Synthetic Studies on Terpenoids. Part XV.[1] Syntheses of 8β-Methylpodocarpanes

By **Soumyendralal Mukherjee, Debabrata Mukherjee, Moheswar Sharma, Nilaj Kumar Basu** (in part), and **Phanindra Chandra Dutta,*** Department of Organic Chemistry, Indian Association for the Cultivation of Science, Jadavpur, Calcutta 32, India

Stereospecific syntheses of 3-acetoxy-8β,13α-dimethylpodocarpan-12-one (IX), the corresponding Δ^{13}-ketone (XI), and 3-acetoxy-8β-methylpodocarpa-5,9(11),13-trien-12-one (XII) are described.

SYNTHESIS of the pentacyclic triterpenes is complicated by the presence of a considerable number of asymmetric centres due to the remarkable array of methyl groups associated with these systems. The approach adopted by Stork [2] for the syntheses of α-onocerin is based on the coupling [3] of two identical units; this has obvious limitations when extended to suitably substituted pentacarbocyclic triterpenes. The desired pentacyclic system has however been constructed [4] from the dimeric tetracyclic product and ultimately β-amyrin [5] was obtained by Barton in a series of steps. Ireland has recently developed a new approach leading to the successful synthesis of alnusenone [6a,b] and germanicol.[6c]

As part of a study directed towards the stereospecific ring by ring synthesis of pentacyclic triterpenoids, we now describe the stereospecific synthesis of the tricyclic ketone (IX) and the corresponding unsaturated ketone (XI), representing rings A, B, and C of taraxerol (I), and of the ketone (XII) for entry into the amyrin systems.

The ketone (II) [7] was condensed with β-chloroethyl ethyl ketone in the presence of potassium t-butoxide; subsequent ring closure with sodium methoxide afforded the tricyclic system (III) in moderate yield. The assignment of a *cis*-relationship to the C-8 and C-10 methyl groups arises from steric considerations [8a] applied to a similar condensation of ethyl vinyl ketone and from n.m.r. data obtained through the courtesy of Prof. Y. Kitahara.[8b] The C-8 and C-10 methyl signals are very close (δ 1·3 and 1·35 p.p.m.), a situation which most probavly arises from almost equal anisotropy effects of the double bonds. The C-11 proton signal appears as a triplet centred at δ 5·5 p.p.m., possibly owing to a strained chair conformation of ring C necessitated by 1,3-diaxial interaction of the angular methyl groups. The stereoelectronically favoured axial alkylation [9] has evidently taken place with ring B of structure (II) in a boat conformation,[10] leading eventually to the product of apparent equatorial attack.[11] The minor product arising from axial alkylation in the chair form of the ring B will not be susceptible to subsequent ring closure, owing to the conformational rigidity [12] of the heavily substituted bicyclic system; hence this product will undergo a retro-Michael reaction with regeneration of the ketone (II). Recovery of a considerable quantity of the ketone (II) may be a consequence of such a reaction and also of the resistance to cyclisation of the intermediate diketone to (II) due to interaction of the 8- and 10-methyl groups. The tricyclic ketone (III) obtained was homogeneous on t.l.c. in several solvent systems.

Methylation [13] of the ketone (III) in the presence of potassium t-pentyloxide under carefully controlled conditions furnished the tetramethyl ketone (IV) in moderate yield.

In order to obtain the equatorial 3-hydroxy-group characteristic of triterpenoids, the doubly unsaturated ketone (IV) was reduced with sodium and ethanol; the crystalline alcohol (V) was acylated to afford the acetate (VI). On oxidation [14] with sodium dichromate in acetic acid, the acetoxy-diene afforded the unsaturated ketone (VII) in moderate yield. That oxidation did not take place at the alternative C-7 allylic position, evidently not favoured for steric reasons, was established through ready condensation of the product with ethyl formate to afford the corresponding formyl derivative (see later). Catalytic hydrogenation of the unsaturated ketone (VII) (uptake 3 mol. equiv.) followed by oxidation with chromic acid furnished the saturated ketone (VIII) in a good yield (see Experimental section for n.m.r.

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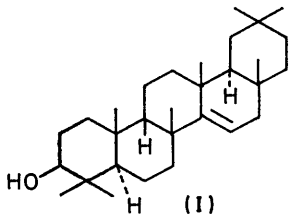
data). Owing to the presence of the three axial methyl groups, reduction is reasonably expected to take place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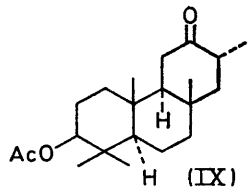
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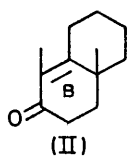
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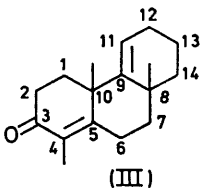
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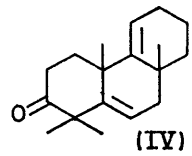
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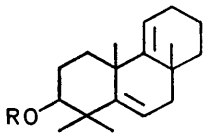
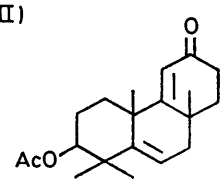
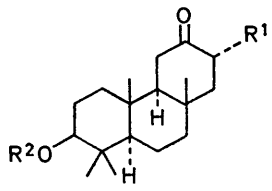
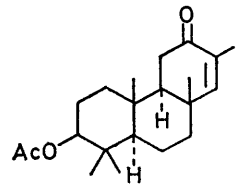
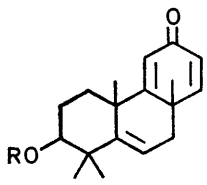
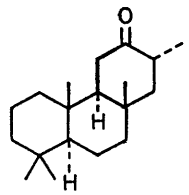

(V) R = H
(VI) R = Ac

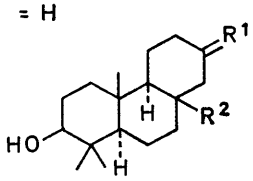

(VII)


(VIII) R^1 = H, R^2 = Ac
(IX) R^1 = Me, R^2 = Ac
(X) R^1 = Me, R^2 = H


(XI)


(XII) R = Ac
(XIII) R = H


(XIV)


(XV) R^1 = O, R^2 = CO_2Me
(XVI) R^1 = H_2, R^2 = CO_2Me
(XVII) R^1 = H_2, R^2 = CH_2·OH
(XVIII) R^1 = H_2, R^2 = Me

from the α-face, leading to the assigned stereochemistry (VIII). An analogous system [15] also leads to the desired *trans,anti*-perhydrophenanthrene system. Addition of hydrogen at C-5 will be highly stereospecific owing to the presence of the 3-acetoxy-group.[6a,16] The α-configuration at C-9 may reasonably be assigned for the same reason.[6c,17]

In order to prepare the pentamethyl acetoxy-ketone (IX), compound (VIII) was condensed with ethyl formate. The resulting formyl derivative was converted into the acetoxymethylene derivative, and the latter on catalytic hydrogenation [18] afforded the ketone[19] (IX). The same pentamethyl ketone could also be prepared from the acetoxymethylene derivative obtained from the formyl compound prepared from the doubly unsaturated ketone (VII), through catalytic reduction with palladium–charcoal in acetic acid and extensive chromatographic purification. The n.m.r. spectrum of compound (IX) showed in addition to a multiplet for the C-3 axial proton and 4β-methyl signal at 1·2 p.p.m. signals at δ 1·05 (d, *J* 7 Hz, 13-Me), 0·95 (s, 4α-, 8-, and 10-Me), and 2·1 p.p.m. (Ac).

In support of the structure and stereochemistry of compound (IX), it was converted into compound (XIV), identical with an authentic sample.[20] For this purpose, the 12-keto-group was protected through formation of the ethylene acetal. This was then subjected to alkaline hydrolysis to regenerate the 3-hydroxy-group. Oxidation with Sarett's reagent gave the 12-ethylenedioxy-3-one, which on Wolff–Kishner reduction and subsequent removal of the acetal function afforded compound (XIV). Alternatively, dehydration [21] of the hydroxy-ketone (X) with phosphoryl chloride and pyridine, followed by catalytic reduction, afforded the same ketone, in poor yield.

Only the n.m.r. spectra of compound (XIV) (in chloroform and in benzene) were available for comparison; the signals for the five methyl groups in both the compounds have exactly the same chemical shifts.

With a view to obtaining more rigorous evidence in favour of the foregoing stereochemical assignment, the keto-acetate (VIII) was converted into the alcohol (XVIII) through Wolff–Kishner reduction. An authentic sample of the latter was obtained as follows. The hydroxy-ketone (XV) [15] was subjected to Wolff–Kishner reduction to afford compound (XVI) after esterification with diazomethane. This was further reduced with lithium aluminium hydride to afford the diol (XVII). The primary hydroxy-group of the diol was converted [22] into the monotosylate, reduction of which with lithium aluminium hydride in tetrahydrofuran afforded a mixture of S–O and C–O cleavage products, (XVII) and (XVIII).

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[16] H. T. Cheung, *Tetrahedron Letters*, 1967, 2807.
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The former constitutes most of the material; its preponderance is due to the highly hindered nature of the sulphonyl derivative. The two samples of compound (XVIII) were identical (mixed m.p. and i.r. spectra).

The five asymmetric centres present in structure (IX) (excluding the C-13 centre, carrying the epimerisable secondary methyl group) have the same stereochemistry as found in rings A, B, and C of taraxerol. With a view to attachment of ring D, ring C of the ketone (IX) was further functionalised. The unsaturated ketone (XI) was prepared by bromination and dehydrobromination with lithium bromide–lithium carbonate in dimethylformamide. The position of the double bond was established on the basis of n.m.r. studies and of analogy with a related system.[23] The n.m.r. spectrum, in addition to the characteristic multiplet at $\delta_{\bullet}$ 4·5 (H-3*ax*) and singlet at 2·1 p.p.m. (Ac) showed signals at δ 1·4 (s, 4α- and 10-Me), 1·0 (s, 8-Me), 1·1 (s, 4β-Me), 1·75 (d, *J* 1·5 Hz, 13-Me), and 6·45 p.p.m. (d, *J* 1·5 Hz, 14-H).

For entry into the amyrin ring system, the unsaturated ketone (VII) was oxidised with selenium dioxide to afford an additional double bond. The product (XII) was hydrolysed under mild alkaline conditions to give the hydroxy-ketone (XIII), which exhibited characteristic i.r. carbonyl absorption and furnished a red 2,4-dinitrophenylhydrazone, indicating that no rearrangement had taken place.

EXPERIMENTAL

M.p.s were taken for samples in open capillary tubes in a sulphuric acid bath. U.v. spectra were recorded with a Beckman DU spectrophotometer for solutions in 95% ethanol. I.r. spectra were taken with a Perkin-Elmer model 21 instrument. N.m.r. spectra were measured for solutions in deuteriochloroform with a Varian A-60 spectrometer, with tetramethylsilane as internal standard. T.l.c. plates were coated (0·2 mm thickness) with silica gel G (200 mesh). Light petroleum refers to the fraction of b.p. 60–80°.

All products were crystalline; their purity was tested by t.l.c. and, in a few cases, by g.l.c.

8-Methyl-4-norpodocarpa-4,9(11)dien-3-one (III).—To a solution of potassium t-butoxide [from potassium (5·4 g)] in t-butyl alcohol (135 ml) at room temperature under nitrogen, 2,6-dimethylbicyclo[4,4,0]dec-1-en-3-one (II) (22·5 g) was added with shaking; the mixture turned deep red in colour. It was warmed at 70—80° for 1 h, cooled in an ice-bath, and treated slowly with β-chloroethyl ethyl ketone (20 g) with occasional shaking. The mixture was left overnight at room temperature and finally refluxed for 3 h under nitrogen. After the usual work-up, the crude product was thoroughly dried, a solution of sodium methoxide [from sodium (4·2 g)] in dry methanol (145 ml) was added, and the mixture was refluxed under nitrogen for 6 h. The solution was cooled, then made just acid with hydrochloric acid, and the methanol was removed. The residue was worked up and the product, on distillation, afforded a forerun of unchanged ketone (10 g); the product (III) (12 g) was collected as a thick liquid, b.p. 160—165° at 1·5 mmHg, which solidified when scratched. Crystallisation from methanol furnished the unsaturated *ketone* (III) (8·3 g), m.p. 83°, $\lambda_{max.}$ 250 nm (ε 12,590) (Found: C, 83·3; H, 10·0. $C_{17}H_{24}O$ requires C, 83·5; H, 9·9%); *2,4-dinitrophenylhydrazone*, m.p. 224° (from ethyl acetate) (Found: C, 65·1; H, 6·8; N, 13·1. $C_{23}H_{28}N_4O_4$ requires C, 65·1; H, 6·7; N, 13·2%).

8-Methylpodocarpa-5,9(11)-dien-3-one (IV).—To an ice-cold solution of dry potassium t-pentyloxide [from potassium (1·6 g)] in benzene (100 ml) the tricyclic ketone (III) (8·3 g) in benzene (20 ml) was added under nitrogen with occasional shaking. The mixture was warmed at 70—80° for 1 h, it was then cooled in an ice–bath, and after addition of methyl iodide (8 ml) was left overnight. Next day the mixture was refluxed for 2 h and the product was worked up to give the monomethylated *ketone* (IV) (5 g) as fine needles, m.p. 92—93° (from methanol) (Found: C, 83·6; H, 10·3. $C_{18}H_{26}O$ requires C, 83·6; H, 10·1%).

3-Acetoxy-8-methylpodocarpa-5,9(11)-diene (VI).—The ketone (IV) (5 g) in dry ethanol (70 ml) was added quickly to sodium (4·5 g). After 25 min the mixture was heated at the boiling point until all the sodium had dissolved. The cooled solution was diluted with water (*ca.* 450 ml), saturated with sodium chloride, and extracted repeatedly with ether. The extracts were washed with water, dried, and evaporated. The residue (4·8 g) yielded shining needles, m.p. 115—116° (Found: C, 82·8; H, 10·9. $C_{18}H_{28}O$ requires C, 83·0; H, 10·8%).

To the resulting alcohol (4·7 g) in cold pyridine (10 ml) a mixture of acetic anhydride (5 ml) and acetyl chloride (2 ml) was slowly added. The product was treated with ether (30 ml) and kept overnight at room temperature. The usual work-up gave the *acetate* (VI) (4 g), prisms, m.p. 110—111° (from methanol) (Found: C, 79·1; H, 10·2. $C_{20}H_{30}O_2$ requires C, 79·4; H, 10·0%).

3-Acetoxy-8-methylpodocarpa-5,9(11)-dien-12-one (VII).—A solution of the acetate (VI) (8 g) and sodium dichromate (9 g) in glacial acetic acid (120 ml) was stirred for 16 h at room temperature, then heated at 40° (bath temperature) with stirring for 3 h. Ethanol (8 ml) was added to the hot solution to decompose the excess of dichromate, and the solution was diluted with water. The product was worked up in the usual way. The residue, on distillation, furnished two fractions, both of which readily solidified: (i) unchanged acetate (VI) (2 g), b.p. 140—160° at 0·3 mmHg, m.p. and mixed m.p. 110°; and (ii) the *ketone* (VII) (5 g), b.p. 180—200° at 0·3 mmHg, the latter was crystallised from light petroleum; yield 3·8 g, m.p. 110—111°, $\lambda_{max.}$ 242 nm (ε 12,590), $\nu_{max.}$ 1664, 1724, and 1250 cm^{-1} (Found: C, 75·8; H, 8·8. $C_{20}H_{28}O_3$ requires C, 75·9; H, 8·9%); *2,4-dinitrophenylhydrazone*, m.p. 205—206° (from ethanol) (Found: C, 63·2; H, 6·9; N, 11·5. $C_{26}H_{32}N_4O_6$ requires C, 62·9; H, 6·5; N, 11·3%).

3-Acetoxy-8β-methylpodocarpan-12-one (VIII).—The unsaturated ketone (VII) (1 g) in ethanol (15 ml) was hydrogenated over palladium–charcoal (10%; 2 g) (uptake 3 mol equiv. in *ca.* 10 h). The mixture was filtered and evaporated. The residue, dissolved in acetic acid (30 ml) was treated with chromic anhydride (200 mg) and kept at room temperature for 16 h. After the usual work-up, the product was chromatographed on neutral alumina (30 g). Fractions eluted with light petroleum–benzene (9 : 1 to 4 : 1) were recrystallised from petroleum ether to afford white needles of the saturated ketone (VIII) (600 mg), m.p. 158—159°, δ 0·89 (9H, s, 4α-, 8-, and 10-Me), 1·15

[23] R. H. Bible, jun., and R. R. Burtner, *J. Org. Chem.*, **1961**, **26**, 1174.

(3H, s, 4β-Me), 2(3H, s, Ac), and 4·3 p.p.m. (1H, m, H-3*ax*) (Found: C, 75·0; H, 10·1. $C_{20}H_{32}O_3$ requires C, 74·9; H, 10·0%).

3-*Acetoxy*-8β-13α-*dimethylpodocarpan*-12-*one* (IX).—To a stirred suspension of freshly prepared sodium methoxide (1·45 g; dried under high vacuum) in dry benzene (40 ml), ethyl formate (6·4 ml) was added under nitrogen. After 30 min the acetoxy-ketone (VIII) (550 mg) dissolved in benzene (20 ml) was added dropwise with cooling. The mixture was then stirred at room temperature for 20 h and subsequently poured into ice–water. The benzene layer was extracted with ice-cold 5% sodium carbonate solution, and the combined aqueous portions were slowly acidified with cold dil. hydrochloric acid. The acidic solution was saturated with sodium chloride and extracted thrice with ether. The viscous brown oil left after evaporation of the extracts gave a deep violet colour with ethanolic iron(III) chloride and was treated without purification with acetic anhydride (15 ml) and pyridine (6 ml). The solution was left at 20° for 18 h. A neutral oil, giving no colour with iron(III) chloride, was isolated. It was hydrogenated in acetic acid (15 ml) over palladium–charcoal (10%; 400 mg) (rapid uptake of 2 mol. equiv.). After the usual work-up, the residue was chromatographed on neutral alumina (18 g). Elution with light petroleum–benzene (9 : 1 to 4 : 1) afforded the *ketone* (IX) (300 mg), plates, m.p. 165—166° (from light petroleum), $\nu_{max.}$ 1736 and 1712 cm^{-1} (Found: C, 75·2; H, 10·1. $C_{21}H_{34}O_3$ requires C, 75·4; H, 10·2%).

3-*Hydroxy*-8β,13α-*dimethylpodocarpan*-12-*one* (X).—The tricyclic acetoxy-ketone (IX) (200 mg) was refluxed with potassium hydroxide (500 mg) in ethanol (5 ml) for 1 h. The usual work-up followed by crystallisation of the solid residue from a large volume of light petroleum afforded *needles* (150 mg), m.p. 155—156° (Found: C, 78·1; H, 11·1. $C_{19}H_{32}O_2$ requires C, 78·1; H, 11·0%).

3-*Acetoxy*-8β,13-*dimethylpodocarp*-13-*en*-12-*one* (XI).—A solution of bromine in acetic acid (3 ml, equivalent to 60 mg of bromine) was added dropwise at 15° during 10 min to a solution of the ketone (IX) (120 mg) in acetic acid (3 ml) containing 48% hydrobromic acid (1 drop). The solution was then set aside at room temperature for 2 h and worked up. The crude bromo-ketone (150 mg) dissolved in dimethylformamide (5 ml) was stirred at 100° (bath temperature) for 15 h in an atmosphere of nitrogen with dry lithium bromide (100 mg) and lithium carbonate (100 mg). After the usual work-up, the residue was reacetylated with acetic anhydride (3 ml) and acetyl chloride (1 ml) in pyridine (6 ml). The acetoxy-ketone was chromatographed on neutral alumina (5 g). Elution with light petroleum–benzene (9 : 1 to 3 : 1) gave the unsaturated *ketone* (XI) (60 mg), m.p. 139—140° (from light petroleum) (Found: C, 75·7; H, 9·6. $C_{21}H_{32}O_3$ requires C, 75·9; H, 9·7%).

3-*Acetoxy*-8β-*methylpodocarpa*-5,9(11),13-*trien*-12-*one* (XII).—The acetoxy-ketone (VII) (1·14 g) and selenium dioxide (600 mg) were heated under reflux with t-butyl alcohol (24 ml) and glacial acetic acid (0·24 ml) under nitrogen for 8 h; more selenium dioxide (600 mg) was then added and refluxing was continued for another 16 h. After filtration the mixture was evaporated under reduced pressure; the residual oil was mixed with ether and the solution filtered to remove the remaining selenium. After work-up, evaporation of the dried ethereal solution left a residue which was chromatographed over neutral alumina (20 g) and eluted with benzene. The product was dissolved in light petroleum and the turbid solution was treated with activated charcoal and filtered through anhydrous sodium sulphate to give a clear filtrate. Concentration afforded glistening *needles* (200 mg), m.p. 144—145° (from light petroleum), $\lambda_{max.}$ 240 nm (ε 15,140) (Found: C, 76·2; H, 8·5. $C_{20}H_{26}O_3$ requires C, 76·4; H, 8·3%); 2,4-*dinitrophenylhydrazone*, m.p. 196—197° (from ethanol) (Found: C, 63·0; H, 6·1; N, 11·4. $C_{26}H_{30}N_4O_6$ requires C, 63·1; H, 6·1; N, 11·3%).

3-*Hydroxy*-8β-*methylpodocarpa*-5,9(11),13-*trien*-12-*one* (XIII).—The tricyclic acetoxy-ketone (XII) (200 mg) was refluxed with potassium hydroxide (1 g) in ethanol (10 ml) for 2 h under nitrogen. Work-up gave a liquid which solidified on trituration with ethyl acetate–light petroleum. The product crystallised from the same solvent mixture (1 : 2) to give button-shaped *crystals*, m.p. 179—180°, $\nu_{max.}$ 3448, 1672, and 1639 cm^{-1} (Found: C, 78·3; H, 8·7. $C_{18}H_{26}O_2$ requires C, 78·3; H, 8·8%).

8β,13α-*Dimethylpodocarpan*-12-*one* (XIV).—A mixture of the ketone (IX) (300 mg), benzene (20 ml), ethylene glycol (2·5 ml), and toluene-*p*-sulphonic acid (20 mg) was distilled very slowly during 5 h, fresh benzene being added at frequent intervals to maintain the initial volume. The usual work-up yielded the ethylene acetal, which was hydrolysed with methanolic potassium hydroxide solution (10%; 5 ml) to furnish the corresponding hydroxy-acetal. The product (300 mg) in pyridine (3 ml) was added dropwise with stirring at 15° to pyridine–chromic anhydride complex, prepared from chromic anhydride (700 mg) and pyridine (3·5 ml) at 15°. The mixture was stirred at 15° for 2 h, then set aside at room temperature for 16 h. The usual work-up gave the desired oxo-acetal. A mixture of this product (280 mg), hydrazine (99%; 3 ml), hydrazine dihydrochloride (800 mg), and diethylene glycol (7 ml) was heated at 130° for 2 h. After addition of potassium hydroxide (1·4 g), the temperature of the mixture was slowly raised to 210° during 1 h to remove the excess of hydrazine. The mixture was heated for a further 1 h at the same temperature, then poured into ice–water and extracted with ether. The product from the extract was heated with 80% acetic acid at 100° for 1 h. After the usual work-up, the residue was chromatographed on neutral alumina (6 g). Elution with light petroleum gave the *ketone* (XIV) (80 mg), white needles, m.p. 112—113° (from methanol), δ 0·87 (9H, s), 1·17 (3H, s), and 0·98 p.p.m. (3H, d, *J* 7 Hz) (Found: C, 82·3; H, 11·6. $C_{19}H_{32}O$ requires C, 82·5; H, 11·7%).

Methyl 3-*Hydroxypodocarpane*-8β-*carboxylate* (XVI).—A mixture of the keto-ester (XV) (300 mg), hydrazine (99%; 3 ml), hydrazine dihydrochloride (800 mg), and diethylene glycol (8 ml) was heated at 120° for 2 h. After addition of potassium hydroxide (1·5 g), the temperature of the mixture was slowly raised to 215° during 1 h to remove the excess of hydrazine. After being heated for 1 h more at the same temperature, the mixture was cooled and acidified with dilute hydrochloric acid. After the usual work-up, the crude product was esterified with ethereal diazomethane. The usual work-up afforded the *hydroxy-ester* (XVI), which formed colourless crystals (160 mg), m.p. 134—135° (from light petroleum) (Found: C, 73·8; H, 10·4. $C_{19}H_{32}O_3$ requires C, 74·0; H, 10·5%).

8β-*Hydroxymethylpodocarpan*-3-*ol* (XVII).—To a suspension of lithium aluminium hydride (100 mg) in tetrahydrofuran (25 ml) a solution of the hydroxy-ester (XVI) (180 mg) in tetrahydrofuran (15 ml) was added dropwise with stirring. The mixture was stirred under reflux for 6 h.

Excess of lithium aluminium hydride was decomposed with saturated sodium sulphate solution and the solution was filtered. Evaporation afforded the *diol* (XVII) (150 mg), which furnished plates, m.p. 190—191° (from acetone–light petroleum) (Found: C, 76·9; H, 11·5. $C_{18}H_{32}O_2$ requires C, 77·1; H, 11·5%).

8β-*Methylpodocarpan-3-ol* (XVIII).—(*a*) A mixture of the keto-acetate (VIII) (80 mg), hydrazine (99%; 1 ml), hydrazine dihydrochloride (260 mg), and diethylene glycol (3 ml) was heated at 120° for 2 h. After addition of potassium hydroxide (500 mg), the temperature of the mixture was slowly raised to 210° during 1 h to remove the excess of hydrazine. The mixture was heated for a further 1 h at the same temperature, then poured into ice–water and extracted with ether. The extract afforded the product as *needles* (30 mg), m.p. 118—119° (from light petroleum) (Found: C, 81·7; H, 12·3. $C_{18}H_{32}O$ requires C, 81·8; H, 12·2%).

(*b*) A solution of the diol (XVII) (150 mg), m.p. 188—189°, in pyridine (2 ml) was cooled to 0° and treated with toluene-*p*-sulphonyl chloride (110 mg). The solution was kept at room temperature for 20 h. The usual work-up afforded a gummy residue (220 mg). A solution of the crude tosylate in tetrahydrofuran (15 ml) was added dropwise with stirring to a suspension of lithium aluminium hydride (100 mg) in tetrahydrofuran (25 ml). The resulting mixture was stirred under reflux for 6 h. After decomposition of excess of lithium aluminium hydride with saturated sodium sulphate solution, the solution was filtered and evaporated. The residue was dissolved in ether and washed with sodium carbonate solution. Removal of ether followed by trituration with benzene afforded the diol (XVII) (70 mg), m.p. 187—188°. The residual gummy material (40 mg) left after removal of benzene was chromatographed over alumina (4 g). Elution with benzene–light petroleum (1 : 1 to 2 : 1) afforded crystals of compound (XVIII) (8 mg), m.p. and mixed m.p. 118—119°. Elution with benzene afforded the diol (XVII) (20 mg), m.p. 189—190°.

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