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Lichen Triterpenoids. I. The Structure of Leucotylin

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The structure of leucotylin, one of the major triterpenoids of a lichen *Parmelia leucotyliza* Nyl., has been established as I on the basis of chemical and X-ray crystallographical investigations. It has also been suggested that zeorin, another major triterpenoid of the same lichen, has a similar carbon skeleton as leucotylin but differs at the C_{21} orientation as is expressed by II.

Only a few triterpenoids had conclusively been elucidated in the lichen family[2)] when we started the investigation on the triterpenic components of a lichen, *Parmelia leucotyliza* Nyl., several years ago. The parallel screening thereafter of some other lichens at hand has enabled us to perceive the fairly wide distribution of such components, and two initial interests, the one from the chemotaxonomical[3)] and the other from the chemical viewpoints, have led us to perform the extensive chemical research on the lichen triterpenoids. In the present paper, we are going to describe the detailed account on the structural study of leucotylin, one of the major triterpenoids of the above-mentioned lichen, leading the structure I.

As illustrated in Chart 1, the ether extracts of *Parmelia leucotyliza* Nyl. collected in the Kinki District or Izu Peninsula of this country afforded two major neutral triterpenes, zeorin[4)] and leucotylin,[5)] along with one triterpenic acid, named leucotylic acid by us.[6)] Among

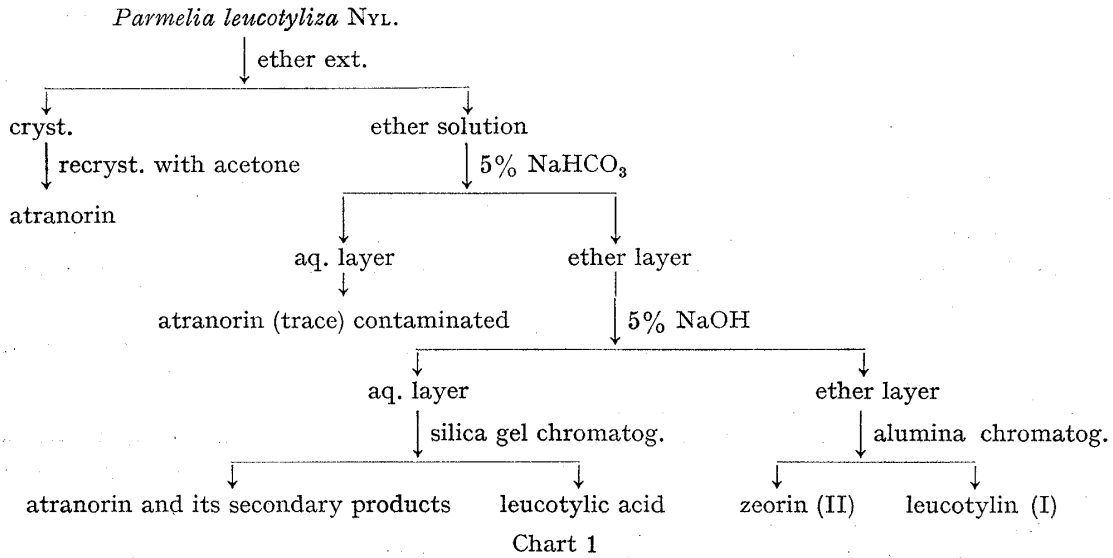


Chart 1

1) Location: *Toneyama, Toyonaka, Osaka.*
2) Y. Asahina and S. Shibata "Chemistry of Lichen Substances," Japan Society for the Promotion of Science, Tokyo, 1954, p. 34. Friedelin, *epi*-friedelinol and taraxerene were isolated from *Cetraria sp.* and *Cladonia sp.* respectively (T. Bruun, *Acta Chem. Scand.*, **8**, 71, 1291 (1954)).
3) S. Shibata "Biogenetical and Chemotaxonomical Aspects of Lichen Substances," in Festschrift Kurt Mothes zum 65 Geburtstag, Gustav Fischer Verlag, Jena, 1965, p. 332.
4) D.H.R. Barton, P. de Mayo, and J.C. Orr, *J. Chem. Soc.*, **1958**, 2239.
5) Y. Asahina and H. Akagi, *Chem. Ber.*, **71**, 980 (1938).
6) I. Yosioka, T. Nakanishi, and E. Tsuda, *Tetrahedron Letters*, **1966**, 607.

three, the studies on zeorin (II) and leucotylic acid will be the subjects of the forthcoming reports from this laboratory.[7,8] It seems noteworthy to point out here that the relative yields of the respective triterpenic components, especially leucotylin and leucotylic acid, very markedly depending upon the place where the lichen was collected.[9]

Gross Structure of Leucotylin[10]

Leucotylin (I), mp 289—292°, $C_{30}H_{52}O_3$ (M^+: 460 *m/e*), was first isolated in 1938 by Asahina and Akagi[5] from the identical lichen in addition to zeorin and reported to possess two secondary and one tertiary hydroxyls. Later on, although another investigation on leucotylin had appeared,[11] the unambiguous elucidation of its structure has never been provided.

It exhibited positive Liebermann–Burchard coloration and negative for tetranitromethane test. It furnished a diacetate (III), $C_{34}H_{56}O_5$, mp 241—242°, infrared (IR) spectrum[12] (Nujol, cm^{-1}): 3554, 1719, 1239, with acetic anhydride and pyridine and a monoketone (IV)[13a] (named[13b] 6-dehydroleucotylin), $C_{30}H_{50}O_3$, mp 288—290°, IR: 3205, 1702, on chromium trioxide–pyridine or chromium trioxide–acetic acid oxidation. The latter gave a monoacetylmonoketone (V), $C_{32}H_{52}O_4$, mp 226.5—230.5°, IR: 3420, 1731, 1684, 1239. The nuclear magnetic resonance (NMR) spectra[14] of I, III, IV and V (Table I) in addition to the IR spectra of those disclose that leucotylin possesses two secondary and one tertiary hydroxyl functions as found by previous workers.[5] The carbonyl function in IV was found almost inert for oximation, Huang–Minlon reduction under the usual reaction condition, while the tertiary hydroxyl function in III, survived under the usual acetylation, was verified to be in an isopropanol moiety as clarified in zeorin[4] by the reactions shown below. Thus, on treatment with phosphorus oxychloride–pyridine, III yielded a dehydration product (VI),[15] which was effectively separated to two components, an isopropenyl derivative (VIa), $C_{34}H_{54}O_4$, mp 210—211°, IR ($CHCl_3$): 1730, 1243 (OAc), 1639, 888 (>C=CH_2) and an isopropylidene compound (VIb), mp 182—183°, IR ($CHCl_3$): 1727, 1242 (OAc), respectively with silver nitrate impregnated silica gel column.[16] The respective formulations (VIa and VIb) are fully consistent with the IR data along with their NMR spectral properties given in Tabe I. Next, our attention was forcused towards the carbon skeleton of leucotylin.

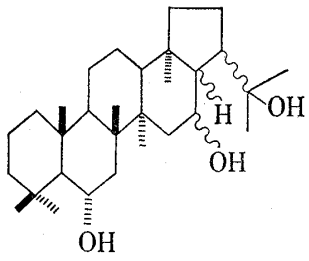
Refluxing of leucotylin in 5% ethanolic hydrogen chloride yielded a conjugated diene (named leucotylidiene) (VII), $C_{30}H_{48}O$, mp 167.5°—168.5°, IR: 3482 (OH), 1637, 787, 772 (double bond), ultraviolet (UV) spectrum (λmax, log ε): 244 (4.59), 252 (4.66), 261 (4.48) showing a characteristic heteroannular diene chromophore,[17] whose physical properties were found in good accord with dehydrozeorinin previously prepared from zeorin (II) *via* zeorinin oxide (X).[4,18] In fact, an acetate (VIII), $C_{32}H_{50}O_2$, mp 223—226° (M^+: 466), derived from

7) I. Yosioka, T. Nakanishi, and I. Kitagawa, *Chem. Pharm. Bull.* (Tokyo), the following paper (Preliminary report: ref. 14).
8) I. Yosioka, *et al.*, to be published. Preliminary report: see ref. 6).
9) See the experimental section. To simplify the presentation, we use the final structure here after.
10) I. Yosioka and T. Nakanishi, *Chem. Pharm. Bull.* (Tokyo), **11**, 1468 (1963) (Preliminary report of this subject).
11) S. Huneck, *Chem. Ber.*, **94**, 614 (1961).
12) The IR spectra were taken in Nujol mull and expressed in cm^{-1} unless specified otherwise.
13) *a*) Although Huneck prepared a diketone derivative by chromium trioxide–sulfuric acid oxidation,[11] we were unable to obtain the diketone under the conditions applied; *b*) 6-Dehydroleucotylin is a same compound with 6-keto-leucotylin in our earlier paper, lit. 10, 22, 38.
14) The NMR spectra were measured with the Hitachi H-60 spectrometer in deuteriochloroform with tetramethylsilane as an internal standard.
15) The product (VI) in lit. 10) was analyzed $C_{34}H_{54}O_4$, mp 177—179°, IR: no hydroxyl, 1730, 1241, 1629, 887, which is now revealed a mixture of VIa and VIb.
16) T. Norin and L. Westfelt, *Acta Chem. Scand.*, **17**, 1828 (1963).
17) D.H.R. Barton and C.J.W. Brooks, *J. Chem. Soc.*, **1951**, 257.
18) Y. Asahina and I. Yosioka, *Chem. Ber.*, **73**, 742 (1940).

VII, was identified with dehydrozeorinin acetate in all respects. In addition, the physical properties (IR, UV, NMR) of VIII provide the reasonable support for its formulation. Especially, an AB type signal at τ 4.43 and 3.77 (Table I) ascribable to C_{15}–H and C_{16}–H of VIII distinctly eliminates another probable $\Delta^{16(17),21(20)}$ heteroannular diene.

All the evidence mentioned above now indicates that leucotylin possesses the identical carbon skeleton (including C_6-α-hydroxyl) with zeorin except the geometry at C_{17} and C_{21}. This also explains the inertness of the carbonyl function of 6-dehydro-leucotylin (IV), as observed in zeorinone,[4] and the location of the tertiary hydroxyl in leucotylin at C_{22}.

The decision of the position C_{16} for another secondary hydroxyl was made as follows. The easy formation of the dienic compound (VII) under the acidic condition provides C_{15} or C_{16} as the possible site based on the mechanistic viewpoint (*via* dehydration of the tertiary hydroxyl at C_{22}, double bond migration to Δ^{17} and then followed by elimination of allyl or homoallyl alcoholic moiety),[19] since zeorin was known to afford zeorinin[4] (IX) by the similar treatment. The choice for C_{16} was made by the examination[20] of intramolecular hydrogen bonding, *i.e.* IR (CCl_4, 5×10^{-4}M): 3602 (free OH), 3424, 3222 (associated OH) in I and IR (CCl_4, 5×10^{-4}M): 3603 (free OH), 3437, 3243[21] (associated OH), 1711 (carbonyl) in IV, which reveals the significant hydrogen bond between



I′

Table I (τ Values in $CDCl_3$)

	O– –C(6)–H	O– –C(16)–H	Other remarks	Methyls
I	5.99 (m., br.)	5.99 (m., br.)		9.25, 9.17, 9.04, 8.97, 8.96, 8.86, 8.86, 8.78
III	4.82 (m., br.)	4.82 (m., br.)	7.96 (s., 3H) (OAc) 7.92 (s., 3H) (OAc)	9.15, 9.15, 9.06, 8.96, 8.88, 8.88, 8.88, 8.88
IV	——	5.95 (m., br.)	——	9.21, 9.18, 9.10, 9.00, 8.86, 8.84. 8.79, 8.74.
V	——	4.79 (m., br.)	7.95 (s., 3H) (OAc)	9.17, 9.12, 9.11, 9.01, 8.86, 8.86, 8.79, 8.79
VIa	4.85 (m., br.)	4.85 (m., br.)	8.12 (s., 3H) (OAc) 7.97 (s., 3H) (OAc) 5.36 (br.s., 2H) >C=CH$_2$ 8.28 (s., 3H) >C=C–CH$_3$	9.18, 9.14, 9.04. 8.96, 8.92, 8.83
VIb	4.76 (m., br.)	4.76 (m., br.)	8.38 (s., 6H) >C=C(CH$_3$)$_2$ 7.89 (s., 6H) (OAcX2)	9.31, 9.10, 9.01, 8.91, 8.86, 8.82
VIII	4.68 (m., br.)	——	3.77 (1H) } ABq. 4.43 (1H) } J=10.4 cps	9.09, 9.09, 9.05, 9.05, 8.91, 8.91, 8.91, 8.79
XI	4.93 (m., br.)	4.93 (m., br.)	8.05 (s., 3H) (OAc) 8.01 (s., 3H) (OAc)	9.25—8.89 (CH$_3$×8)
XII	4.92 (m., br.)	4.92 (m., br.)	8.01 (s., 6H) (OAc)	9.20—8.92 (CH$_3$×8)
XX	4.95 (m., br.)	4.95 (m., br.)	8.07 (s., 3H) (OAc) 7.97 (s., 3H) (OAc) 7.85 (s., 3H) (COCH$_3$)	9.20, 9.14, 9.05, 8.96, 8.91, 8.85

19) Another possible location for the secondary hyroxyl in ring E was rejected due to the formation of 6-membered carbonyl compounds such as XIV and XXIII as mentioned later.

20) The infrared spectral determination on this problem was kindly performed by Dr. T. Kubota, Shionogi Res. Lab. of Shionogi & Co. Ltd.

21) Shoulder.

C_{22}-hydroxyl and the secondary one existing in I and IV thus excluding C_{15} from the reasonable location, and therefore concluding the gross structure of leucotylin as I'.

Stereostructure of Leucotylin and Its Correlation with Zeorin[22]

On catalytic hydrogenation over Adams' catalyst in ethanol, the isopropenyl compound (VIa), retaining the C_{21} configuration of leucotylin, yielded a saturated diacetate (XI) as a sole product, $C_{34}H_{56}O_4$, mp 240—241°, whose structure was supported by its physical properties: disappearance of NMR signals and IR absorption bands ascribable to the isopropenyl moiety and regeneration of eight C-methyl signals in NMR (Table I). On the contrary, by similar hydrogenation in acetic acid–ethyl acetate mixture,[23] another dehydration product (VIb) gave rose to two saturated diacetates,[24] the one identical with XI and the other (major, unexpectedly) (XII), $C_{34}H_{56}O_4$, mp 229—231°, having also eight C-methyl functions as revealed by its NMR spectrum (Table I). Since these two derivatives (XI and XII) could be separable by using neutral alumina column, the catalytic hydrogenation of total dehydrated product (VI) in acetic acid–ethyl acetate as well afforded XI and XII.[24]

The constitution XII was assigned with C_{21}-β-isopropyl side chain, isomeric to XI, based mostly on the mechanistic consideration of its formation as discussed in the previous communication.[25] Thus, protonation on the isopropylidene double bond of VIb would initiate the reaction and result two C_{22}-cationic intermediates, one with α-isopropyl and another having β-isopropyl at C_{21}, which then might suffer hydrogen attack yielding XI and XII respectively.[26] It is unlikely to anticipate the migration of $\Delta^{21,22}$-bond in VIb to $\Delta^{17(21)}$ (zeorinin type) prior to catalytic hydrogen attack, since the $\Delta^{21,22}$-bond (*cf.* hopene-a) has been known stable in acetic acid–ethyl acetate at room temperature, and if not so, the $\Delta^{17(21)}$-bond would not be hydrogenated under the reaction condition used. Therefore, the geometry at C_{17} must be retained in XII. Referring literatures, the analogous speculations in favor of our arguments have been made, for instance, on catalytic hydrogenations in the acidic media of pimaric acid derivatives[28] and hopene-a[29,30] respectively. Accordingly, it has become clear so far that the saturated diacetate XI retains the configuration at C_{21} of leucotylin while the other diacetate XII possesses the inverse geometry at C_{21} (a prefix 21αH is used hereafter).

A diol (=22–desoxy–leucotylin) (XIII), $C_{30}H_{52}O_2$, mp 237.5—238.5°, IR: 3380, prepared from XI, yielded a diketone (XIV), $C_{30}H_{48}O_2$, mp 283.5—284°, IR (KBr): 1709, 1704, with chromium trioxide–acetic acid in good yield. The latter in turn could be converted to the parent diol by sodium–isopropanol reduction also in good yield. Assuming no geometrical alteration at C_{17} occurred during the reaction sequence,[31] leucotylin could be assigned to hold two stable equatorial hydroxylic functions, *i.e.* 6α (as already established above) and 16β. The assignment for C_{16}-β-OH is substantiated by the NMR inspection of IV and V

22) I. Yoshioka, T. Nakanishi, and I. Kitagawa, *Tetrahedron Letters*, **1968**, 1485. (This paper constitutes the preliminary report on this subject).
23) The hydrogenation of VIb in the neutral solvent was uneffected.
24) The compound named deoxyleucotylin diacetate, mp 212—214.5°, in our preliminary report[10] is now revealed to be a mixture of XI and XII, hence it follows that all its derivatives in the same report are mixtures of C_{21}-configurational isomers.
25) I. Yosioka, T. Nakanishi, and I. Kitagawa, *Tetrahedron Letters*, **1966**, 5185.
26) As will be presented in the following paper,[7] on similar catalytic hydrogenation zeorininone-a (VIb type, but lacking 16β-acetoxyl) gave only one saturated product (XI type, without 16β-acetoxyl, presumably formed by hydrogen attack from the less hindered β side),[27] which suggests an anchimeric assistance (although unexplicable minutely here) of 16β-acetoxyl function in case of VIb resulting the simultaneous formation of XII.
27) I. Yoshioka, T. Nakanishi, and I. Kitagawa, *Chem. Pharm. Bull.* (Tokyo), **5**, 353 (1967).
28) J.W. Apsimon, P.V. Demarco, and J. Lemke, *Can. J. Chem.*, **43**, 2793 (1965).
29) Y. Tsuda, K. Isobe, S. Fukushima, H. Ageta, and K. Iwata, *Tetrahedron Letters*, **1967**, 23.
30) R.E. Corbett and R.A.J. Smith, *J. Chem. Soc.*, **1967**, 1622.
31) The assumption was rationalized as discussed later.

(Table I). Thus, the signals due to the C_{16}-carbinyl hydrogens at τ 5.95 (m.) and 4.79 (m.) having respective half-band widths 20 cps and 18 cps[32] account for 16β-OH (equatiorial) orientations in IV and V. Furthermore, the easy acetylation of the hydroxyl at C_{16} (I or IV)[33] corroborates the formulation.

The following descriptions are concerned to the geometry at C_{17} and C_{21} of leucotylin and correlation with the stereostructure of zeorin. The diketone (XIV) was found considerably stable towards either acid or alkali treatment, although an isomeric diketone (XV) (mp 226—230°), presumably having D/E *cis* juncture, could be isolated in poor yield on heating XIV at *ca.* 230° in triethyleneglycol–potassium hydroxide, and the Huang–Minlon reduction of

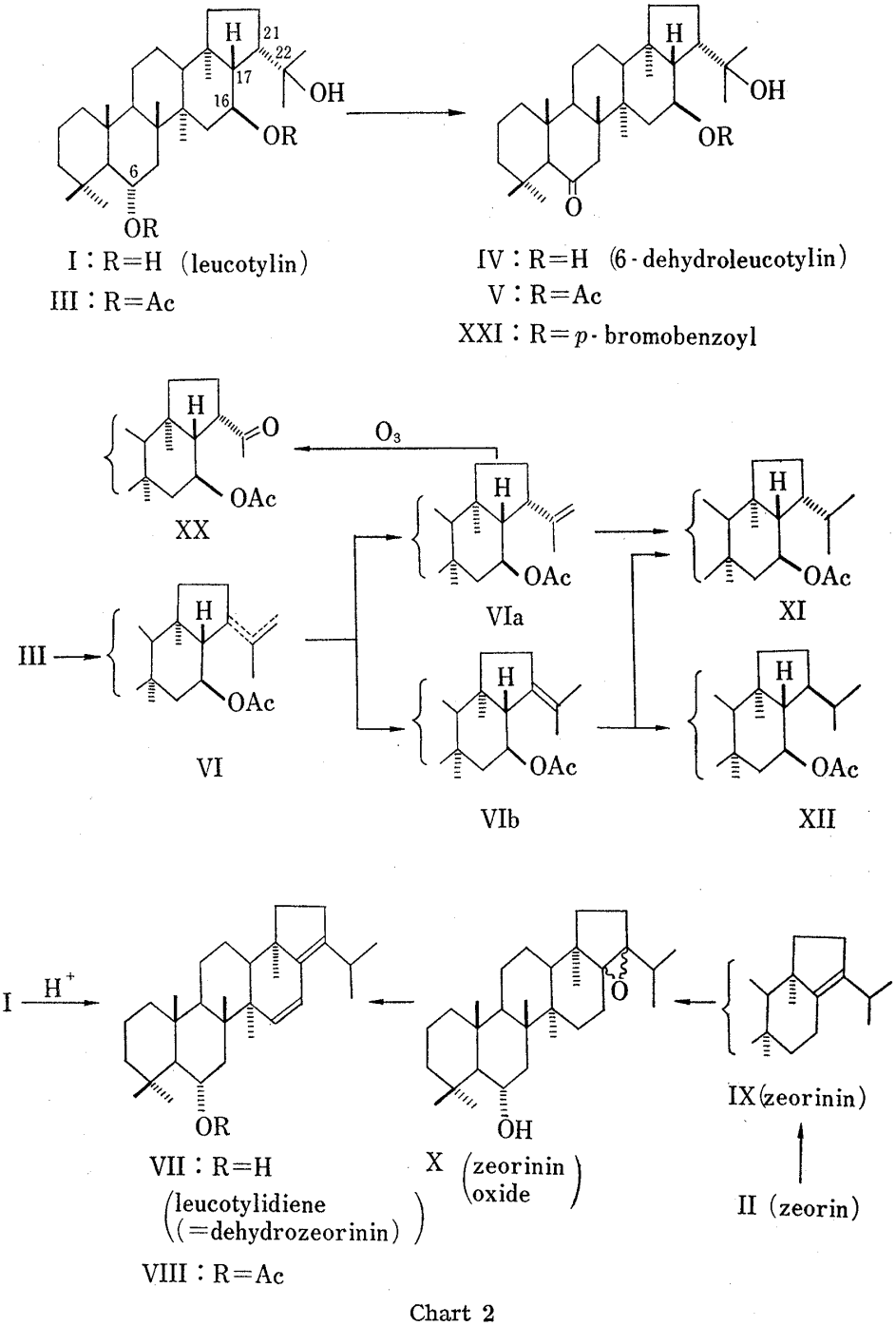


Chart 2

32) [N.S. Bhacca and D.H. Williams, "Applications of NMR spectroscopy in Organic Chemistry," Holden-Day, Inc., San Francisco, 1964, p. 79.

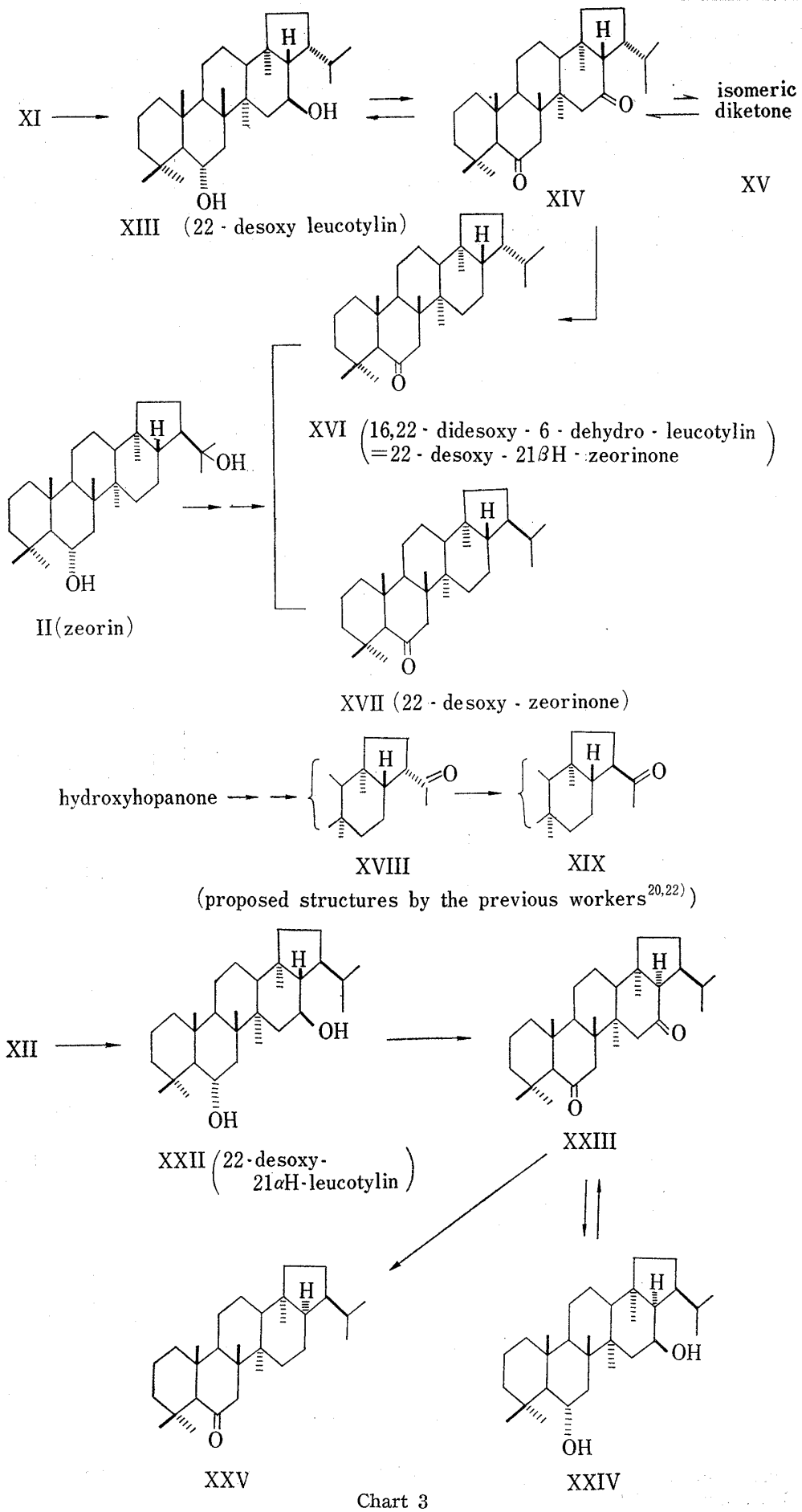


Chart 3

XIV in usual manner gave smoothly a monoketone (=16,22-didesoxy-6-dehydroleucotylin) (XVI) $C_{30}H_{50}O$, mp 207—208°, IR (KBr): 1704. During the reduction procedure, the care was taken to avoid the D/E juncture isomerization by preparing hydrazone at first followed by the alkaline treatment. The monoketone XVI thus obtained possesses the original geometry at C_{17} and C_{21}, and is the key compound to manifest the difference at C_{21} configuration between leucotylin and zeorin. As will be described for particulars in the following paper,[7] among two saturated monoketones derived from zeorin, the one (=22-desoxy-zeorinone) (XVII) keeping the C_{21}-geometry of zeorin was found to be non-identical with XVI, while the other monoketone (=22-desoxy-21βH-zeorinone), possessing inverted C_{21}-geometry was found completely identical with XVI (mixed mp, IR, TLC, and GLC). Consequently, it has become distinct that the D/E juncture isomerization did not occur during the process from XIV to XVI and quite interesting to mention from the biogenetic viewpoint is that leucotylin and zeorin, co-existing widely in the lichen family, have different geometry only at C_{21} in their carbon frameworks. Since the chemical proof on the identity of the carbon skeletons of zeorin and hopane has already been established by Tsuda, *et al.*[29] and by us[27] independently, provided that the stereostructure of hopane is correctly expressed by C_{21} α-isopropyl side chain as has been proposed by Jones, *et al.*[34] leucotylin should have C_{21} β-isopropanol configuration, *i,e.* isohopane framework.[34,35]

The most important ground presented by two previous groups[34,36] supporting C_{21} α-isopropanol orientation in hydroxyhopane is the finding that a norketone (=adiantone, partial structure proposed as XVIII by them) is unstable and easily isomerizable to another norketone (=isoadiantone, expressed XIX by the same authors) presumably due to the severe sterical congestion between C_{18} α-methyl and C_{21} α-methylketone moiety in XVIII as revealed by inspection using Dreiding model where the ring E is constituted in a "C_s" (envelope) form (R=H in **4**, Chart 4). To check the analogous behavior, a norketone derivative (XX), mp 219—222°, IR (KBr): 1738, 1734, 1241 (acetyl), 1710 (shoulder) (ketone) was prepared by ozone oxidation of VIa and was found stable towards the acidic treatment, which was intense enough to convert the corresponding norketone derivative of leucotylic acid[37] to the stable isomer. Accordingly, all the evidence described above could be fitted reasonably, if one would forward the isohopane framework for leucotylin. Not only due to the aforementioned biogenetic interest, however, but the growing importance to have the solid answer on the carbon skeletons of these triterpenoids led us to perform the X-ray analysis of 16β-O-*p*-bromobenzoate (XXI), $C_{37}H_{53}O_4Br$, mp 235—238°, IR (KBr): 3505, 3456 (OH), 1705, 1704 (sh.) (CO), 1593 (benzene), 1267 (C-O-CO), NMR (τ): eight methyls singlets, A_2B_2 quartet (4H, A_2 part 2.16, B_2 part 2.45, J=8.2 cps), prepared by *p*-bromobenzoyl chloride treatment of 6-dehydro-leucotylin (IV) in pyridine. The compound (XXI) regenerated IV by alkaline hydrolysis in quantitative yield. Strikingly, the bromoderivative was clarified to possess C_{21}-α-quasi-equatorial side chain standing on "C_2" form (half-chair) of ring E[38] (Fig. A). This

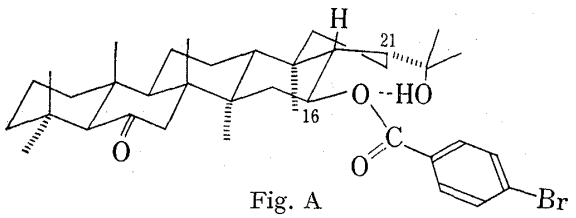


Fig. A

33) Considering the fact that the hydroxyl at C_{16} of IV resisted for oxidation while 16β-OH in XIII could be oxidized by chromium trioxide-acetic acid, the stubborn resistance might be ascribed to the severe intramolecular hydrogen bonding between C_{16}- and C_{22}- hydroxyls of IV as disclosed by IR.[20]

34) G.U. Baddeley, T.G. Halsall, and E.R.H. Jones, *J. Chem. Soc.*, **1961**, 3891.

35) M.N. Galbraith, C.J. Miller, J.W.L. Rawson, E. Ritchie, J.S. Shannon, and W.C. Taylor, *Australian J. Chem.*, **18**, 226 (1965).

36) G. Berti, F. Bottari, A. Marsili, J.M. Lehn, R. Witz, and G. Ourisson, *Tetrahedron Letters*, **1963**, 1283.

37) I. Yosioka, M. Yamaki, T. Nakanishi, and I. Kitagawa, *Tetrahedron Letters*, **1966**, 2227.

38) T. Nakanishi, T. Fujiwara, and K. Tomita, *Tetrahedron Letters*, **1968**, 1491.

confirms the stereostructure of leucotylin being I and consequently infers that C_{21}-isopropanol side chain of zeorin would be β contrary to the previous presentation, which will be detailed in the following paper.[7] Furthermore, the stability of the norketone (XX) should be ascribed to α-quasi-equatorial character of methylketone moiety attached to "C_2" form of ring E (R=OAc in 2, Chart 4) rather than β-equatorial disposition attached to "C_s" form of ring E (R=OAc in 3, Chart 4). Consequently, the significant instability of adiantone would be accounted for either by its unfavorable β-axial nature of the methylketone moiety attached to "C_2" form (R=H in 1, Chart 4) or by the less stability of "C_s" form possessing β-equatorial methyl ketone moiety (R=H in 3, Chart 4).[39]

On the other hand, alkaline hydrolysis of the other saturated diacetate (XII) furnished a diol (=22-desoxy-21αH-leucotylin) (XXII), $C_{30}H_{52}O_2$, mp 251—253°, IR: 3571, 3471, distinguishable from XIII by TLC and having an opposite C_{21}-geometry against XIII. On chromium trioxide–acetic acid oxidation, the diol (XXII) gave a diketone (XXIII), $C_{30}H_{48}O_2$, mp 279—280°, IR (KBr): 1703, 1690, in low yield. The latter is also distinguished from XIV by TLC. Reduction of the diketone (XXIII), with sodium–isopropanol in turn yielded another diol (=22-desoxy-17αH, 21αH-leucotylin) (XXIV), $C_{30}H_{52}O_2$, mp 234—235°, IR: 3411, which reproduced the parent diketone by chromium trioxide–acetic acid oxidation with almost quantitative yield in this case. The findings would rationally be understood by assuming that (i) the D/E ring juncture of XXII might isomerize from *trans* to *cis* on oxidation process or (ii) XXIV might have C_{16}-α-axial hydroxyl attached to D/E trans configuration (*i.e.* C_{16} epimeric to XXII). The former assumption is supported, however, by the following reasons: (i) TLC behavior of XXII and XXIV does not agree with the assumption of XXII having equatorial and XXIV with axial hydroxyls, (ii) the diketone (XXIII) once formed is found considerably stable to acid and alkali, (iii) the Huang-Minlon reduction of XXIII afforded a third monoketone (XXV), mp 156—158°, IR (CCl_4): 1710, being undoubtedly different from XVI and XVII.[40]

In conclusion, the final stereostructure of leucotylin has now been confirmed to be I, and yet as there is some degree of hydrogen bonding in the bromobenzoate (XXI) between the C_{22}-hydroxyl function and C_{16}-hydroxylic oxygen as revealed by the X-ray analysis,[38] the association might cause somewhat conformational distortion especially in the rings D and E circumstances capable of forcing "C_2" form of ring E more favored. Therefore, it might be a kind of over-estimation to induce the result obtained with XXI into the stereochemical nature of hydroxyhopane derivatives which lack any oxygen function at C_{16}. To clarify the subject,

39) These correlations including the relative stability among four typical ring E stereostructures (1, 2, 3, 4) could be illustrated as shown in Chart 4.

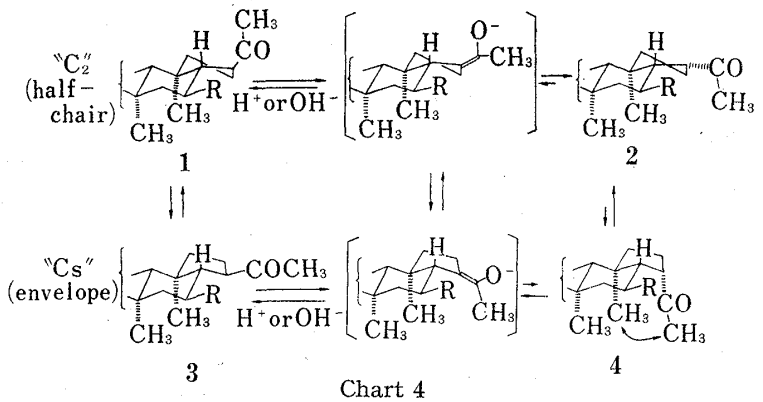


Chart 4

40) The presently available results are in agreement with expression that D/E *trans* juncture having C_{21}-α-isopropyl function (as XIV) is a stable form while D/E *trans* juncture with C_{21}-β-isopropyl is less stable and rapidly isomerizes to D/E *cis* (as XXIII), although the satisfactory interpretation is still lacking and hence the subject seems to be open to further study.

therefore, the X-ray analysis of a heavy atom induced derivative of 3,22-dihydroxyhopane is in progress in this faculty.

Experimental[41]

Isolation of Leucotylin (I)——During the successive ether extraction of the air dried lichen, *Parmelia leucotyliza* Nyl. (3.6 kg) collected in the Izu Peninsula, a crop of crystalline (atranorin,[42] recrystallized with acetone) was precipitated. The combined ether soluble parts were treated with aqueous 5% $NaHCO_3$ and 5% NaOH successively as shown in Chart 1. From the alkali soluble part, on silica gel column chromatography, leucotylic acid (0.4 g, 0.01%) was obtained. The neutral fraction gave 25 g of solid residue, which was repeatedly chromatographed on alumina eluting with chloroform, chloroform–methanol, and methanol successively to give zeorin (II) (10.7 g, 0.3g, recrystallized with benzene and then from methanol, colorless needles, mp 227—229°) and leucotylin (I), mp 289—292°[43] (6.6 g, 0.19%, colorless feathery crystals, recrystallized with methanol) $[\alpha]_D$ +56.5°. *Anal.* Calcd. for $C_{30}H_{52}O_3$ (leucotylin): C, 78.20; H, 11.38; mol. wt., 460.72. Found: C, 77.97; H, 11.25; mol. wt. (mass) $M^+=460$ *m/e*. NMR (τ): 9.25, 9.17, 9.04, 8.97, 8.96, 8.78 (3H each, all singlets) 8.86 (6H, singlet) (total eight methyls), 5.99 (2H, diffused multiplet, 2×>C<u>H</u>OH).

The followings are the respective yields obtained by the similar fractionations as above from the lichens collected at the other places.

Place	Yield (% in the parentheses)
Nose, Osaka-fu	zeorin (0.3), leucotylin (0.05) leucotylic acid (0.16)
Joruri-ji, Kyoto-fu	zeorin (0.3), leucotylin (0.05) leucotylic acid (trace)

6,16-Di-O-acetyl-leucotylin (III)——Leucotylin (I) (9.6 g) was treated with pyridine (250 ml) and Ac_2O (100 ml) at room temperature overnight as usual followed by alumina column purification (eluted with benzene) yielding 7.2 g of III, colorless fine needles crystallized from MeOH, mp 241—242°, $[\alpha]_D$ +120°. *Anal.* Calcd. for $C_{34}H_{56}O_5$: C, 74.95; H, 10.36. Found: C, 74.40; H, 10.40. IR ν_{max}^{Nujol} cm^{-1}: 3554 (OH), 1719, 1239 (OAc). NMR (τ): 9.15 (6H), 9.06 (3H), 8.96 (3H), 8.88 (12H) (each singlet, total eight methyls), 7.96, 7.92 (3H each, singlet, OCOC<u>H</u>$_3$), 4.82 (2H, diffused multiplet, 2×>C<u>H</u>OAc).

6-Dehydro-leucotylin (IV)——a) Oxidation of leucotylin (I) (0.8 g) with CrO_3 (0.4 g) and pyridine (10 ml) at room temperature overnight in a usual manner yielded IV (0.6 g), mp 288—290°, colorless rods recrystallized with AcOEt, $[\alpha]_D$ +23.7°. *Anal.* Calcd. for $C_{30}H_{50}O_3$: C, 78.55; H, 10.99. Found: C, 78.32; H, 10.89. IR ν_{max}^{Nujol} cm^{-1}: 3205 (OH), 1702 (CO), 1277, 1155, 1096. NMR (τ): 9.21, 9.18, 9.10, 9.00, 8.86, 8.84, 8.79, 8.74 (3H each singlet, eight methyls), 5.95 (1H, multiplet, >C<u>H</u>OH).

b) Leucotylin (0.5 g) in AcOH (20 ml) was oxidized with CrO_3 (0.2 g)–water (0.2 ml)–AcOH (2 ml) mixture at room temp. overnight followed by passing through alumina column with benzene giving IV identical with the above mentioned oxidation product in IR.

16-O-Acetyl-6-dehydro-leucotylin (V)——Acetylation of IV (0.6 g) was effected with Ac_2O (5 ml) and pyridine (16 ml) as usual to yield V (0.55 g), colorless needles from methanol, mp 226.5—230.5°, $[\alpha]_D$ +80.4°. *Anal.* Calcd. for $C_{32}H_{52}O_4$: C, 76.75; H, 10.47. Found: C, 76.98; H, 10.60. IR ν_{max}^{Nujol} cm^{-1}: 3420 (OH), 1731, 1239 (OCOCH_3), 1684, (CO). NMR (τ): 9.17, 9.12, 9.11, 9.01 (3H each), 8.86, 8.79 (6H each) (total eight methyls signlets), 7.95 (3H, signlet, OCOC<u>H</u>$_3$), 4.79 (1H, multiplet, >C<u>H</u>OAc).

Leucotylidiene (VII)——Leucotylin (I) (200 mg) was refluxed in conc. HCl (5.5 ml)-EtOH (28 ml) mixture for 20 min. The reaction mixture was diluted with water, extracted with ether. The residue obtained by evaporation of the solvent was chromatographed on silica gel column eluting with $CHCl_3$–benzene (2:1) to afford VII, mp 167.5—168.5° (120 mg) colorless thready crystals, recrystallized with aq. EtOH. $[\alpha]_D$ +79.3°. VII exhibited orange yellow by tetranitromethane. *Anal.* Calcd. for $C_{30}H_{48}O$: C, 84.84; H, 11.39. Found: C, 84.68; H, 11.64. UV λ_{max}^{EtOH} mμ (log ε): 244 (4.59), 252 (4.66), 261 (4.48). IR ν_{max}^{Nujol} cm^{-1}: 3482 (OH), 1637, 787, 772 (double bond).

41) Melting points were taken on the Yanagimoto Micromelting-point Apparatus (a hotstage type) and recorded as read. Specific rotations were measured in chloroform with the Rex Photoelectric Polarimeter NEP-2 (c=1.5—1.0, l=1 cm) or with the Yanagimoto Photomagnetic Direct Reading Polarimeter model OR-20 (c=0.02—0.03, l=1 dm), the mass spectra were taken on the Hitachi RMU-6D mass spectrometer, and GLC data were obtained by using the Yanagimoto Gas Chromatograph Model GCG-3DH, with FID.

42) A known depside, lit. 2) p. 94.

43) Melting point 333° was observed by a $AgNO_3$ bath taken in capillary.[10]

6-O-Acetyl-leucotylidiene (=Dehydrozeorinin Acetate) (VIII)——Acetylation of leucotylidiene (VII) (100 mg) with Ac_2O (8 ml)–pyridine (10 ml) followed by neutral alumina column chromatography (developed with petr. benzine) yielded VIII, mp 223—226°, colorless rods (from MeOH), which showed orange by tetranitromethane. $[\alpha]_D$ +73.5°. *Anal.* Calcd. for $C_{32}H_{50}O_2$: C, 82.34; H, 10.80. Found: C, 82.04; H, 10.86. UV λ_{max}^{EtOH} mμ (log ε): 244 (4.73), 252 (4.79), 261 (4.64). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1716, 1250 ($OCOCH_3$).

The compound obtained here was identified with dehydrozeorinin acetate prepared from dehydrozeorinin *via* zeorinin oxide (X) by UV, IR, and mixed melting point determination.

Dehydration of 6,16-Di-O-acetyl-leucotylin (III) with $POCl_3$ yielding Isopropenyl (VIa) and Isopropylidene (VIb) Derivatives——a) Diacetate (III) (0.6 g) in pyridine (15 ml) was treated with $POCl_3$ (2 ml) at room temperature overnight. By purification on neutral alumina column (eluted with petr. benzine–benzene=(4:1)), a product (VI) of melting at 185.5° (colorless fine needles) was obtained after single crystallization from MeOH. In consequence of repeated recrystallization of VI its melting point varied 186—188°→178—182°→180—183°→177—179,[10] indicating VI to be a mixture, which was revealed by TLC (using silver nitrated impregnated silica gel-G (Merck). *Anal.* Calcd. for $C_{34}H_{54}O_4$ (VI): C, 77.52; H, 10.33. Found: C, 77.39; H, 10.28. IR ν_{max}^{Nujol} cm^{-1}: 1730, 1241 ($OCOCH_3$), 1629 887 (double bond).

b) A dehydrated mixture (VI) obtained from the diacetate (III) (2.7 g), pyridine (85 ml) and $POCl_3$ (13 ml) as described above was chromatographed on silver nitrate impregnated silica gel column[16] developing with *n*-hexane–benzene (1:1) suuccessively. The earlier eluant gave crude isopropylidene derivative (VIb) (550 mg), which was recrystallized with MeOH giving pure VIb (colorless leaflets, 350 mg), mp 182—183°. *Anal.* Calcd. for $C_{34}H_{54}O_4$ (VIb): C, 77.52; H, 10.33. Found: C, 77.97; H, 10.43. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1727, 1242 ($OCOCH_3$). NMR (τ): 9.31, 9.10, 9.01, 8.91, 8.86, 8.82 (3H each, all singlets), 8.38 (6H, singlet $>C=C(C\underline{H}_3)_2$), 7.89 (6H, singlet, 2×$OCOCH_3$), 4.76 (2H, multiplet, 2×$>C\underline{H}OAc$). From the later eluant was obtained crude isopropenyl one (VIa) (230 mg), which gave pure VIa of melting at 210—211° by recrystallization with MeOH (colorless needles, 160 mg). *Anal.* Calcd. for $C_{34}H_{54}O_4$ (VIa): C, 77.52; H, 10.33. Found: C, 77.06; H, 10.26. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 1730, 1243 ($OCOCH_3$), 1639, 888 ($>C=C\underline{H}_2$). NMR (τ): 9.18, 9.14, 9.04, 8.96, 8.92, 8.83 (3H 2× each, all singlets), 8.28 (3H, singlet, $>C=\underset{|}{C}-C\underline{H}_3$), 5.36 (2H, broad singlet, $>C=C\underline{H}_2$), 8.12, 7.97 (3H each, $OCOCH_3$), 4.85 (2H, multiplet, 2×$>C\underline{H}OAc$).

Hydrogenation of VIa giving 6,16-Di-O-acetyl-22-desoxy-leucotylin (XI)——Isopropenyl derivative (VIa) (113 mg) in EtOH (35 ml) was hydrogenated over PtO_2 (70 mg) at room temperature until one mole of hydrogen was uptaken. The product, after recrystallization with MeOH, yielded XI (108 mg), mp 240—241°, negative to tetranitromethane. *Anal.* Calcd. for $C_{34}H_{56}O_4$: C, 77.21; H, 10.67. Found: C, 77.21; H, 10.74. IR ν_{max}^{Nujol} cm^{-1}: 1727, 1738 (shoulder), 1247 ($OCOCH_3$). NMR (τ): total eight methyls between 9.25 and 8.89; 8.05, 8.01 (3H each singlet, 2×$OCOCH_3$), 4.93 (2H, multiplet, 2×=$C\underline{H}OAc$).

Hydrogenation of VIb giving XI and 6,16-Di-O-acetyl-22-desoxy-21αH-leucotylin (XII)——Isopropylidene derivative (VIb) (300 mg) was hydrogenated over PtO_2 (100 mg) in AcOH (30 ml)–AcOEt (30 ml) mixture at room temperature (7 hr). The reaction product showed two spots on TLC (developed with benzene), one with higher *Rf* value (0.40) coincides with XI and the other with lower *Rf* value (0.36) corresponds to XII. Moreover, the TLC of the product using silver nitrate impregnated silica gel G revealed that it contained no more starting compound (VIb) left unreacted. The isolation of two components was effected by neutral alumina column chromatography eluting with *n*-hexane–benzene (5:1) and benzene successively, and by preparative TLC (silica gel G) used together. The compound (60 mg) thus obtained (recrystallized with MeOH) from the earlier eluted fraction was identified with XI (described above) (mixed mp, TLC, and IR), while from the later eluant was obtained the other saturated diacetate (XII) (100 mg), mp 229—231°, colorless needles from MeOH. *Anal.* Calcd. for $C_{34}H_{56}O_4$: C, 77.22; H, 10.67. Found: C, 76.86; H, 10.65. IR ν_{max}^{Nujol} cm^{-1}: 1736 (shoulder), 1722, 1244 ($OCOCH_3$). NMR (τ): eight methyls between 9.20 and 8.92 (total eight methyls), 8.01 (6H, singlet, 2×$OCOCH_3$), 4.92 (2H, multiplet, 2×$>C\underline{H}OAc$). The relative yields of XI and XII were not affected markedly on the hydrogenations in various ratio of AcOH and AcOEt.

Direct Hydrogenation of the Total Dehydrated Product (VI) giving XI and XII——Reaction product by catalytic hydrogenation of the total dehydrated product (VI) (3.29 g) over PtO_2 (250 mg) in AcOH (100 ml) obtained–AcOEt (80 ml) (11 hr) exhibited two spots on TLC (benzene) identical *Rf* values with XI and XII (the latter appeared slightly major) and negative to tetranitromethane test. Another run (VI 1.47 g, AcOH 80 ml, AcOEt 40 ml, PtO_2 90 mg, H_2 uptaken in 10 hr) also gave the similar product. The combined hydrogenation product (4.6 g) of two runs was then chromatographed repeatedly on neutral alumina column (Woelm) developed with *n*-hexane, *n*-hexane–benzene (10:1), (10:3), (1:1), and $CHCl_3$ successively. The *n*-hexane eluant gave pure XI (0.65 g, colorless needles recrystallized with MeOH) and the later eluant furnished XII (0.8 g, colorless needles from MeOH). The rest of the fractions containing two components was not subjected to further separation.

22-Desoxy-leucotylin (XIII)——XI (650 mg) was treated with 15% KOH–MeOH (430 ml) by refluxing 2 hr. The crude product thus obtained was recrystallized with MeOH giving XIII (510 mg, colorless rods), mp 237.5—238.5°, $[\alpha]_D$ +38°. *Anal.* Calcd. for $C_{30}H_{52}O_2$: C, 81.02; H, 11.79. Found: C, 81.30; H, 11.65. IR ν_{max}^{Nujol} cm^{-1}: 3380 (OH).

6,16-Diketo-22-desoxy-leucotylin (XIV)——To a solution of XIII (360 mg) in AcOH (90 ml) was added CrO_3 (300 mg)–water (0.15 ml)–AcOH (16 ml) solution and the mixture was allowed to stand at room temperature one overnight. The product obtained by the usual treatment was chromatographed on neutral alumina column eluted with *n*-hexane–benzene (2:3) giving XIV (325 mg), mp 283.5—284°, colorless needles from EtOH. *Anal.* Calcd. for $C_{30}H_{48}O_2$: C, 81.76; H, 10.98. Found: C, 82.05; H, 10.90. IR ν_{max}^{KBr} cm^{-1}: 1704, 1709 (CO). ORD (c=0.16, dioxane) $[\alpha]^{18°}$ (mμ): −38° (350), −388° (323) (trough), 0° (308), +530° (289) (peak), +288° (270); (c=0.12, MeOH) $[\alpha]^{32°}$ (mμ): −34° (589), −427° (324) (trough), −308° (316) (sh.), 0° (304), +162° (299) (sh.), +239° (292) (peak), +188° (285) (sh.).

Na-Isopropanol Reduction of XIV——During refluxing a solution of XIV (300 mg) in dry benzene (45 ml) and isopropanol (80 ml), Na (10 g) was added in small portions in the period of 3 hr. EtOH was then added to inactivate excess Na and the residue obtained after removing the solvent *in vacuo* was treatd with water, extracted with ether. The extract, on neutrl alumina column chromatography (developed with benzene, $CHCl_3$), gave a diol, mp 235—237° (260 mg) (recrystallized with MeOH), identical with XIII by mixed mp, IR and TLC.

Attempts for Isomerization of XIV——a) Refluxing XIV for 2.5 hr either in 10% HCl–EtOH or in 10% KOH–MeOH recovered the starting material.

b) Refluxing XIV (30 mg) in triethyleneglycol (20 ml) containing KOH (1.5 g) for 9 hr (bath temp.: 228—235°) yielded a minor product (lower *Rf* spot on TLC) with the most of the starting dione (XIV) recovered. After removing XIV with EtOH (easily crystallized), the mother liquor was subjected to the preparative TLC separation giving the isomeric diketone (XV) (*ca.* 2.5 mg), mp 226—230°. IR ν_{max}^{KBr} cm^{-1}: 1703, 1706 (CO). ORD (c=0.1, MeOH) $[\alpha]^{31°}$ (mμ): −10° (589), −500° (326) (trough), −260° (314) (sh.), 0° (308), +320° (290) (peak), +280° (280), +120° (250). Not analyzed further due to the shortage of the material.

16,22-Didesoxy-6-dehydroleucotylin (=22-desoxy-21β*H*-zeorinone) (XVI)——A solution of 6,16-diketo-22-desoxy-leucotylin (XIV) (37 mg) in triethyleneglycol (15 ml) was added with 80% hydrazine hydrate (1 ml) and refluxed in an oil bath (bath temp. 172—180°) for 3.5 hr. The mixture was then added with KOH (1.05 g) and refluxed for additional 1 hr. After setting the condenser downward, the bath temperature was raised up to 240° gradually to distill unreacted hydrazine and water completely. The downward condenser was then replaced by a air-cooler and the mixture was heated in the oil bath (237—240°) for further 4.5 hr. During the period, N_2 evolution occurred. When the reaction mixture was poured into ice-water, were precipitated colorless needles, which were extracted with ether, recrystallized with MeOH yielding XVI. mp 207—208°, (30 mg colorless needles). *Anal.* Calcd. for $C_{30}H_{50}O$: C, 84.44; H, 11.81. Found: C, 84.34; H, 11.64. IR ν_{max}^{KBr} cm^{-1}: 1704 (CO).

The monoketone (XVI) was proved identical (mixed mp, IR, TLC, and GLC) with a compound, derived from zeorinone and being inverse at C_{21} configuration to zeorin, as will be described in the following paper.[7]

Norketone (XX) from Isopropenyl Derivative (VIa)——An ozonide mixture prepared from the isopropenyl derivative (VIa) (20 mg) in EtOH (15 ml) with slow stream of ozone (2.5 hr) was hydrogenated over PtO_2 (20 mg) for 4 hr. After removing the catalyst by filtration, the product obtained by the evaporation of the solvent was crystallized from aqueous MeOH to give XX (colorless needles), mp 219—222°. *Anal.* Calcd. for $C_{33}H_{52}O_5{\cdot}\frac{1}{2}H_2O$: C, 73.70; H, 9.93. Found: C, 73.83; H, 9.83. IR ν_{max}^{KBr} m^{-1}: 1738, 1734, 1241 ($OCOCH_3$), 1710 (shoulder) (>CO). NMR (τ): 9.20, 9.14, 9.05, 8.96, 8.91, 8.85 (3H each , all singlets, six methyls) 8.07, 7.97, 7.85 (3H each, all singlets, 2×-OCOC<u>H</u>$_3$, one-COC<u>H</u>$_3$), 4.96 (2H, multiplet, 2×>C<u>H</u>OAc). ORD (c=0.14, MeOH) $[\alpha]^{15.5°}$ (mμ): +79° (589), +586° (298) (peak), +314° (269) (trough), +386° (246) (peak), +329° (233) (trough).

On refluxing a solution of XX (3 mg) in AcOH–Ac_2O (5:1) (1.5 ml) for 4 hr (bath temp. 120—130°), only the starting norketone (XX) was recovered (confirmed by mp, IR and TLC).

22-Desoxy-21α*H*-leucotylin (XXII)——6,16-Di-O-acetyl-22-desoxy-21α*H*-leucotylin (XII) (500 mg) was hydrolyzed with 20% KOH–MeOH (500 ml) by refluxing 2 hr. The crystalline product obtained by diluting the reaction mixture with water was recrystallized with AcOEt giving XXII (colorless rods, 380 mg), mp 251—253°, $[\alpha]_D$ +92°. *Anal.* Calcd. for $C_{30}H_{52}O_2$: C, 81.02; H, 11.79. Found: C, 80.90; H, 11.77. IR ν_{max}^{KBr} cm^{-1}: 3571, 3471 (OH).

The diol (XXII) described here is distinctly discriminated from 22-desoxy-leucotylin (XIII) described above by TLC.

6,16-Diketo-22-desoxy-17α*H*,21α*H*-leucotylin (XXIII)——A solution of 22-desoxy-21αH-leucotylin (XXII) (360 mg) in AcOH (30 ml) was treated with CrO_3 (180 mg)–water (0.15 ml)–AcOH (16 ml) mixture by keeping at room temperature overnight. The product was then chromatographed on neutral alumina eluting with *n*-hexane–benzene (1:1), yielding XXIII (150 mg), mp 279—280° (colorless needles, recrystallized with EtOH). *Anal.* Calcd. for $C_{30}H_{48}O_2$: C, 81.76; H, 10.98. Found: C, 81.51; H, 10.78. IR ν_{max}^{KBr} cm^{-1}: 1703, 1690 (CO), ν_{max}^{Nujol} cm^{-1}: 1704, 1685 (CO). ORD (c=0.42, dioxane) $[\alpha]^{22°}$ (mμ): −1100° (319.5) (trough), 0° (304), +2140° (276) (peak). The diketone (XXIII) mentioned here is discriminated from the former diketones (XIV and XV) by TLC, IR, and ORD.

22-Desoxy-17*aH*,21*aH*-leucotylin (XXIV)——The above diketone (XXIII) (130 mg) in anhydrous benzene (35 ml), isopropanol (45 ml) was treated with Na (5 g) refluxing for 4 hr as described for the reduction of XIV, yielding the crude product, which on neutral alumina column chromatography (eluted with benzene, $CHCl_3$), gave XXIV (50 mg) as the major product, mp 234—235° (colorless needles from aq. EtOH). *Anal.* Calcd. for $C_{30}H_{52}O_2$: C, 81.02; H, 11.79. Found: C, 80.99; H, 11.70. IR ν_{max}^{Nujol} cm^{-1}: 3411 (OH).

The diol (XXIV) was proved nonidentical with the original diol (XXII) by comparisons of mp, TLC and IR.

Oxidation of XXIV regenerating XXIII——Diol (XXIV) (20 mg) in AcOH (60 ml) was oxidized with CrO_3 (23 mg)–water (0.15 ml) –AcOH (3 ml) by keeping room temperature overnight. The product was purified by neutral alumina column chromatography (eluting with *n*-hexane–benzene (1:1) mixture) to yield a diketone (15 mg), mp 283—284° (colorless needles from EtOH). IR ν_{max}^{Nujol} cm^{-1}: 1704, 1685 (CO). ORD ($c=0.15$, dioxane) $[\alpha]^{18°}$ (mμ): −1060° (319.5) (trough), 0° (304), +2420° (276) (peak). The identity of the diketone here with the above-described diketone XXIII was established by mixed mp (279.5—280.5°), TLC, IR (Nujol) and ORD.

Huang-Minlon Reduction of XXIII yielding 17*aH*-Zeorinone (XXV)——XXIII (10 mg) in triethyleneglycol (15 ml) was treated with 80% hydrazin hydrate (1.5 ml), KOH (1 g) similary as for the reduction of XVI from XIV. Recrystallization of the product with EtOH gave XXV, mp 156—158°, (colorless needles). IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1710 (CO). The monoketone (XXV) had the earlier retention time (GLC) comparing to two monoketones, XVI and XVII, both derived from zeorinone and retaining the D/E trans juncture. Due to the shortage of the material, further analysis of XXV was not done.

***p*-Bromobenzoate (XXI) of 6-Dehydroleucotylin (IV)**——To a solution of 6-dehydroleucotylin (IV) (400 mg) in pyridine (15 ml) was added *p*-bromobenzoyl chloride (4.2 g) and pyridine (5 ml) under ice cooling. After stirring 30 min, the mixture was allowed to stand room temperature two overnights, poured into ice–water, extracted with ether. The ether extract, after treating in a usual manner, gave crude benzoate, which was then purified by silica gel column chromatography (developed with *n*-hexane–benzene (1:1), benzene successively). From the benzene eluant was obtained XXI (410 mg), mp 235—238° (colorless hexagonal plates from EtOH), $[\alpha]_D$ +72°, exhibiting positive Beilstein test. *Anal.* Calcd. for $C_{37}H_{53}O_4Br$: C, 69.25; H, 8.32; Br, 12.45. Found: C, 69.31; H, 8.27; Br. 12.53. IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3518 (OH), 1703, 1260, (OCOAr, >CO) 1594 (benzene); ν_{max}^{KBr} cm^{-1}: 3505, 3456 (OH), 1705, 1704 (shoulder), 1267 (OCOAr, >CO), 1593 (benzene), NMR (τ) : 9.16, 9.10, 9.06, 8.98, 8.91, 8.84, 8.78, 8.72 (3H each , all singlets, eight methyls), 2.16 (2H), 2.45 (2H) (A_2B_2 type quartet, $J=8.2$ cps).

The crystal for the X–ray analysis was prepared by letting stand the ethanolic solution of XX at room temperature for a weak.

Alkaline Hydrolysis of XXI——XXI (20 mg) was hydrolyzed with KOH (5 g)–water (10 ml)–MeOH (40 ml) mixture by refluxing 1.5 hr. The hydrolysate (single spot on TLC) yielded 6-dehydroleucotylin (IV), identified by mixed mp, IR ($CHCl_3$), and TLC.

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