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216. Takuo Okuda and Takashi Yoshida[*1] : Coriamyrtin. XI.[*2] Stereochemistry of Coriamyrtin and Problems of Derivatives.[*3]

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Dihydrocoriamyrtin and α-bromocoriamyrtin were reduced with lithium aluminum hydride to afford acetals, (IV) and (V), respectively. The formation of these derivatives coupled with other evidences indicates the relative configurations of coriamyrtin to be represented by (Ia). The product of the lead tetraacetate oxidation of coriamyrtin was found to be an acetoxy-oxide (XVII) of which the correlation with the product (XVIII) of the performic acid oxidation of coriamyrtin, and also with α-bromocoriamyrtin were established. Among the two structures for dihydrocoriamyrtinpentaol, (XIb) was shown to be preferable. The problems concerning the stereo-structure of isohydrocoriamyrtin (VI), the aromatization of coriamyrtin to (XI), and some other derivatives were also investigated.

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The structural formulas for coriamyrtin and the derivatives related to the structural elucidation were presented in the last paper. The relative configurations of coriamyrtin and derivatives, along with some problems encountered during the research of this series will be discussed in the present paper.

The evidences of the configurations at C_6 and C_8 in coriamyrtin (I) had been provided by the ring closure between C_6-oxygen and C_8 on the formation of apocoriamyrtin, α-bromocoriamyrtin, and isocoriamyrtin.[*2] The hydroxyl group and the isopropenyl group in I accordingly would be *cis*-1,3-diaxial on the cyclohexane ring. The -CO-O- linkage of the lactone then should be *trans* to C_6-OH and C_4-isopropenyl group.

The configurations at C_1 and the epoxides are shown as follows : Among two kinds of the ring fusion of the cyclopentane ring with cyclohexane ring, *cis* and *trans*, the stereomodel[*4] indicates that *trans* fusion is accompanied by strong distortion, while *cis* fusion can be made without much strain. Although the *trans* fusion can not be excluded by this reason only, the *cis* fusion is preferred when the stability of the epoxides on the reactions such as the bromination, and the isomerization in the presence of concentrated mineral acid etc., is taken into consideration as follows : The *cis* fusion of the rings coupled with the configurations of the epoxides as shown in Ia will enable the lactone carbonyl to be located sterically close behind both of the two epoxides and thus to protect them from the rear attack, while no other combination of the configurations at C_1 and epoxides can make such steric correlation of the lactone carbonyl and the two epoxides. A similar example had been shown with β-bromopicrotoxininic acid[1)] although β-bromopicrotoxininic acid has only one epoxide which is located at a different position from those in coriamyrtin. The relative configurations in coriamyrtin, therefore, could be shown by I.

Such steric correlation of the epoxides and the lactone in I has been proved by lithium aluminum hydride reduction of dihydrocoriamyrtin (II) and α-bromocoriamyrtin (III). By lithium aluminum hydride reduction of dihydrocoriamyrtin, a product (IV), $C_{15}H_{24}O_5$, m.p. 177~178°, was obtained. Reduction of the lactone is shown by the

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[*1] Sakyo-ku, Kyoto (奥田拓男, 吉田隆志).

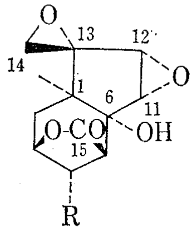
[*2] Part X : This Bulletin, **15**, 1687 (1967).

[*3] This paper constitutes Part XVII of a series entitled "Studies on the Components of *Coriaria japonica* A. Gray." A preliminary report of a part of this work has been published : Chem. & Ind. (London), **1965**, 37.

[*4] Dreiding stereomodel was used.

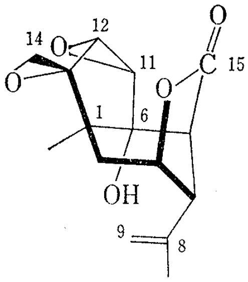
1) H. Conroy : J. Am. Chem. Soc., **79**, 1726 (1957).

disappearance of the carbonyl band in the infrared (IR) spectrum, while the molecular formula is incompatible with simple reduction of the lactone to a primary hydroxyl and a secondary hydroxyl group. The nuclear magnetic resonance (NMR) spectrum*5 (in pyridine) indicates the presence of two methyl groups on the tertiary carbon (8.62τ, s, and 8.42τ, s), of which one will be the angular methyl group, and the other is considered to be the methyl group at C_{13}, which has been produced accompanied by the formation of a tertiary hydroxyl group on the reduction of the terminal epoxide. The absence of the epoxide protons, and the appearance of an AB quartet at 5.33 and 4.99τ ($J=6$ c/s) are indicative of opening of the epoxide at $C_{11}\sim C_{12}$. The doublet at 4.20τ ($J=3$ c/s) is assignable to the acetal proton since the product Ⅳ is considered to have no olefinic hydrogen in any respect. A proton at 7.12τ which is assignable to C_5-H appears as a triplet ($J=3$ c/s) in accord with the formation of an acetal at C_{15}. The product Ⅳ consumed one-mole equivalent of periodate, and gave a monoacetate, $C_{17}H_{26}O_6$, m.p. 176~177°. These properties of Ⅳ are attributable to either one of the structures, (Ⅳa) or (Ⅳb) of which the β-configuration of C_{13}-methyl will be substantiated by the subsequent experiment. The acetal formation in Ⅳ proves the sterically close location of the $C_{11}\sim C_{12}$ epoxide to the lactone carbonyl, and the formation of $CH_3\text{-}\overset{|}{\underset{|}{C}}\text{-}$ provides an additional evidence of the terminal epoxide.

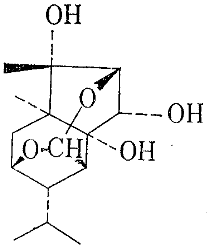


$\mathrm{I:R=\ -\overset{8}{C}(CH_3)=\overset{9}{C}H_2}$

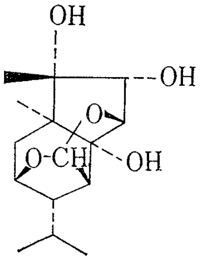
$\mathrm{II:R=\ -CH(CH_3)_2}$



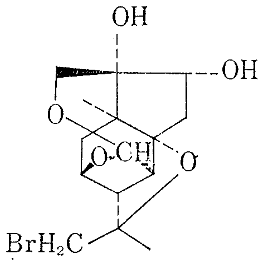
Ia



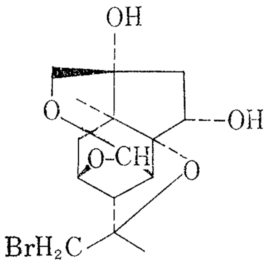
ⅣA



Ⅳb



Va



Vb

The steric correlation of the terminal epoxide and the lactone carbonyl has been proved by lithium aluminum hydride reduction of α-bromocoriamyrtin to the product (V), $C_{15}H_{21}O_5Br$, m.p. 212~213°. This product also shows complete disappearance of the carbonyl absorption in the IR spectrum, and the presence of an acetal proton at 4.20τ as a doublet ($J=5$ c/s) in the NMR spectrum (in pyridine). This proton appears to be spin-coupled to the proton at 7.22τ (t, $J=5$ c/s) or to the proton at 6.88τ (t, $J=5$ c/s), which is assignable to C_5-H. Two AB quartets which are attributable to $-CH_2O-$ and

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*5 NMR spectra were determined on a Varian Associates recording spectrometer (A-60) at 60 Mc. Chemical shifts were recorded in τ values, using tetramethylsilane as the internal reference.

$-CH_2Br$ are shown at 5.98 and 5.46τ (J=13 c/s) and at 6.30 and 6.11τ (J=11 c/s). However, unlike the NMR spectrum of Ⅳ, the product V does not show the signal which corresponds to a newly formed methyl group. A monobenzoate, $C_{22}H_{25}O_6Br$, m.p. 152～153°, has been produced from V. These properties indicate that the structure should be either Va or Vb, but V has been found to consume one mole of periodate to indicate the structure Va alone is compatible. This structure indicates that C_{14} in coriamyrtin is β-oriented. The difference in the acetal formation between dihydrocoriamyrtin and α-bromocoriamyrtin will be attributable to the distortion in the latter molecule caused by the ether formation at C_6～C_8.

These results of the lithium aluminum hydride reduction of Ⅱ and Ⅲ establishes the *cis* fusion of the cyclopentane ring with the cyclohexane ring. The α-configuration of -O- in both of the two epoxides is also shown by these results since the attack at the rear side of the epoxides by the lactone carbonyl will be reasonably explained when the epoxides take such a configuration. The relative configurations of coriamyrtin have thus been determined to be (I). Concerning the conformations, *quasi* chair form (Ia) and *quasi* boat form of the cyclohexane ring of coriamyrtin, the examination of the stereomodel shows that the severe repulsive interaction between the isopropenyl group and the angular methyl group in the latter conformation will tend to invert the latter conformation to the former. The lactone carbonyl is thus located close behind the two epoxides in the former conformation to stabilize them.

The stereochemistry and some problems concerning derivatives of coriamyrtin have been investigated as follows. The configuration of C_{11}-OH in isohydrocoriamyrtin which is allylic may not be determined on the basis of the acetonide formation from tetrahydrocoriamyrtin (Ⅶ), and from isohydrocoriamyrtin-2,4-dinitrophenylhydrazone which were described in the preceding paper.*[2] Such acetonide might be produced even from the *trans* glycol as is shown by examples of formation of an identical acetonide from *cis* and *trans* glycol in which one hydroxyl group is allylic.[2] However, the saturated constituent (Ⅷ) of "hexahydrocoriamyrtin"*[2] also provided a monoacetonide (Ⅸ), $C_{18}H_{28}O_5$, to be in accord with the α-configuration of C_{11}-OH. The relative configurations of isohydrocoriamyrtin are thus shown by (Ⅵ).

There is not enough evidence to determine the configuration of the hydroxymethyl group at C_{13} in Ⅷ. The retarded hydrogenation of tetrahydrocoriamyrtin may be attributable to the steric hindrance by C_1-methyl and -CO-O- which stand on each side of the double bond, although the possibility that -CO-O- of the lactone group at the β-side exerts the directive effects[3] upon the catalytic hydrogenation to induce α-configuration of the hydroxymethyl group in Ⅷ might also be conceivable.

The structure of methyl coriamyrtate[4] could be shown by (X) if the original configuration at C_5 is retained on the mild reaction condition of the formation of this ester. The NMR spectrum (in $CHCl_3$) shows a methyl ester by the singlet at 6.30τ, and retention of the two epoxides by the AB quartets at 7.35 and 6.94τ (J=4 c/s), and at 7.07 and 6.28τ (J=3 c/s). Other signals at 9.25τ (s, $CH_3-\overset{|}{\underset{|}{C}}-$), 8.22τ (s) and 4.9～5.1τ (m) ($CH_3-\underset{|}{C}=CH_2$), and 7.63τ (d, J=4 c/s, C_5-H) are also in accord with the structure X. The comparatively low yield of X might be due to the lability of epoxides induced by removal of the lactone carbonyl from the back side of the epoxides.

As for dihydrocoriamyrtinpentaol,*[2] the IR spectrum was rather incompatible with the structures which have a δ-lactone as shown in the last paper. Among the remaining

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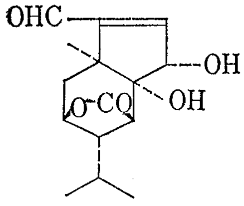
[2] W. Nagata, T. Terasawa: This Bulletin, **9**, 745 (1961); K. Yoshida, T. Kubota: *Ibid.*, **13**, 156 (1965).

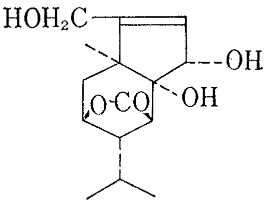
[3] S. Mitsui, S. Imaizumi: Nippon Kagaku Zasshi, **77**, 1516 (1956).

[4] T. Okuda: This Bulletin, **9**, 404 (1961).

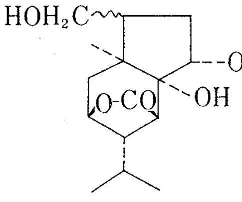
two structures, (XIa) and (XIb), the latter is favored by the data shown as follows: The pentaol yielded a mono-acetonide, $C_{18}H_{28}O_7$, m.p. 165~167°, IR $\nu_{\max}^{CHCl_3}$ cm^{-1}: 1770. The proton at C_3 in the NMR (in pyridine) spectrum is exhibited at 5.72τ, while the two doublets assignable to C_{12}-H and C_{11}-H are shown at 5.33τ (J=7 c/s) and at 4.80τ (J=7 c/s). The C_3-proton of the triacetate is shown at 4.05τ. These NMR shifts are suggestive of the presence of a free hydroxyl group at C_3 of the pentaol. On the periodate oxidation, the pentaol consumed two moles of periodate, and the acetonide consumed one mole. The result of the oxidation of the acetonide may be attributable to the acetonide formation at C_3~C_{14}.



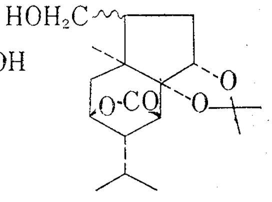
VI



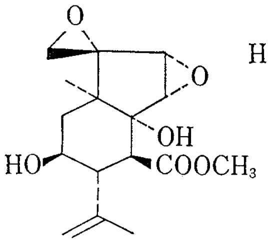
VII



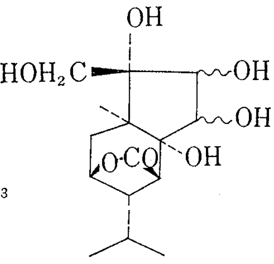
VIII



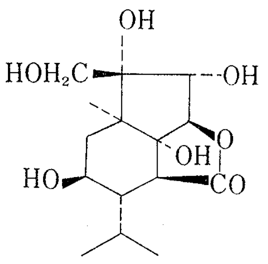
IX



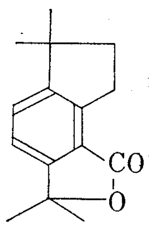
X



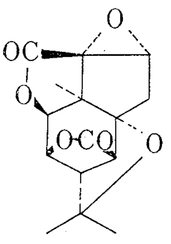
XIa



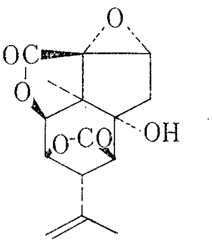
XIb



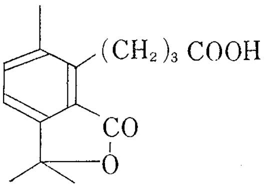
XII



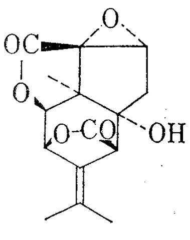
XIII



XIV



XV



XVI

The aromatization of coriamyrtin to coriarialactone (XII)[5] in concentrated hydriodic acid apparently proceeded through opening of the lactone followed by relactonization with the isopropenyl group which was oriented *trans* to the original lactone. The ready conversion of coriamyrtin in hydriodic acid to apocoriamyrtin in high yield*[2] is suggestive of initial formation of apocoriamyrtin on the aromatization reaction. Analogously, anhydropicrotin (XIII)*[2] is regarded as the initial intermediate product of the aromatization of picrotoxinin (XIV) to picrotic acid (XV) and analogues.[6] The ease of the isomerization of anhydropicrotin to neopicrotoxinin (XVI) described in the last paper shows that the relactonization between C_8 and C_{15}, which were *trans* to each other in picrotoxinin, on

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5) T. Kariyone, T. Okuda: Yakugaku Zasshi, **73**, 928 (1953).

6) D. Mercer, A. Robertson, R.S. Cahn: J. Chem. Soc., **1935**, 997; K. Tettweiler, I. Drishaus: Ann., **520**, 163 (1935).

the formation of picrotic acid could have been made *via* neopicrotoxinin in which the allylic rearrangement would take place to initiate the aromatization reaction. The hypothetical aromatization mechanism of picrotoxinin suggested by Holker, *et al.*7) is in accord with these findings in the later part of the process. The intermediate which corresponds to neopicrotoxinin has not yet been isolated by the reaction of coriamyrtin as is described in the last paper. Such difference might be related to a certain extent to the difference of the ease of the aromatization of coriamyrtin and picrotoxinin, which has been observed during the investigation of these compounds.4)

The product of the lead tetraacetate oxidation of coriamyrtin, which was reported by Kariyone and Kawano8) to be $C_{15}H_{18}O_6$, is now shown to be $C_{17}H_{20}O_7$, and to have the ether between C_6 and C_8, and an acetoxyl group at C_9. A proof of the structure at C_8 in α-bromocoriamyrtin has also been obtained by correlating it with the product of the lead tetraacetate oxidation of coriamyrtin. Coriamyrtin consumed one mole of lead tetraacetate in acetic acid solution at room temperature to yield the product (XVII), m.p. 224~225°. The product did not react with the carbonyl reagents nor did it reduce Fehling solution, and is presumed to be identical with the oxidation product previously reported.8) The IR and NMR spectra of this product show presence of an acetoxyl group (IR $\nu_{\max}^{\text{Nujol}}$ cm^{-1}: 1740, 1260, 1230. NMR $_{\max}^{\text{pyridine}}(\tau)$: 7.90 (s)). An AB quartet at 5.53 and 5.43τ (J=11 c/s) attributable to the methylene in $-\overset{|}{\underset{|}{C}}-CH_2-OAc$, and retention of the other part of coriamyrtin are also exhibited in the NMR spectrum, and the absorption of the γ-lactone ($\nu_{\max}^{\text{Nujol}}$ 1765 cm^{-1}) is shown in the IR spectrum. These data and the result of microanalysis are consistent with the structure XVII, whose molecular formula is $C_{17}H_{20}O_7$. A further proof of the structure has been provided by the synthesis through another route in which the initial process is analogous to the preparation of hydroxypicrotoxinin formate and hydroxypicrotoxinin from picrotoxinin9): Performic acid oxidation of coriamyrtin provided a product, $C_{16}H_{18}O_7$, m.p. 247~249°, which shows the absorptions of the formyloxy group at 1720, 1183 and 1165 (shoulder) cm^{-1} in the IR spectrum (in Nujol), and is presumed to be 9-formyloxyapocoriamyrtin (XVIII). Hydrolysis of XVIII in dilute formic acid yielded hydroxyapocoriamyrtin (XIX), $C_{15}H_{18}O_6$, m.p. 222° (decomp.), whose NMR spectrum (in pyridine) shows an AB quartet at 5.86 and 5.97τ (J=11 c/s)which is assignable to a hydroxymethyl group on the tertiary carbon. The acetylation of XIX gave the product which was identical with the product of the lead tetraacetate oxidation of coriamyrtin. The hydroxyl derivative XIX showed positive response to chromic acid oxidation although coriamyrtin is not oxidized at the same reaction condition. Such behavior of XIX on the acetylation and chromic acid oxidation, coupled with the downfield shift of the methylene signals in the NMR spectra on the acetylation of XIX to XVII, indicate that the oxide has been formed at the tertiary C_8 and not at C_9.

The hydroxyl derivative XIX was treated with thionyl bromide to produce a bromide which was identified with α-bromocoriamyrtin III. This result indicates that the structure of α-bromocoriamyrtin is (IIIa) or (IIIb), and that the structures (IIIc) and (IIId) are excludable. As for the analogous bromides, bromopicrotoxinins and bromotutins, the configuration at C_8 of β-bromopicrotoxinin, which is the main product on the bromination of picrotoxinin, has not been determined, while the X-ray crystallography10) has shown that the configuration at C_8 in α_1-bromopicrotoxinin (XX), which is a minor product is

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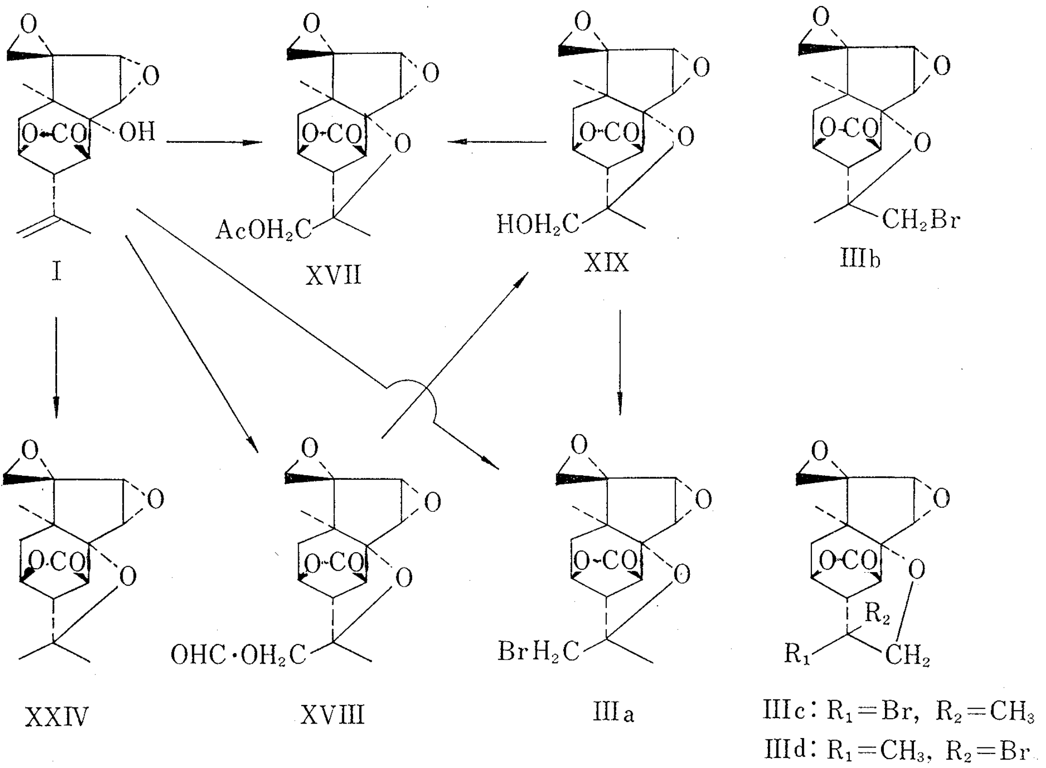
7) J.S.E. Holker, A. Robertson, J. H. Taylor, with (in part) K.U. Holker, W.R.N. Williamson: J. Chem. Soc., **1958**, 2987.

8) T. Kariyone, N. Kawano: Yakugaku Zasshi, **71**, 924 (1951).

9) R.B. Johns, S.N. Slater, R.J. Woods (with in part, D. Brasch & R. Gee): J. Chem. Soc., **1956**, 4715.

10) B.M. Craven: Acta Cryst., **15**, 387 (1962).

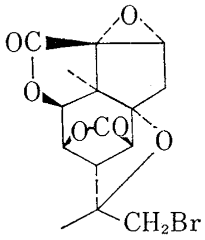
identical with that of IIIb. The corresponding part of α-bromotutin (XXI) which is the major product obtained from the bromination of tutin has been shown by X-ray analysis to be identical with IIIa.[11] The structure of α-bromocoriamyrtin which is the major product of bromination of coriamyrtin may preferably be shown by IIIa by analogy to XXI, and to β-bromopicrotoxinin which may be regarded as the C_8-epimer of XX. The configuration at C_8 in XVII, XIX and XX, which has been correlated with that in IIIa, may also be depicted by these structural formulas.



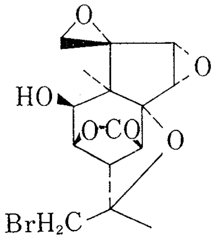
I XVII XIX IIIb

XXIV XVIII IIIa

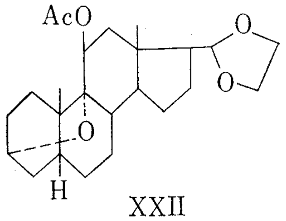
IIIc: R_1=Br, R_2=CH_3
IIId: R_1=CH_3, R_2=Br



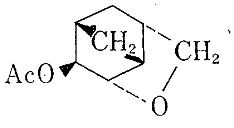
XX



XXI



XXII



XXIII

There has been an example of similar reaction of lead tetraacetate with unsaturated steroidal secondary alcohol, 3α-hydroxy-20,20-ethylenedioxy-$\Delta^{9,11}$-5β-pregnene to form 20,20-ethylenedioxy-3α,9α-oxidopregnene-11β-ol-11-acetate (XXII) reported by Jeger, *et al.*[12] The reaction with an unsaturated primary alcohol, 2α-hydroxymethylbicyclo-[2.2.1.]-hept-5-ene to 6-oxatricyclo-[3.2.1.$1^{3,8}$.]-nonan-4β-ol-acetate (XXIII) has also been presented by Moriarty and Kapadia.[13] Both of these reactions have been carried out in boiling benzene. Although the attempt by the latter workers to prove the generality of the reaction has been reported to be unsuccessful, the acetoxy-oxide formation from

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11) B.M. Craven : Nature, **1963**, 1193; M.F. Mackay, A.M. Mathieson : Tetrahedron Letters, **1963**, 1399.
12) H. Immer, M. Lj. Mihailović, K. Schaffner, D. Arigoni, O. Jeger : Helv. Chim. Acta, **45**, 753 (1962).
13) R.M. Moriarty, K. Kapadia : Tetrahedron Letters, **1964**, 1165.

coriamyrtin shows that the similar result is obtainable by the reaction at room temperature. Concerning the problem as to whether the hydroxyl group reacts first with lead tetraacetate, or the double bond reacts first, the initial reaction of the hydroxyl group was indicated by Jeger, *et al.* who also suggested the diaxial *trans* addition to the double bond in the radical mechanism for their compounds. Moriarty and Kapadia described that the stereospecificity of the acetoxylation appears somewhat more compatible with the initial addition of $\oplus\mathrm{Pb(OAc)_3}$ to the double bond followed by *trans* opening of the bridged ionic intermediate by the hydroxyl group. The lead tetraacetate oxidation of coriamyrtin, which resulted in the ether formation at tertiary C_8, and not at C_9 which could be located somewhat closer to C_6-oxygen, seems to be rather compatible with the initial reaction of lead tetraacetate with the double bond followed by the attack at C_8 by the C_6-oxygen, if XVII is the only product in which the acetoxy-oxide has been formed. This could be partially analogous to the probable mechanism of the formation of α-bromocoriamyrtin III and apocoriamyrtin (XXIV), and also of formyloxyapocoriamyrtin XVIII.

Experimental[*6]

Reduction of Dihydrocoriamyrtin (II) with Lithium Aluminum Hydride——A solution of (II) (700 mg.) in dioxane (20 ml.) was dropped in portions into a stirred suspension of $\mathrm{LiAlH_4}$ (400 mg.) in ether (50 ml.), and the reaction mixture was refluxed for 1 hr. After cooling, the excess reagent was decomposed with EtOAc and the mixture was acidified with $\mathrm{H_2SO_4}$, and then extracted with ether. The ether solution was washed with water, dried over $\mathrm{Na_2SO_4}$, and evaporated to give a crystalline residue which was recrystallized from $\mathrm{CHCl_3}$-petr. ether to provide colorless needles of (IV), m.p. 177~178° (170 mg.). *Anal.* Calcd. for $\mathrm{C_{15}H_{24}O_5}$: C, 63.36; H, 8.51. Found : C, 63.11; H, 8.21. $[\alpha]_D^{25}$ $+23.1°$ (c=1.08).

Acetylation of Reduced Dihydrocoriamyrtin (IV)——To a solution of (IV) (70 mg.) in pyridine (0.5 ml.), $\mathrm{Ac_2O}$ (0.5 ml.) was added, and the mixture was allowed to stand overnight, and then poured on ice, and extracted with $\mathrm{CHCl_3}$. The dried organic layer was evaporated to provide a crystalline residue which was recrystallized from $\mathrm{CHCl_3}$-petr. ether to afford colorless crystals, m.p. 176~177° (48 mg.). *Anal.* Calcd. for $\mathrm{C_{17}H_{26}O_6}$: C, 62.56; H, 8.03. Found : C, 62.85; H, 7.86. $[\alpha]_D^{25}$ $+83.8°$ (c=0.76). $\mathrm{IR}\nu_{\max}^{\mathrm{CHCl_3}}$ $\mathrm{cm^{-1}}$: 3500 (OH); 1740, 1240(AcO). $\mathrm{NMR}_{\max}^{\mathrm{CDCl_3}}(\tau)$: 7.83(AcO × 1).

Reduction of α-Bromocoriamyrtin (III) with Lithium Aluminum Hydride——A solution of α-bromocoriamyrtin (600 mg.) in dioxane (20 ml.) was added in portions to a stirred suspension of $\mathrm{LiAlH_4}$ (400 mg.) in ether, and the mixture was refluxed for 1 hr. After cooling, the reaction was terminated with EtOAc, and 20% $\mathrm{H_2SO_4}$ was added. When worked up in the usual way, the ethereal extract provided a solid (207 mg.) which after repeated recrystallization from EtOH afforded colorless needles of (V), m.p. 212~213°. $[\alpha]_D^{15}$ $-145.5°$ (c=0.44). *Anal.* Calcd. for $\mathrm{C_{15}H_{21}O_5Br}$: C, 49.87; H, 5.85. Found : C, 50.10; H, 5.93. $\mathrm{IR}\nu_{\max}^{\mathrm{KBr}}$ $\mathrm{cm^{-1}}$: 3420, 3350(OH). $\mathrm{NMR}_{\max}^{\mathrm{pyridine}}(\tau)$: 8.42(s), 8.38(s) ($\mathrm{CH_3}$ × 2); 6.30, 6.11(ABq, J=11 c/s), 5.98, 5.46(ABq, J=13 c/s) ($-\mathrm{OCH_2}-$ and $-\mathrm{CH_2Br}$); 4.20(d, J=5 c/s, $-\mathrm{O}\underset{|}{\mathrm{C}}\mathrm{HO}-$).

Benzoate of Reduced α-Bromocoriamyrtin (V)——To a solution of (V) (50 mg.) in pyridine (1 ml.), benzoylchloride (50 mg.) was added, and the mixture was left standing overnight at room temperature, and then poured on ice-chilled dilute HCl, and extracted with $\mathrm{CHCl_3}$. The $\mathrm{CHCl_3}$ solution was washed with $\mathrm{H_2O}$, dried over $\mathrm{MgSO_4}$, and the solvent was distilled to leave an oily residue which was chromatographed on a silicic acid column (1.5 × 12 cm., Mallincrodt) with $\mathrm{CHCl_3}$. Crystalline residue obtained on evaporation of the eluate was recrystallized from EtOH to give colorless needles, m.p. 152~153° (24 mg.). *Anal.* Calcd. for $\mathrm{C_{22}H_{25}O_6Br}$: C, 56.78; H, 5.41. Found : C, 56.90; H, 5.14. $[\alpha]_D^{15}=-131.5°$ (c=0.274). $\mathrm{IR}\nu_{\max}^{\mathrm{KBr}}$ $\mathrm{cm^{-1}}$: 3400 (OH); 1720, 1600, 1580, 705 (-OCOPh). $\mathrm{NMR}_{\max}^{\mathrm{pyridine}}(\tau)$: ABq, 6.31, 6.14(J=10 c/s) ($\mathrm{C_9}-\mathrm{C\underline{H}_2}-$); ABq, 5.60, 5.26(J=12 c/s) ($\mathrm{C_{14}}-\mathrm{C\underline{H}_2}-$).

Acetonide (IX) from the Saturated Constituent (VIII) of "Hexahydrocoriamyrtin"——To a solution of (VIII) (56 mg.) in acetone (5 ml.), anhydrous $\mathrm{CuSO_4}$ (50 mg.) and a drop of conc. $\mathrm{H_2SO_4}$ were added. The reaction mixture was stirred for 2.5 hr. at room temperature. The filtered solution was neutralized with anhydrous $\mathrm{Na_2CO_3}$, and filtered. Removal of the solvent afforded a colorless oily residue which was purified by filtration through a column of alumina. The purified oil showed only one spot which moved faster than (VIII) on the thin-layer chromatography (EtOAc-petr. benzine, 9:1). *Anal.* Calcd. for $\mathrm{C_{18}H_{28}O_5}$: C, 66.64; H, 8.70.

[*6] Melting points are uncorrected. Specific rotations were recorded in dioxane with a Rex Photoelectric Polarimeter. Woelm's neutral alumina and Mallincrodt's silicic acid (100 mesh) were used for elution chromatography. Silica gel G acc. to Stahl (E. Merck) was used for thin-layer chromatography.

Found: C, 66.41; H, 8.88. IR$\nu_{max}^{CHCl_3}$ cm^{-1}: 3450(OH); 1770 (γ-lactone); 1460, 1445, 1380. NMR$_{max}^{CDCl_3}$(τ): 9.09 (d, J=6 c/s), 8.95(d, J=6 c/s) (iso-Pr.); 8.74(s), 8.59(s), 8.50(s) ($CH_3-\overset{|}{\underset{|}{C}}-\times 3$).

Dihydrocoriamyrtinpentaol-acetonide——A suspension of dihydrocoriamyrtinpentaol (50 mg.) and anhydrous $CuSO_4$ (50 mg.) in 10 ml. of acetone containing a drop of H_2SO_4 was refluxed with stirring for 20 hr. After cooling, the solid was filtered, extracted with boiling acetone, and the extract was combined with the filtrate. The mixture was neutralized with anhydrous Na_2CO_3, filtered, and concentrated *in vacuo* to give an oily residue. This residue was dissolved in ether and petr. ether was added to provide an amorphous precipitate which was dissolved in a cetone, and filtered through Al_2O_3(0.5×1.5 cm.). The filtrate was evaporated to yield a crystalline residue which was recrystallized from acetone-petr. ether to afford colorless needles, m.p. 165∼167°. *Anal.* Calcd. for $C_{18}H_{28}O_7$: C, 60.66; H, 7.92. Found: C, 60.96; H, 8.14. IR$\nu_{max}^{CHCl_3}$ cm^{-1}: 1770(γ-lactone). NMR$_{max}^{pyridine}$(τ): 8.55, 8.48, 8.26$\left((CH_3)_2C\langle\begin{smallmatrix}O-\\O-\end{smallmatrix},\ CH_3-\overset{|}{\underset{|}{C}}-\right)$; 5.72(2H, s, $-CH_2O-$); 5.72(1H, m, C_3-H); 5.33(1H, d, J=7 c/s), 4.80(1H, d, J=7 c/s) (C_{12}-H, C_{11}-H).

Oxidation of Coriamyrtin with Lead Tetraacetate——Coriamyrtin (500 mg.) was dissolved in a solution of $Pb(OAc)_4$ (1.14 g.) in AcOH (50 ml.) by stirring, and the resultant solution was allowed to stand for 2 days at room temperature to consume 0.957 mole equivalent of $Pb(OAc)_4$. The solvent was evaporated *in vacuo*, the residue was taken up with water (100 ml.), and extracted with ether. The ether extract was washed with saturated $NaHCO_3$ solution and H_2O, dried over Na_2SO_4, and evaporated to give colorless oil which was recrystallized from EtOH to afford colorless needles of (XVII), m.p. 224∼225°. *Anal.* Calcd. for $C_{17}H_{20}O_7$: C, 60.71; H, 5.99. Found: C, 60.82; H, 5.82. IRν_{max}^{Nujol} cm^{-1}: 1765(γ-lactone); 1740, 1260, 1230(OAc). NMR$_{max}^{pyridine}$(τ): 8.51(s), 8.46(s) ($CH_3-\overset{|}{\underset{|}{C}}-\times 2$); 7.90(s, CH_3CO-), ABq, 6.95, 6.70(J=4 c/s, terminal epoxide); ABq, 6.35, 5.95(J=3 c/s, epoxide at $C_{11}\sim C_{12}$); ABq, 5.53, 5.43(J=11 c/s, $-\overset{|}{\underset{|}{C}}-C\underline{H}_2-OAc$).

Formyloxyapocoriamyrtin (XVIII)——Coriamyrtin (500 mg.) was dissolved in 99% HCOOH (3.5 ml.), and 3% H_2O_2 (0.25 ml.) was added. After standing at room temperature for 24 hr., the reaction mixture was diluted with H_2O and the crystalline precipitate was collected. Recrystallization from acetone-petr. benzine afforded colorless needles, m.p. 247∼249° (235 mg.). *Anal.* Calcd. for $C_{16}H_{18}O_7$: C, 59.62; H, 5.63. Found: C, 59.52; H, 5.45. $[\alpha]_D^{21}$ −36.36° (c=0.264). IRν_{max}^{Nujol} cm^{-1}: 1778(γ-lactone); 1720, 1183(OHCO-).

Hydroxyapocoriamyrtin(XIX)——To a solution of (XVIII) (150 mg.) in hot dioxane (2 ml.), 2.5% HCOOH (6 ml.) was added, and the mixture was heated on a boiling water-bath for 1.5 hr., and then evaporated *in vacuo* to provide colorless crystals. Recrystallization from EtOH-petr. benzine afforded (XIX), m.p. 222° (decomp.) (80 mg.). *Anal.* Calcd. for $C_{15}H_{18}O_6$: C, 61.21; H, 6.17. Found: C, 61.12; H, 6.20. $[\alpha]_D^{25}$ −109.1° (c=1.02). IRν_{max}^{Nujol} cm^{-1}: 3400(OH); 1770(γ-lactone). NMR$_{max}^{pyridine}$(τ): ABq, 5.97, 5.86(J=11 c/s).

Acetylation of Hydroxyapocoriamyrtin——Hydroxyapocoriamyrtin (75 mg.) was acetylated with Ac_2O (0.3 ml.) and pyridine (0.3 ml.) overnight. Working up in the usual way, crystalline product was obtained which was recrystallized from $CHCl_3$-petr. benzine to provide colorless plates, m.p. 220∼222° (40 mg.), which were identified with (XVII) by mixed fusion and IR comparison.

Bromination of Hydroxyapocoriamyrtin——Hydroxyapocoriamyrtin (30 mg.) was suspended in pyridine (0.05 ml.) in a glass tube sealed at one end, and freshly distilled $SOBr_2$ (22 mg.) was dropped under ice-cooling. The mixture was left to stand to reach the room temperature, and then the other end of the tube was sealed, and heated on a boiling water-bath for 1 hr. After cooling, dil. HCl was added, and the precipitate was collected. This was dissolved in boiling EtOH, and the first precipitate to appear on cooling was removed by filtration. The filtrate was concentrated to give a crystalline residue which was purified by repeated recrystallization from dil. EtOH to afford colorless needles (3 mg.), which were identified with α-bromocoriamyrtin by mixed fusion and IR comparison.

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