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Diterpenoids. XXVI.[1] Synthesis of 11-Methoxy-diterpenoids. (1). Synthesis of Antipodal 11-Methoxy-deoxypodocarpic Acid Derivatives

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7-Oxo esters (IV) and (V) derived from *l*-abietic acid (III) were converted to half esters (XI) and (XV), respectively. Intramolecular cyclization of XV gave the expected 11-methoxy oxo ester (XVI), but that of XI yielded the undesirable bicyclo[3,3,1]nonane ester (XVII) *via* a methoxy migration of the methoxy carbonyl group. 11-Hydroxy diterpenoid is not only a potential intermediate for the syntheses of taxodione (I) and callicarpone (II), but also is regarded as an important substance for an oxidative substitution of A-ring or 10-methyl group from its 11-hydroxyl group.

Recently, interesting 11-hydroxy (or–oxo)-diterpenoids (*e. g.* tumor-inhibitor taxodione (I),[3] and fish-killing callicarpone (II)[4]) have been found from natural sources and, subsequently, the synthesis of taxodione (I) was completed by two groups.[5]

Chemical conversions of *l*-abietic acid (III), major component of pine rosin, to biologically active natural products are our research project in the present decade. A synthesis of the 11-substituted diterpenoids was also attempted by the use of *l*-abietic acid (III) as the starting material.

In the resin acids of dehydroabietic and dehydropodocarpic acid types, it is generally considered that the substitution at C-11 position is hard to occur, for the position is sterically hindered. In order to solve the problem and synthesize the aimed 11-hydroxy compounds (XVIII (in reality, XVII was resulted) and XVI), a route of oxidative 7,8-bond cleavage of 7-oxo ester (IV and V) *via* the respective lactone (VI and VII) and subsequent B-ring recyclization was attempted. Soon after the whole of the present work was concluded, a work on IV was independently published on the basis of the same idea as our route.[6] The communication accelerated the publication of our results in detail.

1) Oxidative Cleavage and Recyclization of B-Ring of 7-Oxo Esters (IV and V)

7-Oxo esters (IV[7] and V[8]) derived from *l*-abietic acid (III) readily oxidized (CF_3CO_3H-Na_2HPO_4-CH_2Cl_2, room temp.) to give the respective lactones (VI), mp 98—99°, and (VII),

1) The whole of this work was presented at the 92nd Annual Meeting of the Pharmaceutical Society of Japan at Osaka, April 1972 (Meeting Abstracts, p. II-197). Part XXV: T. Ohsawa, M. Kawahara, and A. Tahara, *Chem. Pharm. Bull.* (Tokyo), **21**, 487 (1973).

All melting points were measured on a micro hot-stage and are uncorrected. Nuclear magnetic resonance (NMR) spectra were measured at 60 MHz in $CDCl_3$ (5—10% solution) *vs.* Me_4Si as internal reference. High-resolution mass spectra were taken with a JMS-01SG spectrometer. Retention times (t_R) of gas-liquid chromatography were detected by using of the column (1.5% OV-17 on Shimalite W (80—100 mesh), 4 mm × 2.0 m) and carrier N_2 gas.

2) Location: *Wako-shi, Saitama-ken*; *a*) To whom inquiries regarding this report should be addressed.

3) S.M. Kupchan, A. Karim and C. Marcks, *J. Am. Chem. Soc.*, **90**, 5923 (1968).

4) K. Kawazu, M. Inaba, and T. Mitsui, *Agr. Biol. Chem.* (Japan), **31**, 494 (1967).

5) K. Mori and M. Matsui, *Tetrahedron*, **26**, 3467 (1970); T. Matsumoto, Y. Tachibana, J. Uchida, and K. Fukui, *Bull. Chem. Soc. Japan*, **44**, 2766 (1971).

6) T. Matsumoto, S. Imai, M. Aizawa, H. Kitagawa, and K. Fukui, *Chem. Letters* (Japan), **1972**, 581.

7) E. Wenkert and B.G. Jackson, *J. Am. Chem. Soc.*, **80**, 211 (1958).

8) A. Tahara, O. Hoshino, and Y. Hamazaki, *Chem. Pharm. Bull.* (Tokyo), **11**, 1328 (1963); *Sci. Papers Inst. Phys. Chem. Res.* (Japan), **58**, 15 (1964).

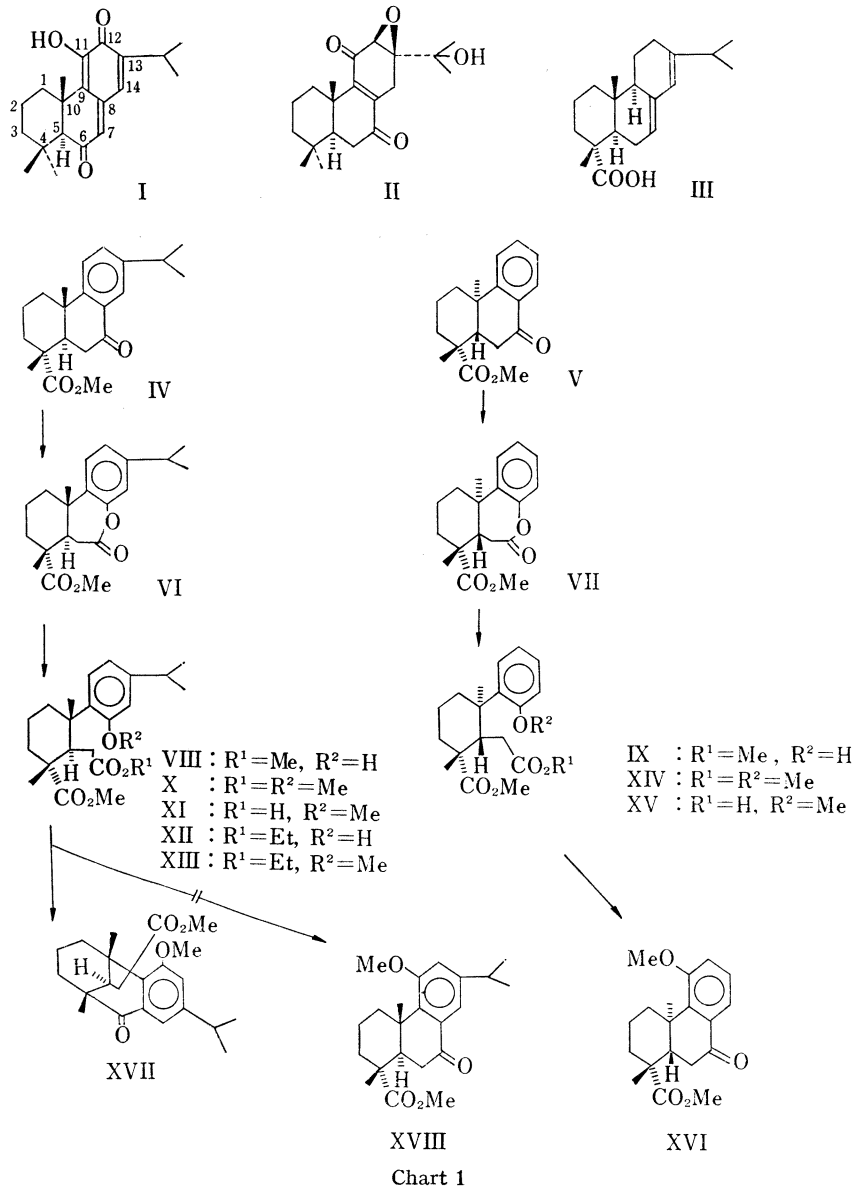


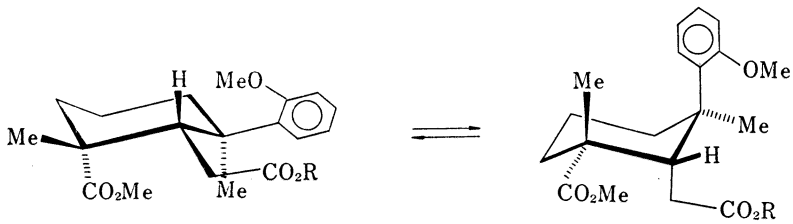
Chart 1

mp 112.5—113°, in good yield. These structures of VI and VII were consistent with their IR spectra (VI: ν_{max}^{KBr} 1760, 1725 cm^{-1} and VII: ν_{max}^{KBr} 1763, 1720 cm^{-1}). Methanolysis (MeOH-conc. HCl aq., reflux) of the lactone (VI and VII) gave quantitatively phenolic hydroxy diester (VIII), mp 118.5—119.5°, and (IX), mp 166—167°, respectively. The NMR signal due to 6-methylene protons appeared as doublet peaks at δ 2.28(J=6.0 Hz) in VIII and at δ 2.33(J=7.0 Hz) in IX.

Methylation (CH_2N_2-MeOH, room temp.) and successive partial hydrolysis (10% KOH aq.-MeOH, reflux) of hydroxy diester (VIII) gave methoxy half acid (XI), mp 133—134°, δ 3.30 (CO_2CH_3), 3.93(OCH_3), *via* methoxy diester (X), bp 122—123° (bath temp.) /10^{-3} mmHg, δ 3.33(CO_2CH_3), 3.35(CO_2CH_3), 3.92(OCH_3). Which 6-methoxycarbonyl group of diester (X) was hydrolyzed, was determined by the following analogous reactions. Ethanolysis

and successive methylation of the lactone (VI) gave methoxy ethyl methyl diester (XIII), bp 125—127° (bath temp.)/3×10^{-3} mmHg, *via* hydroxy ethyl methyl diester (XII), mp 100.5—101.5°. 6-Ethoxycarbonyl group of XIII only disappeared by the partial hydrolysis (5% KOH aq.-iso-C_3H_7OH, reflux) and the resulting product was identified with methoxy half acid (XI) obtained from X.

Similarly, methylation and successive hydrolysis of hydroxy diester (IX) gave methoxy half acid (XV), mp 170—171.5°, δ 3.67(4-CO_2CH_3), 3.77(OCH_3), *via* methoxy diester (XIV), mp 82—83°, δ 3.26(6-CO_2CH_3), 3.66(4-CO_2CH_3), 3.85(OCH_3). The methyl signal of methoxycarbonyl group of XIV (δ 3.26) was observed at an abnormally higher magnetic field and it disappeared during the hydrolysis (XIV→XV). The fact is reasonably explained from that methyl of methoxycarbonyl group is suffered by a diamagnetic effect of the aromatic ring as shown in the structure of a stable conformation (XIVa) (Chart 2).



XIVa : R=Me
XVa : R=H

XIVb : R=Me
XVb : R=H

Chart 2

Recyclization ($(CF_3CO)_2O$-CF_3CO_2H, room temp.) of the obtained methoxy half acids (XV and XI) gave methoxy oxo esters (XVI), mp 106—108°, $\nu_{max}^{CCl_4}$ 1730, 1690 cm^{-1}, and (XVII), bp 110° (bath temp.)/10^{-3} mmHg, $\nu_{max}^{CCl_4}$ 1740, 1680 cm^{-1}, respectively. It is interesting that XV is cyclized to the expected compound (XVI) having a hydrophenanthrene skeleton, but the cyclization of XI proceeds to the undesired direction.

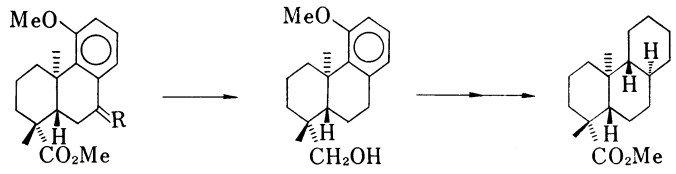
2) Structural Determination of Methoxy Oxo Ester (XVI)

From the molecular model of XV (Chart 2), the cyclization (XV→XVI) of 6-carboxyl group is only possible. Firstly, the skeleton of XVI was certified by chemical evidence. Methoxy oxo ester (XVI) was hydrogenolyzed (H_2, 15% Pd-C-AcOH-conc. H_2SO_4, room temp.) to give methoxy ester (XIX), mp 113—113.5°, which was reduced ($LiAlH_4$-ether, reflux) to methoxy alcohol (XX), mp 120—122°. The alcohol (XX) was converted to ester (XXI)[9] without separation of the intermediates by the reaction sequences; reduction of aromatic ring (Li- liq. NH_3), hydrolysis (MeOH- dil. HCl aq.), hydrogenolysis (10% Pd-C- MeOH), oxidation (Jones reagent[10]-acetone) and methylation (CH_2N_2). The resulting ester was identified with the authentic compound (XXI)[9] having a hydrophenanthrene skeleton.

Next, the 11-methoxy position of XVI was confirmed by NMR analysis. The signal (δ 7.70) of 14-H is distinguishedly observed in a lower magnetic field than those of the other aromatic protons by the effect of 7-oxo group. The NMR pattern ($J_{12,14}$=2.0, $J_{13,14}$=7.5 Hz) of 14-H shows evidently that the methoxy group of XVI is located at C-11 position.

Further proof of the methoxy position was adduced by comparison of chemical shifts of 10-methyl groups of methoxy compounds (XVI, XIX and XX) with those of the corresponding demethoxy compounds (V, XXII and XXIII) (Table I). It is known that the NMR

9) A. Tahara, Y. Ohtsuka, N. Umino, K. Nagasawa, and K. Hirao, *Chem. Pharm. Bull.* (Tokyo), **17**, 1527 (1969); *idem, ibid.*, **19**, 1756 (1971).
10) A. Bowers, T.G. Halsall, E.R.H. Jones, and A.J. Lemin, *J. Chem. Soc.*, **1953**, 2548.



XVI : R=O
XIX : R=H_2

XX

XXI

XXII

XXIII

Chart 3

signal of 10-methyl group of abietane series having a 11-methoxy group is shifted *ca.* 0.1—0.2 ppm to a lower magnetic field than the usual chemical shift.[11] In fact, the chemical shifts of 10-methyl groups of 11-methoxy compounds (XVI, XIX and XX) are *ca.* 0.1 ppm lower than those of the corresponding demethoxy compounds (V, XXII and XXIII), respectively.

Table I. Chemical Shifts 4- and 10-Methyl Groups of 11-Methoxy- and the Corresponding Demethoxy-compounds.

	7-Oxo-esters		Esters		Alcohols	
	XVI	V	XIX	XXII	XX	XXIII
10-Me	1.23	1.11	1.13	1.03	1.28	1.18
4-Me	1.25	1.25	1.26	1.27	1.05	1.05

3) Structural Determination of Methoxy Oxo Ester (XVII)

Hydrogenolysis (H_2, 15% Pd-C-AcOH-conc. H_2SO_4, room temp.) of methoxy oxo ester (XVII) gave methoxy ester (XXIV), mp 88.5—90°, $\nu_{max}^{CCl_4}$ 1740 cm^{-1}, which was reduced ($LiAlH_4$-ether, reflux) to the corresponding alcohol (XXV), bp 117—118° (bath temp.)/10^{-3} mmHg. NMR analysis of XXIV and XXV aroused firstly a question that XXIV had not a hydrophenanthrene skeleton. Generally, a NMR signal of 4-methyl group is shifted to a higher magnetic field (0.28 ppm) when methyl dehydroabietate (XXVI) was reduced to dehydroabietanol (XXVII).[12] However, the NMR signal of 5-methyl group of XXV (δ 0.97) (The 5-methyl group corresponds to the 4-methyl group in the desired phenanthrene typed ester (XVIII)) was not shifted from that of XXIV (δ 0.92). Furthermore, the NMR signals due to methylene protons (CH_2OR) of hydroxymethyl group of XXV and acetoxymethyl group of methoxy acetate (XXVIII) (Ac_2O–pyridine, room temp.), bp 109—110° (bath temp.)/10^{-3} mmHg, appear as the triplet splitting (XXV: δ 3.45(J=8.0 Hz) and XXVIII: δ 4.05(J=7.5 Hz)). Thus, a hydroxy- (and an acetoxy-) methyl group in XXV (and XXVIII) should combine with a methylene group such as -CH_2-CH_2OR.

11) C.H. Brieskorn, A. Fuchs, J.B-son Bredenberg, J.D. McChesney, and E. Wenkert, *J. Org. Chem.*, **29**, 2293 (1964).

12) E. Wenkert, A. Afonso, P. Beak, R.W.J. Carney, P.W. Jeffs, and J.D. McChesney, *J. Org. Chem.*, **30**, 713 (1965).

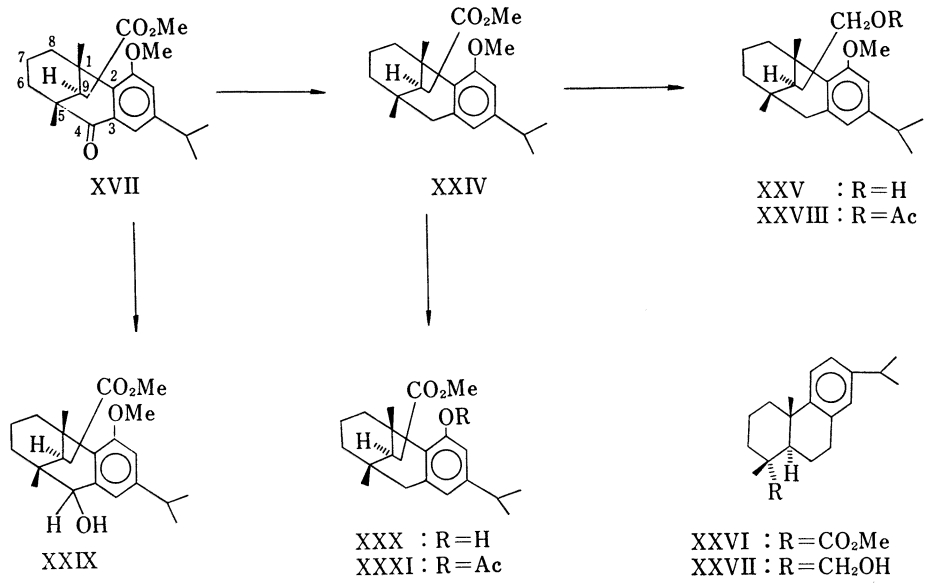


Chart 4

Furthermore, the structure of oxo ester (XVII) was supported by the following definite evidences. Oxo ester (XVII) was reduced ($NaBH_4$-MeOH, reflux) to give hydroxy ester (XXIX), bp 138° (bath temp.)/10^{-3} mmHg. The singlet NMR signal (δ 4.50, 1H) due to 4-hydrogen at the carbon bearing the hydroxy group of XXIX shows that no hydrogen atom is attached to the adjacent carbon.

Acidic hydrolysis (AcOH- 47%HBr aq., reflux) and successive methylation of methoxy ester (XXIV) gave phenolic hydroxy ester (XXX), $\nu_{max}^{CCl_4}$ 3626, 1735 cm^{-1}, δ 0.93 (s; 5-CH_3), 1.54(s; 1-CH_3), an acetylation (Ac_2O- pyridine, room temp.) of which gave acetoxy ester (XXXI), mp 111.5—113.5°, $\nu_{max}^{CCl_4}$ 1763, 1738, 1195 cm^{-1}, δ 0.94(s; 5-CH_3), 1.22(s; 1-CH_3). By comparison of NMR spectra of XXX and XXXI, it was observed that the δ-value of 1-methyl group was shifted from 1.54 (XXX) to 1.22 (XXXI) by acetylation. That is, the phenolic hydroxy group give a paramagnetic effect on the methyl group of XXX, so the hydroxy group is located near one of the methyl groups.

All of the observations adduce the obvious proof of the structure of the cyclized product (XXIV). The undesirable cyclization (XI→XVII) is in essential agreement with Fukui and co-workers' observation.[6,13]

In the cyclization (XI→XVII), a methoxy group of XI should be migrated to 6-carboxyl group from 4-methoxycarbonyl group. The mechanism can be considered at present to be a methoxy migration *via* methyl oxonium intermediate (B) as shown in Chart 5. A similar result of cyclization (PPA) of anhydride (XXXII) has been reported by Ireland.[14]

In conclusion, *l*-abietic acid derivatives (IV) and (V) were converted to half acid (XI) and (XV), respectively. Intramolecular cyclization of XV gave the expected 11-methoxy oxo ester (XVI), but that of XI yielded bicyclo[3,3,1]nonane ester (XVII) *via* a methoxy migration of the methoxycarbonyl group. In order to prevent the undesirable cyclization (XI→XVII), 4-methoxycarbonyl group of XI was chemically modified to accomplish the aimed cyclization and the result will be published in our successive report.

13) Fukui and co-workers[6] reported that the cyclization of XI ($SnCl_4$, benzene) *via* acylchloride gave oxo ester (XVII) (66% yield), unidentified lactone (11% yield) and a small amount of the expected 7-oxo ester (XVIII) (4% yield).

14) R.E. Ireland, P.S. Grand, R.E. Dickerson, J. Bordner, and D.R. Rydjeski, *J. Org. Chem.*, **35**, 570 (1970).

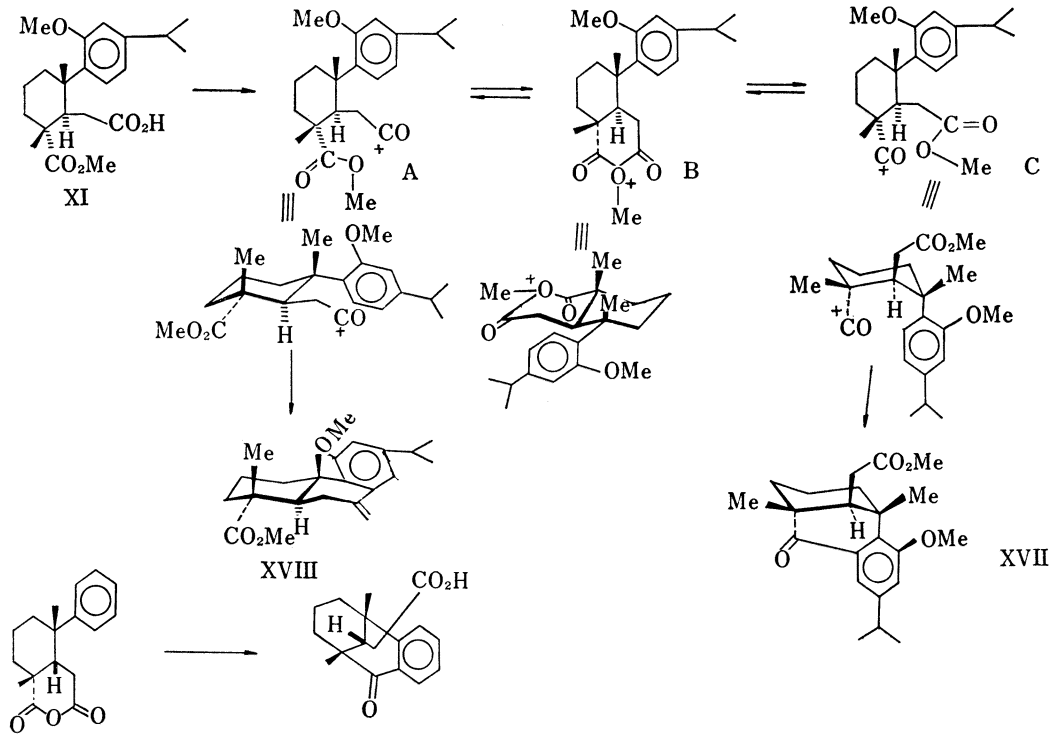


Chart 5

The 11-hydroxy diterpene is not only a potential intermediate for the syntheses of taxodione (I) and callicarpone (II), but also is regarded as an important substance for an oxidative substitution of A-ring or 10-methyl group from its 11-hydroxyl group. Now our study is in progress to the direction.

Experimental

Oxidative Cleavage of 7-Oxo Esters (IV) and (V)——i) Oxidation of Methyl 7-Oxo-dehydroabietate (IV) to Lactone (VI): Trifluoroacetic anhydride (5.25 ml) was added carefully to a solution of 90% H_2O_2 (4.10 ml) in CH_2Cl_2 (41 ml) at 4—7° with stirring. The peracid solution was dropwise added to a mixture of oxo ester (IV) (1.675 g) and Na_2HPO_4 (4.100 g) in CH_2Cl_2 (41 ml) at 5—7° with vigorous stirring. After the mixture was stirred for 20 min at room temperature, the mixture was diluted with H_2O and, then, extracted with ether. The ether extract was washed with sat. Na_2CO_3 aq., sat. NaCl aq. and dried over Na_2SO_4. The solvent was removed to give crystals (VI) (1.719 g), whose gas-liquid chromatogram (t_R=6.37 min: 230°) showed it was single product. The crude crystals were recrystallized from MeOH–H_2O to give colorless prisms (VI) (1.310 g), mp 96.5—99° and mp 98—99° as analytical sample. *Anal.* Calcd. for $C_{21}H_{28}O_4$: C, 73.22; H, 8.19. Found: C, 73.26; H, 7.93. IR ν_{max}^{KBr} cm^{-1}: 1760, 1725. NMR δ: 1.23 (d, 6H, J= 7.0 Hz; -CH(C$\underline{H}_3$)$_2$), 1.48 (s, 6H; 4- and 10-CH_3), 3.60 (s, 3H; CO_2CH_3).

ii) Oxidation of Methyl 7-Oxo-5β,10α-podocarpa-8,11,13-trien-15-oate (V) to Lactone (VII): A mixture of 7-oxo ester (V) (1.250 g) and Na_2HPO_4 (2.800 g) in CH_2Cl_2 (28 ml) was treated as in the case of 7-oxo ester (IV) with a peracid solution prepared from $(CF_3CO)_2O$ (3.60 ml)-90% H_2O_2 (2.80 ml)–CH_2Cl_2 (28 ml). The resulting crude crystals (VII) (1.144 g) whose retention time of the gas-liquid chromatography (t_R= 8.30 min; 210°) showed it was single product, was recrystallized from MeOH–H_2O to give colorless prisms (VII) (800 mg) and further recrystallization from petr. ether–ether gave colorless prisms, mp 112.5—113°. *Anal.* Calcd. for $C_{18}H_{22}O_4$: C, 71.50; H,7.33. Found: C, 71.52; H, 7.35. IR ν_{max}^{KBr} cm^{-1}: 1763, 1720. NMR δ: 1.25 (s, 6H; 4- and 10-CH_3), 3.73 (s, 3H; CO_2CH_3).

Alcoholysis of Lactones (VI) and (VII)——i) Methanolysis of Lactone (VI) to Hydroxy Diester (VIII): A solution of lactone (VI) (2.00 g) in MeOH (200 ml)–conc. HCl aq. (5 ml) was refluxed for 30 min. The

solvent was removed under reduced pressure and the resulting residue was extracted with ether. The ether extract was washed with sat. Na_2CO_3 aq., sat, NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give crystals (VIII) (2.20 g), which were pure enough for the further experiment. A part of the crystals (533 mg) was purified by chromatography on silica gel (30 g) in petr. ether–ether (4: 1) elution to give crystals (484 mg), which were recrystallized from MeOH–H_2O to give a colorless needles (VIII), mp 118.5—119.5°. *Anal.* Calcd. for $C_{22}H_{32}O_5$: C, 70.18; H, 8.57. Found: C, 69.90; H, 8.44. IR ν_{max}^{KBr} cm^{-1}: 3260, 1715, 1694. NMR δ: 1.15 (d, 6H, J=7.0 Hz; -CH($C\underline{H}_3$)$_2$), 1.20 (s, 3H), 1.30 (s, 3H), 2.28 (d, 2H, J=6.0 Hz; -$C\underline{H}_2$-CO_2CH_3), 3.33 (s, 3H; CO_2CH_3), 3.43 (s, 3H; CO_2CH_3), 3.97 (t, 1H, J=6.0 Hz; -$C\underline{H}$-$CH_2CO_2CH_3$). t_R=6.27 min (230°).

ii) Methanolysis of Lactone (VII) to Hydroxy Diester (IX): Lactone (VII) (1.000 g) was treated (MeOH (100 ml)-conc. HCl aq. (3 ml)) as in the case of lactone (VI). The resulting crude crystals (IX) (1.027 g) was pure enough for the further experiment and a part (215 mg) was purified by chromatography on silica gel (15 g) in petr. ether–ether (3: 1) elution to give crystals (199 mg), which were recrystallized from MeOH–H_2O to give colorless leaflets (IX), mp 166—167°. *Anal.* Calcd. for $C_{19}H_{26}O_5$: C, 68.24; H, 7.84. Found: C, 68.23; H, 7.74. IR ν_{max}^{KBr} cm^{-1}: 3320, 1730, 1703. NMR δ: 1.20 (s, 3H), 1.23 (s, 3H), 2.33 (d, 2H, J=7.0 Hz; -$C\underline{H}_2$-CO_2CH_3), 3.30 (s, 3H; -CH_2-$CO_2C\underline{H}_3$), 3.68 (s, 3H; CO_2CH_3). t_R=4.60 min (220°).

iii) Ethanolysis of Lactone (VI) to Hydroxy Ethyl Methyl Diester (XII): Lactone (VI) (500 mg) was treated (EtOH (40 ml)-conc. HCl aq. (1 ml)) as in the case of a methanolysis of lactone (VI). The resulting crude crystals (XII) (538 mg) was pure enough for the further experiment and a part (50 mg) was chromatographed on silica gel (10 g) in petr. ether–ether (4: 1) elution to give crystals (XII) 42 (mg) which were recrystallized from MeOH–H_2O to give colorless prisms (33 mg), mp 100.5—101.5°. *Anal.* Calcd. for $C_{23}H_{34}O_5$: C, 70.74; H, 8.78. Found: C, 70.91; H, 8.80. IR ν_{max}^{KBr} cm^{-1}: 3330, 1734, 1698. NMR δ: 1.17 (d, 6H, J=6.0 Hz; -CH($C\underline{H}_3$)$_2$), 1.17 (t, 3H, J=7.5 Hz; -CO_2CH_2-$C\underline{H}_3$), 1.24 (s, 3H), 1.31 (s, 3H), 2.34 (d, 2H, J=6.0 Hz; -$C\underline{H}_2$-$CO_2C_2H_5$), 3.33 (s, 3H; CO_2CH_3), 3.98 (t, 1H, J=6.0 Hz; -$C\underline{H}$-$CH_2CO_2C_2H_5$), 3.95 (q, 2H, J=7.5 Hz; -$CO_2C\underline{H}_2$-CH_3). t_R=6.65 min (250°).

Methylation of Hydroxy Diesters (VIII), (IX), and (XII)——i) Methylation of Hydroxy Diester (VIII) to Methoxy Diester (X): Hydroxy diester (VIII) (1.076 g) in MeOH (70 ml) was methylated (CH_2N_2–ether) as usual. The mixture was evaporated under reduced pressure and the resulting residue was separated by chromatography on silica gel (50 g) to give a colorless oil (X) (963 mg) in petr. ether–ether (9: 1) elution and to give crystals (114 mg) in petr. ether–ether (2: 1) elution. The latter crystals (114 mg) were identified with the starting hydroxy diester (VIII) by comparison of IR spectrum (CCl_4) and t_R.

The former oil (X) was distilled at 122—123° (bath temp.)/10^{-3} mmHg for an analytical sample. *Anal.* Calcd. for $C_{23}H_{34}O_5$: C, 70.74; H, 8.74. Found: C, 70.35; H, 8.58. IR ν_{max}^{film} cm^{-1}: 1736, 1727, 1674. NMR δ: 1.18 (s, 3H), 1.21 (d, 6H, J=7.0 Hz; -CH(CH_3)$_2$), 1.30 (s, 3H), 2.20 (d, 2H, J=6.0 Hz; -$C\underline{H}_2$-CO_2CH_3), 3.33 (s, 3H; CO_2CH_3), 3.35 (s, 3H; CO_2CH_3), 3.92 (s, 3H; OCH_3), 4.00 (t, 1H, J=6.0 Hz; -$C\underline{H}$-$CH_2CO_2CH_3$). t_R=3.70 min (230°).

ii) Methylation of Hydroxy Ethyl Methyl Diester (XII) to Methoxy Ethyl Methyl Diester (XIII): Hydroxy ethyl methyl diester (XII) (485 mg) in MeOH (25 ml) was methylated as in the case of hydroxy diester (VIII) and the resulting oil was purified by chromatography on silica gel (25 g) in petr. ether–ether (9: 1) elution to give a colorless oil (XIII) (435 mg), bp 125—127° (bath temp.)/3×10^{-3} mmHg. *Anal.* Calcd. for $C_{24}H_{36}O_5$: C, 71.25; H, 8.97. Found: C, 71.15; H, 8.98. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1723. NMR δ: 1.13 (t, 3H, J=7.0 Hz; -CO_2CH_2-$C\underline{H}_3$), 1.18 (s, 3H), 1.22 (d, 6H, J=7.5 Hz; -CH($C\underline{H}_3$)$_2$), 1.30 (s, 3H), 2.20 (d, 2H, J=6.0 Hz; -$C\underline{H}_2$-$CO_2C_2H_5$), 3.30 (s, 3H; CO_2CH_3), 3.83 (q, 2H, J=7.0 Hz; -$CO_2C\underline{H}_2$-CH_3), 3.92 (s, 3H; OCH_3), 4.00 (t, 1H, J=6.0 Hz; -$C\underline{H}$-CH_2-$CO_2C_2H_5$). t_R=4.10 min (250°).

iii) Methylation of Hydroxy Diester (IX) to Methoxy Diester (XIV): a) Methylation with CH_2N_2-MeOH: Hydroxy diester (IX) (175 mg) in MeOH (11 ml) was methylated as in the case of hydroxy diester (VIII) and, then, the resulting residue was purified by chromatography on silica gel (20 g) in petr. ether–ether (9: 1) elution to give crystals (XIV) (153 mg) which were recrystallized from MeOH–H_2O to give colorless prisms (147 mg), mp 82—83°. *Anal.* Calcd. for $C_{20}H_{28}O_5$: C, 68.94; H, 8.10. Found: C, 68.82; H, 7.84. IR ν_{max}^{KBr} cm^{-1}: 1730, 1720. NMR δ: 1.17 (s, 3H), 1.19 (s, 3H), 3.26 (s, 3H; -CH_2-$CO_2C\underline{H}_3$), 3.66 (s, 3H; CO_2CH_3), 3.85 (s, 3H; OCH_3). t_R=2.15 min (230°).

b) Methylation by Me_2SO_4–KOH: After an addition of Me_2SO_4 (1.56 ml) to a solution of hydroxy diester (IX) (1.090 g) and KOH (910 mg) in MeOH (50 ml), the mixture was refluxed for 20 min under a nitrogen atmosphere. An addition of KOH (910 mg)–Me_2SO_4 (1.56 ml) and refluxing (20 min) were repeated twice. After the solvent was removed under reduced pressure, the resulting residue was diluted with H_2O and extracted with ether. The ether extract was washed with sat. Na_2CO_3 aq., then sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give crude crystals (1.150 g) which were separated by chromatography on silica gel (110 g) to give colorless crystals (768 mg) in petr. ether–ether (4: 1) elution and to give colorless crystals (167 mg) in petr. ether–ether (2: 1) elution. The former crystals were identified with methoxy diester (XIV) and the latter crystals were identified the starting hydroxy diester (IX) by comparison of those IR spectra (CCl_4) and t_R, respectively.

Partial Hydrolysis of Methoxy Diesters (X), (XIII), and (XIV)——i) Hydrolysis of Methoxy Diester (X) to Methoxy Half Acid (XI): A mixture of methoxy diester (X) (643 mg) and 10% KOH aq. (23 ml)

in MeOH (23 ml) was refluxed for 90 min with stirring and, then, the solvent was removed under reduced pressure. The resulting residue was diluted with H_2O and extracted with ether (neutral part). The aqueous solution was acidified with dil. HCl aq. and extracted with ether (acidic part). Both ether extracts were respectively washed with sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give only a trace as the neutral part, but to give a colorless powder (XI) (570 mg) as the acidic part, which was pure enough for the further experiment. A part of the powder (413 mg) was chromatographed on silicic acid–Celite (1: 1) (40 g) to give colorless crystals (XI) (387 mg) in petr. ether–ether (9: 2) elution. The crystals were recrystallized from petr. ether–ether to give colorless fine needles, mp 133—134°. *Anal.* Calcd. for $C_{22}H_{32}O_5$: C, 70.18; H, 8.57. Found: C, 70.09; H, 8.46. IR ν_{max}^{KBr} cm^{-1}: 1725, 1710, 1697. NMR δ: 1.21 (s, 3H), 1.22 (d, 6H, J=7.0 Hz; -CH(CH_3)$_2$), 1.31 (s, 3H), 2.29 (d, 2H, J=6.0 Hz; -CH_2-CO_2H), 3.30 (s, 3H; CO_2CH_3), 3.93 (s, 3H; OCH_3), 4.04 (t, 1H, J=6.0 Hz; -CH-$CH_2CO_2CH_3$).

ii) Hydrolysis of Methoxy Ethyl Methyl Diester (XIII) to Methoxy Half Acid (XI): A mixture of methoxy diester (XIII) (352 mg) and 5% KOH aq. (12 ml) in isopropanol (12 ml) was refluxed for 45 min with stirring and, then, the reaction mixture was treated as in the case of methoxy diester (X) to give a colorless oil (155 mg) as the neutral part and a caramel (178 mg) as the acidic part. The former oil (neutral part) was identified with the starting methoxy diester (XIII) by comparison of IR spectrum (CCl_4) and t_R. The latter caramel (acidic part) was purified by chromatography on silicic acid-Celite (1: 1) (20 g) in petr. ether–ether (9: 1) elution to give crystals (163 mg) which were recrystallized from petr. ether–ether to give colorless prisms (116 mg), mp 132—134°. The crystals were identified with methoxy half acid (XI) obtained from methoxy diester (X) by comparison of physical data (mp (mixed mp), IR (KBr) and NMR spectra) as described before.

iii) Hydrolysis of Methoxy Diester (XIV) to Methoxy Half Acid (XV): a) Hydrolysis in MeOH: A mixture of methoxy diester (XIV) (50 mg) in MeOH (3 ml)–10% KOH aq. (3 ml) was treated as in the case of methoxy diester (X) to give acidic crystals (33 mg) and neutral crystals (12 mg) which was identified with starting methoxy diester (XIV) by comparison of IR spectrum (CCl_4) and t_R. Acidic crystals (33 mg) were purified by chromatography on silicic acid–Celite (1: 1) (10 g) in petr. ether–ether (4: 1) elution to give methoxy half acid (XV) (26 mg) as crystals which were recrystallized from petr. ether–ether to give colorless fine prisms (17 mg), mp 170—171.5°. *Anal.* Calcd. for $C_{19}H_{26}O_5$: C, 68.24; H, 7.84. Found: C, 67.90; H, 7.71. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1725, 1703. NMR δ: 1.15 (s, 3H), 1.17 (s, 3H), 3.67 (s, 3H; CO_2CH_3), 3.77 (s, 3H; OCH_3).

b) Hydrolysis in EtOH: Methoxy diester (XIV) (330 mg) was treated (10% KOH aq. (12 ml)–EtOH (12 ml), 60 min) as in the case of methoxy diester (X). The resulting acidic crystals (XV) (260 mg) was pure enough for the further experiment and was identified with methoxy half acid (XV) obtained by hydrolysis of (XIV) in MeOH by comparison of IR spectrum (CCl_4).

Cyclization of Methoxy Half Acids (XV) and (XI)——i) Cyclization of Methoxy Half Acid (XV) to Methyl 11-Methoxy-7-oxo-5β,10α-podocarpa-8,11,13-trien-15-oate (XVI): A solution of methoxy half acid (XV) (290 mg) in $(CF_3CO_2)_2O$ (2.0 ml)–CF_3CO_2H (1.0 ml) was left standing for 2.5 hr at room temperature. The reaction mixture was poured into ice and extracted with ether. The ether extract was washed with 10% KOH aq. and sat. NaCl aq. The ether solution was dried over Na_2SO_4 and the solvent was evaporated to give a colorless oil (264 mg). The oil was purified by chromatography on silica gel (25 g) in petr. ether–ether (9: 1) elution to give methoxy oxo ester (XVI) (211 mg) as colorless crystals, a part (100 mg) of which was recrystallized from MeOH–H_2O to give colorless fine needles (70 mg), mp 106—108°. *Anal.* Calcd. for $C_{19}H_{24}O_4$: C, 72.12; H, 7.65. Found: C, 72.12; H, 7.55. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1730, 1690. NMR δ: 1.23, 1.25 (s, 3H; 4- and 10-CH_3), 3.67 (s, 3H; 4-CO_2CH_3), 3.81 (s, 3H; 11-OCH_3), 7.70 (dd, 1H, J=2.0, 7.5 Hz; 14-H). t_R=6.50 min (220°).

ii) Cyclization of Methoxy Half Acid (XI) to Methyl *anti*-9-(1β,5β-Dimethyl-4-oxo-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl)acetate (XVII): a) Cyclization by $(CF_3CO)_2O$-CF_3CO_2H: A solution of methoxy half acid (XI) (199 mg) in $(CF_3CO)_2O$ (1.4 ml)-CF_3CO_2H (0.7 ml) was treated as in the case of methoxy half acid (XV) to give an oil (180 mg), whose gas chromatogram showed it was almost single product (t_R=5.85 min (230°)). The oil was chromatographed on silica gel (18 g) in petr. ether–ether (9: 1) elution to give methoxy oxo ester (XVII) (108 mg) as a colorless oil, bp 110° (bath temp.)/10^{-3} mmHg. *Anal.* Calcd. for $C_{22}H_{30}O_4$: C, 73.71; H, 8.44. Found: C, 73.51; H, 8.33. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1740, 1680. NMR δ: 1.14 (s, 3H; 5-CH_3), 1.25 (d, 6H, J=7.0 Hz; -CH(CH_3)$_2$), 1.53 (s, 3H; 1-CH_3), 2.56 (s, 2H), 3.67 (s, 3H; CO_2CH_3), 3.83 (s, 3H; OCH_3), 6.94 (d, 1H, J=2.0 Hz; aromatic 6-H), 7.63 (d, 1H, J=2.0 Hz; aromatic 4-H). t_R=5.83 min (230°).

b) Cyclization by $(CF_3CO)_2O$ in CH_2Cl_2: A mixture of methoxy half acid (XI) (540 mg) in $(CF_3CO)_2O$ (340 mg: 1.1 equivalent mole) and CH_2Cl_2 (22 ml) was refluxed for 2 hr. After a further addition of $(CF_3CO)_2O$ (340 mg) to the reaction mixutre, it was refluxed for 1 hr and the solvent was removed under reduced pressure. An ether extract of the resulting residue was washed with 10% KOH aq., then, sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give a colorless oil (483 mg), which was chromatographed on silica gel (50 g) in petr. ether–ether (9: 1) elution to give a colorless oil (368 mg). The physical constants (t_R, IR(CCl_4) and NMR spectra) were identical with those of methoxy oxo ester (XVII) synthesized by $(CF_3CO)_2O$-CF_3CO_2H as described before.

Hydrogenolysis of Methyl 11-Methoxy-7-oxo-5β,10α-podocarpa-8,11,13-trien-15-oate (XVI) to Methyl 11-Methoxy-5β,10α-podocarpa-8,11,13-trien-15-oate (XIX)——A solution of methoxy oxo ester (XVI) (210 mg) in conc. H_2SO_4 (4 drops)–AcOH (40 ml) was stirred in the presence of 15% Pd-C (400 mg) under an atmospheric hydrogen pressure at room temperature. After hydrogen absorption was ceased, the catalyst was filtered off and the filtrate was evaporated under reduced pressure. An ether extract of the resulting residue was washed with sat. Na_2CO_3 aq., then, sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give methoxy ester (XIX) (181 mg) as crystals, which was pure enough for the further experiment. A part of crystals (35 mg) was purified by chromatography on silica gel (5 g) in petr. ether–ether (19: 1) elution to give crystals (30 mg) which were recrystallized from MeOH–H_2O to give colorless needles (XIX) (25.5 mg), mp 113—113.5°. *Anal.* Calcd. for $C_{19}H_{26}O_3$: C, 75.46; H, 8.67. Found: C, 75.63; H, 8.56. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1727. NMR δ: 1.13 (s, 3H; 10-CH_3), 1.26 (s, 3H; 4-CH_3), 3.63 (s, 3H; 4-CO_2CH_3), 3.75 (s, 3H; 11-OCH_3). t_R=4.10 min (210°).

Reduction of Methyl 11-Methoxy-5β,10α-podocarpa-8,11,13-trien-15-oate (XIX) to 11-Methoxy-5β,10α-podocarpa-8,11,13-trien-15-ol (XX)——A mixture of methoxy ester (XIX) (45 mg) and $LiAlH_4$ (50 mg) in ether (15 ml) was refluxed for 4 hr with stirring. The reaction mixture was diluted with H_2O, then acidified and extracted with ether. After the ether extract was dried over Na_2SO_4, the solvent was evaporated to give crystals (XX) (41 mg) which were purified by chromatography on silica gel (8 g) to give colorless crystals (33 mg) in petr. ether–ether (9: 1) elution. The crystals were recrystallized from MeOH–H_2O to give methoxy alcohol (XX) (25 mg) as colorless needles, mp 120—122°. *Anal.* Calcd. for $C_{18}H_{26}O_2$: C, 78.79; H, 9.55. Found: C, 78.69; H, 9.43. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3670. NMR δ: 1.05 (s, 3H; 4-CH_3), 1.28 (s, 3H; 10-CH_3), 3.73 (s, 3H; 11-OCH_3), 3.51 (d, 1H, J=11.0 Hz; 4-CH_2OH), *ca.* 3.81 (d, undistinguishable; 4-CH_2-OH). t_R=5.15 min (210°).

Successive Reaction of Hydrogenation, Oxidation and Methylation of 11-Methoxy-5β,10α-podocarpa-8,11,13-trien-15-ol (XX) to Methyl 5β,8α,9β,10α-Podocarpan-15-oate (XXI)——A piece of lithium metal (350 mg) was added to a solution of methoxy alcohol (XX) (40 mg) in EtOH (5 ml) and liq. NH_3 (10 ml). After the reaction mixture was refluxed for 20 min with stirring, liq. NH_3 (15 ml) was added and, then, refluxed for 20 min with stirring. MeOH (2 ml) was carefully added to the reaction mixture and the solvent was removed to give a solid and it was extracted with ether. The extract was washed with sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give an oil (35 mg). After a solution of the oil (35 mg) in MeOH (2 ml) and 5N HCl (0.5 ml) was stirred for 2 hr at room temperature, the reaction mixture was diluted with H_2O and extracted with ether. The extract was washed with sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give an oil (34 mg), IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3660, 1705. A solution of the oil in MeOH (10 ml) was stirred for 16 hr in the presence of 10% Pd-C (100 mg) at room temperature under an atmospheric hydrogen pressure. The catalyst was filtered off and the filtrate was evaporated under reduced pressure. The resulting oil (31 mg) was chromatographed on silica gel (10 g) to separate in every petr. ether–ether (9: 1) elution (100 ml). Crystals of 14 mg and 7 mg were obtained from the first and the second fractions, respectively. The latter crystals (7 mg) was identified with the starting methoxy alcohol (XX) by comparison of t_R and IR spectrum (CCl_4).

The former crystals (14 mg) was oxidized in acetone (2 ml) with Jones reagent[10] (0.15 ml) by stirring for 2 hr at room temperature. The reaction mixture was diluted with H_2O and extracted with ether. The extract was washed with H_2O and, then, extracted with 10% KOH aq. The alkaline extract was acidified and extracted with ether. The ether extract was washed with sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give an acidic oil (10 mg), which was treated with CH_2N_2 in ether solution to give an oil (11 mg). The oil (11 mg) was chromatographed on silica gel (10 g) in petr. ether elution to give colorless crystals (3.5 mg), whose physical data (t_R (3.83 min: 180°), IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1723) and NMR spectra (δ: 0.62 (s, 3H; 10-CH_3), 1.15 (s, 3H; 4-CH_3), 3.61 (s, 3H; 4-CO_2CH_3)) was identical with those of the authentic ester (XXI) synthesized *via* the reliable route.[9]

Hydrogenolysis of Methyl *anti*-9-(1β,5β-Dimethyl-4-oxo-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Acetate (XVII) to Methyl *anti*-9-(1β,5β-Dimethyl-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo-[3,3,1]nonanyl) Acetate (XXIV)——A solution of methoxy oxo ester (XVII) (300 mg) in acetic acid (70 ml) and conc. H_2SO_4 (5 drops) was stirred at room temperature in the presence of 15% Pd-C (600 mg) under an atmospheric hydrogen pressure. After hydrogen absorption was ceased, the reaction mixture was treated as in the case of methoxy 7-oxo ester (XVI) to give crystals (XXIV) (274 mg) which was pure enough for the further experiment. A part of crystals (32 mg) was chromatographed on silica gel (5 g) in petr. ether–ether (19: 1) elution to give crystals (28 mg) which were recrystallized from MeOH–H_2O to afford colorless needles (XXIV) (24 mg), mp 88.5—90°. *Anal.* Calcd. for $C_{22}H_{32}O_3$: C, 76.70; H, 9.36. Found: C, 76.64; H, 9.28. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1740. NMR δ: 0.92 (s, 3H; 5-CH_3), 1.21 (d, 6H, J=7.0 Hz; -$CH(CH_3)_2$), 1.48 (s, 3H; 1-CH_3), 3.69 (s, 3H; CO_2CH_3), 3.73 (s, 3H; OCH_3), 6.66 (s, 2H; aroamtic protons). t_R=2.85 min (230°).

Reduction of Methyl *anti*-9-(1β,5β-Dimethyl-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Acetate (XXIV) to *anti*-9-(1β,5β-Dimethyl-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Ethyl Alcohol (XXV)——Methoxy ester (XXIV) (130 mg) in ether (20 ml) was treated with $LiAlH_4$ (100 mg) as in the case of methoxy ester (XIX) to give a colorless oil (113 mg). The oil was chromatographed on silica

gel (15 g) in petr. ether–ether (4: 1) elution to give methoxy alcohol (XXV) (109 mg) as a colorless oil, bp 117—118° (bath temp.)/10^{-3} mmHg. *Anal.* Calcd. for $C_{21}H_{32}O_2$: C, 79.70; H, 10.19. Found: C, 79.62; H, 10.15. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3650. NMR δ: 0.97 (s, 3H; 5-CH_3), 1.21 (d, 6H, J=7.0 Hz; -CH(CH_3)$_2$), 1.50 (s, 3H; 1-CH_3), 3.45 (t, 2H, J=8.0 Hz; -CH_2OH), 3.74 (s, 3H; OCH_3), 6.50 (s, 2H; aromatic protons), 1.84 br; OH). t_R=4.10 min (220°).

Acetylation of *anti*-9-(1*β*,5*β*-Dimethyl-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Ethyl Alcohol (XXV) to *anti*-9-(1*β*,5*β*-Dimethyl-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Ethyl Acetate (XXVIII)——A mixture of methoxy alcohol (XXV) (49 mg) in pyridine (1 ml) and Ac_2O (2 ml) was left standing for 23 hr at room temperature and, then, the solvent was removed under reduced pressure to give a colorless oil (52 mg). A part of an oil (46 mg) was chromatographed on silica gel (9.2 g) in petr. ether–ether (50: 1) elution to give methoxy acetate (XXVIII) (35 mg) as a colorless oil, bp 109—110° (bath temp.)/10^{-3} mmHg. *Anal.* Calcd. for $C_{23}H_{34}O_3$: C, 77.05; H, 9.56. Found: C, 77.14; H, 9.56. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1735, 1227. NMR δ: 0.98 (s, 3H; 5-CH_3), 1.19 (d, 6H, J=6.5 Hz; -CH(CH_3)$_2$,) 1.50 (s, 3H; 1-CH_3), 2.01 (s, 3H; -OCOCH_3), 3.74 (s, 3H; OCH_3), 4.05 (t, 2H, J=7.5 Hz; -CH_2-OCOCH_3), 6.50 (s, 2H; aromatic protons). t_R=3.14 min (230°).

Reduction of Methyl *anti*-9-(1*β*,5*β*-Dimethyl-4-oxo-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]-nonanyl) Acetate (XVII) to Methyl *anti*-9-(1*β*,5*β*-Dimethyl-4-hydroxy-(1-methoxy-5-isopropyl-)benzo[2,3-*b*]-bicyclo[3,3,1]nonanyl) Acetate (XXIX)——A mixture of methoxy oxo ester (XVII) (55 mg) and $NaBH_4$ (34 mg) in MeOH (0.9 ml) was refluxed for 12 hr and, then, the solvent was removed under reduced pressure. Dil·HCl was added to the resulting residue, which was extracted with ether. The ether extract was washed with sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give a colorless oil (XXIX) (51 mg), bp 138° (bath temp.)/10^{-3} mmHg. *Anal.* Calcd. for $C_{22}H_{32}O_4$: C, 73.30; H, 8.95. Found: C, 73.74; H, 8.89. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3630, 1735. NMR δ: 0.98 (s, 3H; 5-CH_3), 1.22 (d, 6H, J=6.75 Hz; -CH(CH_3)$_2$), 1.45 (s, 3H; 1-CH_3), 1.72 (br; OH) 3.63 (s, 3H; CO_2CH_3), 3.74 (s, 3H; OCH_3), 4.50 (br, 1H, width of half height ($W^H/_2$)=3.3 Hz; -CH-OH), 6.60 (d, 1H, J=1.5 Hz; aromatic 6-H), 7.04 (d, 1H, J=1.5 Hz; aromatic 4-H). t_R=7.25 min (220°).

Hydrolysis and Subsequent Methylation of Methyl *anti*-9-(1*β*,5*β*-Dimethyl-(1-methoxy-5-isopropyl-)-benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Acetate (XXIV) to Methyl *anti*-9-(1*β*,5*β*-Dimethyl-(1-hydroxy-5-isopropyl-)-benzo[2,3-*b*]bicyclo[3,3,1]nonanyl) Acetate (XXX)——A solution of methoxy ester (XXIV) (144 mg) in AcOH (5 ml) and 47% HBr aq. (510 mg) was refluxed for 12 hr and, then, 47% HBr aq. (250 mg) was added. The reaction mixture was refluxed for 2 hr. The mixture was poured into ice-water and extracted with ether. The ether extract was washed with sat. NaCl aq. and dried over Na_2SO_4. The solvent was evaporated to give a powder (120 mg), which was methylated by an excess of CH_2N_2 in ether solution to give an oil. The oil was purified by chromatography on silica gel (20 g) in petr. ether-ether (19: 1) elution to give hydroxy ester (XXX) (108 mg) as a colorless oil. *Anal.* by high-resolution mass spectrometry. Calcd. for $C_{21}H_{30}O_3$ (M^+; *m/e*): 330.2195. Found: 330.2216. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 3625, 1735. NMR δ: 0.93 (s, 3H; 5-CH_3), 1.18 (d, 6H, J=7.0 Hz; -CH(CH_3)$_2$), 1.54 (s, 3H; 1-CH_3), 3.66 (s, 3H; CO_2CH_3), 4.89 (s, 1H; OH), 6.31 (br, 1H, $W^H/_2$=4.0 Hz; aromatic proton), 6.49 (br, 1H, $W^H/_2$=4.0 Hz; aromatic proton). t_R=4.15 min (230°).

Acetylation of Methyl *anti*-9-(1*β*,5*β*-Dimethyl-(1-hydroxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl)-acetate (XXX) to Methyl *anti*-9-(1*β*,5*β*-Dimethyl-(1-acetoxy-5-isopropyl-)benzo[2,3-*b*]bicyclo[3,3,1]nonanyl)-acetate (XXXI)——Hydroxy ester (XXX) (44 mg) in pyridine (1 ml) was treated with Ac_2O (2 ml) as in the case of methoxy alcohol (XXV). The resulting oil (47 mg) was purified by chromatography on silica gel (4.7 g) in petr. ether–ether (20: 1) elution to give acetoxy ester (XXXI) (40 mg) as colorless crystals which were recrystallized from MeOH–H_2O to give colorless prisms (37 mg), mp 111.5—113.5°. *Anal.* Calcd. for $C_{23}H_{32}O_4$: C, 74.16; H, 8.66. Found: C, 74.19; H, 8.49. IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1763, 1738, 1195. NMR δ: 0.94 (s, 3H; 5-CH_3), 1.19 (d, 6H, J=7.0 Hz; -CH(CH_3)$_2$), 1.22 (s, 3H; 1-CH_3), 2.26 (s, 3H; OCOCH_3), 3.66 (s, 3H; CO_2CH_3), 6.59 (br, 1H, $W^H/_2$=3.5 Hz; aromatic proton), 6.77 (br, 1H, $W^H/_2$=4.0 Hz; aromatic proton). t_R=6.30 min (220°).

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