0·46 g), m.p. 205—206° (lit.,[25] 208°) (a second crop gave 0·14 g), R_F (solvent D) 0·60, τ [$(CD_3)_2SO$] 7·96 (3H, s, $ArCH_3$), 6·19 (6H, s, OMe), and 2·83 (2H, s, ArH).

3,5-Dimethoxy-4-methylbenzyl Alcohol.—3,5-Dimethoxy-4-methylbenzoic acid (0·298 g), dried azeotropically with benzene, was dissolved in dry tetrahydrofuran (5 ml) and added dropwise (1·5 h) with stirring to lithium aluminium hydride (0·158 g) suspended in tetrahydrofuran (1·5 ml). The mixture was refluxed (2·25 h) and after being worked up with ethyl acetate, acidification, and final alkali washing of the ethereal extract, the *alcohol* was obtained as an oil (0·199 g), crystallising as blunt needles, m.p. 62—63° [from light petroleum (60—80°)], R_F 0·35 (solvent D), $\nu_{max.}$ (film) 3460 cm^{-1} (OH), τ (CCl_4) 3·63 (2H, s, ArH), 5·53 (2H, s, $ArCH_2{\cdot}O$), 6·24 (6H, s, 2OMe), 8·02 (3H, s, CH_3Ar), and 8·28 (1H, s, OH) (Found: C, 65·9; H, 7·45. $C_{10}H_{14}O_3$ requires C, 65·9; H, 7·6%).

3,5-Dimethoxy-4-methylbenzaldehyde. Control experiments with *p*-methylbenzyl alcohol showed that an $ArCH_3$ group was stable to CrO_3–pyridine. To 3,5-dimethoxy-4-methylbenzyl alcohol (0·19 g) in dry pyridine (2 ml) at 0°, chromium trioxide (0·90 g) suspended in cold dry pyridine (9 ml) was slowly added and the mixture was kept at 0° (16 h) then at 15° (2 h), by which time successive samples indicated (t.l.c.) substantially complete oxidation. The mixture was acidified and filtered, and the dried ethereal extract gave the *aldehyde* (0·148 g), which crystallised from light petroleum (60—80°) as white needles, m.p. 89—90°, R_F (solvent A + 1% formic acid) 0·67, τ (CCl_4) 0·2 (1H, s, CHO), 3·06 (2H, s, 2ArH), 6·12 (6H, s, $2OCH_3$), and 7·90 (3H, s, CH_3Ar) (Found: C, 66·6; H, 6·7. $C_{10}H_{12}O_3$ requires C, 66·6; H, 6·7%). The 2,4-dinitrophenylhydrazone gave dark crimson needles, m.p. 189—190°.

Attempts to reduce the acid chloride (from 3,5-dimethoxy-4-methylbenzoic acid with thionyl chloride) in bis-(2-methoxyethyl) ether solution with lithium tri-t-butoxyaluminium hydride at −70° [14] were found, despite the claim, to be non-specific and t.l.c. (solvent D + 1% formic acid) clearly showed the presence of 3,5-dimethoxy-4-methylbenzyl alcohol, the acid, and the required aldehyde; these were not easily separable. Manganese dioxide oxidation was also ineffective.

1-(3,5-Dimethoxy-4-methylphenyl)pentadecan-1-ol. It was essential to carry out all Grignard reactions in a nitrogen atmosphere by means of an evacuable apparatus to avoid the sequence $RMgBr \longrightarrow RO_2MgBr \longrightarrow RO_2H \longrightarrow ROH$ leading in the present case to n-tetradecanol, which possessed similar chromatographic properties to the product. The conditions were optimised by control experiments with 3,5-dimethoxybenzaldehyde.

Tetradecylmagnesium bromide was prepared from tetradecyl bromide (12·7 g) in ether (28 ml) added (2·5 h) to magnesium (1·140 g) covered by ether (3 ml) followed by refluxing (0·5 h). An aliquot portion (1 ml) of the mixture withdrawn with a nitrogen-filled syringe, was treated (0·5 h) with 3,5-dimethoxy-4-methylbenzaldehyde (0·1573 g) in ether (3 ml). A further portion (1 ml) was added and the mixture was refluxed (2·5 h). Work-up in the usual way, initially in the absence of air while excess of Grignard reagent was present, ethereal extraction of the acidified solution, drying, and evaporation, gave an oil (1·0579 g) purified by p.l.c. (solvent B). The crude material (1·0325 g) gave five bands (weight, R_F), (1) 3,5-dimethoxy-4-methylbenzyl alcohol, 0·172 g, 0·15, (2) n-tetradecanol, 0·5108 g, 0·35, (3) 1-(3,5-dimethoxy-4-methylphenyl)pentadecan-1-ol, 0·107 g, 0·45, (4) 3,5-dimethoxy-4-methylbenzaldehyde, 0·003 g, 0·60, and (5) C_{28} hydrocarbon and tetradecane, 0·1884 g, 0·8. A slightly less pure fraction of the required alcohol (0·1165 g) was collected just below band (3). Fraction (3) eluted with methanol, evaporated, extracted with ether, washed free of Rhodamine 6G, dried, and crystallised from light petroleum gave the *alcohol* as prisms, m.p. 58—59°, R_F (solvent C) 0·60 [slightly greater than for the 3,5-dimethoxyphenyl compound (the same relationship of the saturated phenol to saturated cardol)], $\nu_{max.}$ (film) 3460 cm^{-1} (OH), τ (CCl_4) 3·64 (2H, s, ArH), 5·55 (1H, m, $ArCH{\cdot}O$), 6·23 (6H, s, $2OCH_3$), 8·04—8·16 (4H, s, CH_3Ar and OH), 8·76 (26H, s, $[CH_2]_{13}$), and 9·13 (3H, t, CH_3) (Found: C, 75·8; H, 11·1. $C_{24}H_{42}O_3$ requires C, 76·1; H, 11·1%).

3,5-Dimethoxy-4-methylpentadecylbenzene. Ethyl acetate containing a trace of sulphuric acid [17] was found to be unsatisfactory (since the acetate of the preceding alcohol and the olefin were both formed) and ethanol was used instead. It was desirable to employ relatively inactive Pd–C; more active grades caused ring reduction (described under 4-Me compound). 1-(3,5-Dimethoxy-4-methylphenyl)pentadecan-1-ol (0·047 g) in ethanol (2 ml) (from 100 ml treated with 4 drops of concentrated H_2SO_4) containing 10% palladised charcoal (0·0368 g) was shaken under hydrogen (25 lb in^{-2} at 55 °C) overnight by which time the solution was colourless (t.l.c., solvent B, one spot). The mixture was filtered, the solid was washed with ether and the filtrate with water, and the dried ethereal solution was evaporated to give an oil (0·048 g) which was purified by p.l.c. (solvent B) to give substantially one band and a trace of the starting alcohol.

[25] Y. Asabina and J. Asano, *Ber.*, 1933, 687.

The eluted dimethyl ether was crystallised (−20°) from light petroleum to give 1,3-*dimethoxy-2-methyl-5-pentadecylbenzene* as white prisms, m.p. 36—37°, τ (CCl_4) 3·82 (2H, s, ArH), 6·25 (6H, s, OCH_3), 8·06 (3H, s, CH_3Ar), 8·96 (26H, s, $[CH_2]_{13}$), and 9·13 (3H, s, CH_3) (the ArH signal remained unresolved in C_6D_6) (Found: C, 79·2; H, 11·4. $C_{24}H_{42}O_2$ requires C, 79·5; H, 11·5). The m.p. and mixed m.p. with the dimethyl ether of the saturated phenol were identical; the R_F values, 0·61 (chloroform–light petroleum, 20 : 80) were also identical; the colour produced on concentrated H_2SO_4 charring was the same; and the i.r. spectra were identical, $\nu_{max.}$ (film) 2870, 2800, (CH_2 stretch), 1580, 1600 (C=C conj.), and 1135 cm^{-1} (C–O stretch).

2-Methyl-5-pentadecylresorcinol. 1,3-Dimethoxy-2-methyl-5-pentadecylbenzene (0·035 g) with pyridine hydrochloride (0·4909 g) was heated at 250—260° (6 h) in an apparatus previously evacuated, filled with nitrogen, and maintained under a slight pressure of nitrogen. The cooled product was treated with water and the ethereal extract was washed with dilute hydrochloric acid, dried, and evaporated to give a brown solid which was purified by p.l.c. (solvent A) to give three bands. The least polar was the required product *2-methyl-5-pentadecylresorcinol* (0·022 g) (from light petroleum–ether), m.p. 99—100°, identical (m.p. and mixed m.p.) with the saturated phenol derived from the natural product, τ ($CDCl_3$) 3·78 (2H, s, ArH), 5·33br (2H, s, ArOH, exchangeable with D_2O), 7·4—7·66 (2H, t, $ArCH_2$), 7·9 (3H, s, $ArCH_3$), 8·72 (26H, s, $[CH_2]_3$), and 9·05—9·2 (3H, t, CH_3), τ $[(CD_3)_2SO]$ 1·20br (2H, s, ArOH), 3·80 (2H, s, ArH), 8·09 (3H, s, $ArCH_3$), 8·76 (26H, s, $[CH_2]_3$), and 9·05—9·2 (3H, t, CH_3). Several crystallisations from light petroleum (60—80°) were necessary to obtain material satisfactory for microanalysis, and careful drying for 24 h *in vacuo* was necessary to remove traces of solvent. The crystals of dried product showed a pronounced ' electrostatic ' effect (Found: C, 79·05; H, 11·2. $C_{22}H_{38}O_2$ requires C, 79·05; H, 11·3%). The R_F values (0·54) of 2-methyl-5-pentadecylresorcinol and the saturated phenol were identical. The chromogenic effect upon H_2SO_4 charring was the same.

Synthesis of 4-Methyl-5-pentadecylresorcinol.—*3,5-Dimethoxy-2-methylbenzoic acid.* 3,5-Dihydroxy-2-methylbenzoic acid was prepared by a process similar to that for the 4-methyl compound rather than by the described procedure [26] in which no details were given. *o*-Toluic acid (28 g) and 24% oleum (180 ml) were carefully mixed, kept at ambient temperature (3 days), then heated at 160° (5 h). The cooled mixture was poured into ice–water and the isolated barium salt was converted into the potassium salt. The dried potassium salt (15·1 g) was fused with potassium hydroxide (50 g) at 270° (0·5 h), cooled, diluted with water, acidified, and continuously extracted with ether. The sticky solid obtained upon evaporation (almost pure by t.l.c.) was triturated with ethanol to remove a less polar impurity and crystallised (from water) to give brown prisms of the *acid*, m.p. 236° (lit.,[26] 245°) (Found: C, 57·5; H, 4·6. $C_8H_8O_4$ requires C, 57·1; H, 4·7%), τ $[(CD_3)_2SO]$ 0—1·5br (3H, s, 2OH, CO_2H, the latter exchangeable with D_2O), 3·3—3·35 and 3·48—3·53 (2H, 2d, ArH), and 7·77 (3H, s, $ArCH_3$).

3,5-Dihydroxy-2-methylbenzoic acid (1·1 g) in 12% aqueous sodium hydroxide was methylated with dimethyl sulphate (2 ml), alternative additions of reagents were made until methylation was complete, and the methyl ester was hydrolysed. The filtrate was acidified and the product isolated to give *3,5-dimethoxy-2-methylbenzoic acid* as white prisms (from benzene), m.p. 159—160°, R_F (solvent D) 0·5, τ $[(CD_3)_2SO]$ 7·68 (3H, s, $ArCH_3$), 6·17, 6·12 (6H, 2s, OCH_3), and 3·1—3·15, 3·28—3·33, and 1·5—2·5br (1H, s, CO_2H, exchangeable with D_2O) (Found: C, 61·3; H, 6·1. $C_{10}H_{12}O_4$ requires C, 61·2; H, 6·1%).

3,5-Dimethoxy-2-methylbenzyl alcohol. 3,5-Dimethoxy-2-methylbenzoic acid (0·429 g) in dry tetrahydrofuran (THF) (7·5 ml) was slowly added to stirred lithium aluminium hydride (0·2269 g) in THF (4 ml). The mixture was refluxed (3 h) and worked up to give an oil which gave the *alcohol* (from light petroleum) as prisms, m.p. 43—44°, $\nu_{max.}$ (KBr) 3400 cm^{-1} (OH), τ (CCl_4) 3·55—3·6, 3·73—3·78 (2H, 2d, ArH), 5·5 (2H, s, $PhCH_2$–O), 6·23—6·26 (6H, 2s, OCH_3), 7·97 (3H, s, $ArCH_3$), and 8·165 (1H, s, OH, exchangeable with D_2O) (Found: C, 65·9; H, 7·5. $C_{10}H_{14}O_3$ requires C, 65·9; H, 7·6%).

3,5-Dimethoxy-2-methylbenzaldehyde. 3,5-Dimethoxy-2-methylbenzyl alcohol (0·2336 g) in pyridine (2 ml) at 0° was added to chromium trioxide (1·0943 g) in pyridine (10 ml) kept at 0° (6 h), then the mixture was allowed to warm up to ambient temperature and worked up. Crystallisation (light petroleum) of the crude product (0·122 g) gave the *aldehyde* as clusters of needles, m.p. 65—66°, $\nu_{max.}$ (KBr) 1683 cm^{-1} (C=O), τ (CCl_4) −0·25 (1H, s, CHO), 3·16—3·19 and 3·46—3·49 (2H, 2d, ArH), 6·18 (6H, 2s, OCH_3), and 7·59 (3H, s, $ArCH_3$) (Found: C, 66·7; H, 6·6. $C_{10}H_{12}O_3$ requires C, 66·6; H, 6·7%). The 2,4-dinitrophenylhydrazone (crimson needles) had m.p. 194—195°.

1-(3,5-Dimethoxy-2-methylphenyl)pentadecan-1-ol. 3,5-Dimethoxy-2-methylbenzaldehyde (0·137 g) in ether (4 ml) was added under nitrogen to a 3 ml portion of ethereal n-tetradecylmagnesium bromide [prepared from n-tetradecyl bromide (6·497 g), and magnesium (0·5616 g) in ether (21 ml)]. After refluxing, the mixture (t.l.c. control) was worked up to give an oil (0·7468 g) which solidified to a waxy solid. Variations of solvent A, B, or C were not as effective as ethyl acetate-chloroform (10 : 90) for p.l.c. purification. The following bands were collected: (1) baseline, a trace of 3,5-dimethoxy-2-methylbenzyl alcohol, (2) n-tetradecanol (0·075 g), (3) 1-(3,5-dimethoxy-2-methylphenyl)pentadecan-1-ol (0·205 g), (4) 3,5-dimethoxy-2-methylbenzaldehyde, and (5) tetradecane and C_{28} hydrocarbon (0·314 g) (total recovered 0·642 g). Fraction (3) gave the *alcohol* (from light petroleum) as prisms, m.p. 59—60°, τ (CCl_4) 3·48—3·51 and 3·81—3·84 (2H, 2d, ArH), 5·2 (1H, m, ArCH–O), 6·46 and 6·48 (6H, 2s, OCH_3), 7·96 (1H, s, OH), 8·0 (3H, s, $ArCH_3$), 8·75 (26H, s, $[CH_2]_{13}$), and 9·13 (3H, t, CH_3) (Found: C, 75·6; H, 11·0. $C_{24}H_{42}O_3$ requires C, 76·1; H, 11·1%).

1,3-Dimethoxy-4-methyl-5-pentadecylbenzene. 1-(3,5-Dimethoxy-2-methylphenyl)pentadecan-1-ol (0·0467 g) and 10% Pd–C (0·040 g) in ethanol (2 ml; from 200 ml treated with 8 drops of concentrated H_2SO_4) was shaken at 50° and 25 lb in^{-2} (16 h). Work-up yielded an oil, which was purified by p.l.c. (solvent B) to yield the *dimethyl ether* (0·0433 g), crystallised from light petroleum at −20° as prisms, m.p. 39°, giving a mixed m.p. depression with the dimethyl ether of the saturated novel phenol, $\nu_{max.}$ (KBr) 3390 cm^{-1} (OH), τ (C_6D_6) 3·59 and 3·66 (2H, 1d, ArH), 6·56 and 6·66 (6H, 2s, OCH_3), 7·43 (2H, t, CH_2Ar), 7·76 (3H, s, CH_3Ar), 8·72 (26H, s, $[CH_2]_n$), and 9·12 (3H, t, CH_3), τ (CCl_4) 3·87 (2H, s, ArH), 6·27 and 6·31 (6H, s, OCH_3), 8·05 (3H, s, CH_3Ar), 8·76 (26H, s, $[CH_2]_n$), and 9·13

[26] O. Jacobsen, *Chem. Ber.*, 1960, 1883.

(3H, t, CH_3) (Found: C, 79·0; H, 11·6. $C_{24}H_{42}O_2$ requires C, 79·5; H, 11·5%), R_F (solvent C) 0·54, ($CHCl_3$–petroleum, 1 : 4) 0·48. Chromogenic behaviour (t.l.c.) with concentrated H_2SO_4 was different from that of the 2-Me compound. Upon drastic hydrogenolysis it was found that a product lacking ArH signals in the n.m.r. spectrum was formed as well as the expected product. After p.l.c., an oil was isolated whose mass spectrum indicated that demethoxylation and ring reduction had occurred.

4-Methyl-5-pentadecylresorcinol. 1,3-Dimethoxy-4-methyl-5-pentadecylbenzene (0·035 g) was heated with anhydrous pyridine hydrochloride (0·3652 g) under nitrogen at 250—260° (6 h), and worked up; the crude product was purified by p.l.c. (EtOAc–$CHCl_3$, 10 : 90) to give four bands, the second of which (from the baseline) was *4-methyl-5-pentadecylresorcinol* (0·0167 g). Crystallisation from light petroleum–ether gave off-white prisms, m.p. 71—72°, τ (CCl_4) 9·13 (3H, t, CH_3), 8·76 (26H, s, $[CH_2]_n$), 7·99 (3H, s, $ArCH_3$), 7·56 (2H, t, CH_2Ar), and 3·93 (2H, s, ArH), R_F (solvent B) 0·14 [almost identical with that of 5-pentadecylresorcinol, and lower than that of the 2-Me compound (0·49)].

Demethylation of 1,3-Dimethoxy-4-methyl- and 1,3-Dimethoxy-2-methyl-5-pentadecylbenzene Under Drastic Conditions. —The foregoing demethylations gave yields of 74% (2-methyl compound) and 51% (4-methyl compound). On repetition under more vigorous conditions in an attempt to speed up the reaction, *C*-demethylation and methyl group migration were observed.

1,3-Dimethoxy-2-methyl-5-pentadecylbenzene (0·0568 g) and pyridine hydrochloride (0·6172 g) were heated together at 270° (refluxing temp.) in an atmosphere of nitrogen (8·5 h); the mixture was worked up, and purified by p.l.c. Four bands were observed and identified by g.l.c.; (1) top band, a trace of the unchanged dimethyl ether, R_F 0·90 (solvent B), (2) a trace (possibly the monomethyl ether), (3) 2-methylresorcinol R_F 0·59, M^+, 334, and (4) 4-methyl-5-pentadecylresorcinol and 5-pentadecylresorcinol, identical R_F values 0·25, M^+, 320 and 334, respectively. The proportions (by g.l.c.) of the 2-Me, 4-Me, and *C*-demethylated compound, 5-pentadecylresorcinol, were 64, 5, and 31%. Mass spectrometry of fraction (4) indicated a rather larger proportion of the *C*-demethylated compound in relation to the 4-methyl compound. The n.m.r. spectrum of fraction (4) showed almost no $ArCH_3$ absorption.

1,3-Dimethoxy-4-methyl-5-pentadecylbenzene (0·0166 g) and pyridine hydrochloride (0·2392 g) were refluxed together in a nitrogen atmosphere (8·5 h) and the mixture was then worked up. Four bands were recovered and identified by g.l.c.: (1) top band, a trace of the unchanged dimethyl ether, R_F 0·95, (2) trace (possibly a monomethyl ether), (3) 2-methyl-5-pentadecylresorcinol (22%), R_F 0·63, and (4) 4-methyl-5-pentadecylresorcinol (34%) and 5-pentadecylresorcinol (21%) with identical R_F 0·25 (g.l.c. indicated that traces of *C*-dimethylphenols were present, *i.e.* 2,4-dimethyl-5-pentadecylresorcinol, and 4,6-dimethyl-5-pentadecylresorcinol).

1-(3,4-Dimethoxyphenyl)pentadecan-1-ol.—3,4-Dimethoxybenzaldehyde (6·2 g) in ether (40 ml) was treated with the Grignard reagent prepared from magnesium (1·2 g), n-tetradecyl bromide (12·7 g), and ether (30 ml). After work-up and p.l.c., the *alcohol* crystallised from light petroleum as prisms, m.p. 67—68°, τ (CCl_4) 9·13 (3H, t, CH_3), 8·76 (26H, s, $[CH_2]_n$), 7·97 (1H, s, OH, exchangeable with D_2O), 6·26 (6H, s, OCH_3), 5·60 (1H, t, ArCH–O), and 3·27—3·37 (3H, d, ArH) (Found: C, 76·0; H, 10·9. $C_{23}H_{40}O_3$ requires C, 75·8; H, 10·9%).

1,2-Dimethoxy-4-pentadecylbenzene.— 1-(3,4-Dimethoxyphenyl)pentadecan-1-ol (3·0 g) in ethyl acetate (50 ml), containing 10% palladised charcoal (0·5 g) was treated,with concentrated sulphuric acid (8 drops) and shaken at 37 lb in^{-2} (16 h). The crude product was purified by p.l.c. (solvent B), and the second band from the top gave the *dimethyl ether* as prisms (from light petroleum at −20°), m.p. 54—56°, τ (CCl_4) 9·11 (3H, t, CH_3), 8·73 (26H, s, $[CH_2]_{13}$), 7·51 (2H, t, CH_2Ar), 6·23 and 6·25 (6H, 2s, OCH_3), and 3·39—3·43 (3H, d, ArH) (Found: C, 79·3; H, 11·5. $C_{23}H_{40}O_3$ requires C, 79·3; H, 11·5%). The R_F of the dimethyl ether and the chromogenic behaviour with conc. H_2SO_4 were different from those of the dimethyl ether of the saturated novel phenol.

4-Pentadecylpyrocatechol.— 1,2-Dimethoxy-4-pentadecylbenzene (0·8 g) and pyridine hydrochloride (0·8 g) were warmed together at 200—220° (5 h). After t.l.c. had shown incomplete reaction, the mixture was heated further (5 h) at 230°. Worked up in the usual way, the product was puified by crystallisation from light petroleum (charcoal) and then recrystallised twice to give buff prisms, m.p. 91° (lit.,[9] 92—93°), τ (CCl_4) 9·1 (3H, t, CH_3), 8·74 (26H, s, $[CH_2]_{13}$), 7·56 (2H, t, CH_2Ar), 5·6—6·2br (2H, s, OH), and 3·4—3·6 (2H, m, ArH).

T.l.c. of Phenols.—The R_F values (solvent B) of reference and methyl-substituted phenols were as follows; pyrocatechol (0·27), 3-methylpyrocatechol (0·34), 4-methylpyrocatechol (0·26), resorcinol (0·12), 2-methylresorcinol (0·25), 4-methylresorcinol (0·13), 5-methylresorcinol (0·12), hydroquinone (0·095), 2-methylhydroquinone (0·11), trimethylhydroquinone (0·74), phloroglucinol (0), *m*-cresol (0·65), 3-pentadecylphenol (0·87), 2-methyl-5-pentadecylresorcinol (0·61), and 5-pentadecylresorcinol (0·17).

G.l.c. of Phenols and Methyl Ethers.—Run on 3% SE30 (220°; N_2 45 ml min^{-1}; 5 ft col.). Relative retention times of long-chain compounds: 3-pentadecylphenol (1·0), 5-pentadecylresorcinol (2·46), 2-methyl-5-pentadecylresorcinol (2·77) 4-methyl-5-pentadecylresorcinol (3·17), 1,3-dimethoxy-5-pentadecylbenzene (1·0), 1,3-dimethoxy-2-methyl-5-pentadecylbenzene (1·19), and 1,3-dimethoxy-4-methyl-5-pentadecylbenzene (1·31).

Relative retention times of *C*-methyl phenyl ethers (4% Carbowax 20M, 70—80 Chromosorb G); 1,3-dimethoxybenzene (7·0), 1,3-dimethoxy-5-methylbenzene (12·5), 1,3-dimethoxy-2-methylbenzene (9·59), 1,2-dimethoxy-3-methylbenzene (4·5), 1,2-dimethoxy-4-methylbenzene (10·85), 3-methylanisole (1·6), and 1,4-dimethoxy-2-methylbenzene (9·7) (100°).

Mass Spectra.—The following main peaks were observed (at 70 eV): 5-pentadecylresorcinol [natural: 18, 27, 29, 41, 43, 55, 57, 69, 123, 124 (base peak), 137, 166, 320 (molecular ion), and 348. Peak height (124/123) ratio 5·0], 2-methyl-5-pentadecylresorcinol [synthetic: 18, 28, 29, 41, 43, 55, 57, 69, 71, 123 (m* 109·6), 125, 137, 138 (m* 57·0) (base peak), 150, 179, 334 (molecular ion), 348 (trace), and 362; natural: 41, 43, 57, 69, 123 (*m** 109·6), 137, 138 (base peak) (*m** 57·0), 151, 180, 334, 362 (about 11% of molecular ion). Peak height (138/137) ratio 3·4], 4-methyl-5-pentadecylresorcinol [18, 28, 29, 41, 43, 55, 57, 71, 123 (*m** 109·6) 137, 138 (base peak) (*m** 57·0), 149, 151, 334 (molecular ion), and 362].

U.v. Absorption of Phenols.—The absorption maxima ($\lambda_{max.}$/nm, ε) were as follows: 2-methylresorcinol (273,

1215), 5-methylresorcinol (275, 1597), 3-methylpyrocatechol (276, 1826), 2-methylhydroquinone (292, 4308), *m*-cresol (274, 1567), 3-pentadecylphenol (274, 1887), 5-pentadecylresorcinol (276, 280, 1558, 1524), and 2-methyl-5-pentadecylresorcinol (274, 1165).

I.r. Spectra of Phenols and Phenyl Ethers.—$\nu_{max.}$ (KBr) 1,3-dimethoxy-5-pentadecylbenzene (synthetic and natural): 2875, 2800s (CH_2), 1585s (C=C), 1455s (C=C), 1424m, 1345m, 1285m, 1196s, 1145s (C–O–C), 1060 (1,3,5-trisubstitution, in-plane), 945w, 930w, 833m, and 685w; 1,3-dimethoxy-2-methyl-5-pentadecylbenzene (synthetic and natural): 2875, 2800s (CH_2), 1600, 1578s (C=C), 1500w, 1460, 1448s, 1412m, 1373w, 1340w, 1305w, 1233m, 1175w, 1136s (C–O–C), 1050w, 975w, 828m (1,2,3,5-tetrasubstitution, out-of-plane) and 720w; 1,3-dimethoxy-4-methyl-5-pentadecylbenzene: 2880, 2815s (CH_2), 1597, 1585s (C=C), 1490w, 1465s, 1420w, 1378w, 1340w, 1316w, 1276w, 1198s, 1145s, 1120w, 1057w, 955w, 834m, and 723w; 2-methyl-5-pentadecylresorcinol (synthetic and natural): 3400s, 2945, 2860s, 1636m, 1592s, 1475s, 1438s, 1390w, 1334m, 1172m, 1078s, 1008w, 946w, 856m, 728m, and 672w. This spectrum was similar to that of 5-pentadecylresorcinol (Sadtler spectrum 7365).

[3/052 *Received*, 10*th January*, 1973]