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THE STRUCTURES OF FIVE NEW TRITERPENOIDS OBTAINED FROM *RHODODENDRON LINEARIFOLIUM*

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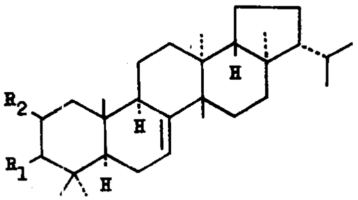
In 1957 Kariyone, Hashimoto and Tobinaga (1) isolated from a viscous substance of *Rhododendron linearifolium* Sieb. et Zucc. a triterpene alcohol $C_{30}H_{50}O$, m.p. 217°, $[\alpha]_D$ -27.4°, and named it motiol. Reinvestigation of this plant led to the isolation of four new triterpene alcohols as well as motiol. In this communication structural studies of motiol and the compounds are presented.

The viscous substance extracted from the plant with carbon tetrachloride was treated with *n*-hexane and the hexane-soluble part (2) was chromatographed on acid-washed alumina. The five alcohols thus obtained are shown in Table I.

TABLE I

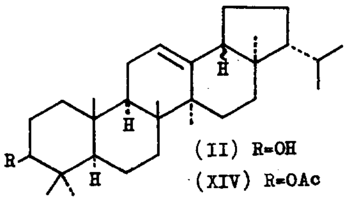
Motiol (I)	$C_{30}H_{50}O$	m.p. 218°	$[\alpha]_D$ -44°
Neomotiol (II)	$C_{30}H_{50}O$	228°	-24°
Germanidiol (III)	$C_{30}H_{50}O_2$	275°	+36.8°
Motidiol (IV)	$C_{30}H_{50}O_2$	233°	-22.3°
Adianenediol (V)	$C_{30}H_{50}O_2$	229.5-231°	+ 3°

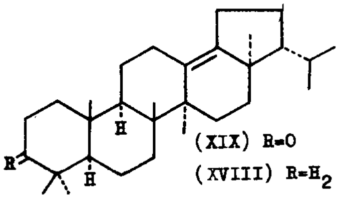
Motiol (I), on acetylation, gave a monoacetate (VI) $C_{32}H_{52}O_2$ (3), m.p. 247°, $[\alpha]_D$ -3°. The presence of a trisubstituted double bond is shown by monoperphthalic acid titration and a vinyl-proton signal (τ 4.75) in the NMR spectrum of the acetate. Oxidation of I with chromium trioxide in pyridine afforded motienone (VII) $C_{30}H_{48}O$, m.p. 218°, ν_{max}^{KBr} 1703 cm^{-1}, which was converted to motiene (VIII) $C_{30}H_{50}$, m.p. 208°, $[\alpha]_D$ -27°, by the Huang-Minlon reduction. The hydrocarbon VIII was shown to be identical with fern-7-ene (4) by comparison of their m.p. and IR spectra. Oxidation of the acetate VI with selenium dioxide gave the 7,9-diene (IX) $C_{32}H_{50}O_2$, m.p. 238°, $[\alpha]_D$ -144°, λ_{max}^{EtOH} mμ (ε) 232 (14000), 238 (15500), 248 (9500), which was further oxidised with chromium trioxide in acetic acid to give the 8-ene-7,11-dione (X) $C_{32}H_{48}O_4$, m.p. 228°, λ_{max}^{EtOH} 270 mμ (ε=7000), ν_{max}^{KBr} 1735, 1685 cm^{-1}. On reduction of the enedione with zinc dust in acetic acid afforded the saturated 7,11-dione (XI) $C_{32}H_{50}O_4$, m.p. 270°, ν_{max}^{KBr} 1735, 1705, 1703 cm^{-1}. That motiol (I) has a 3β-hydroxyl group was shown by the following way. Isomotienone (XII) was obtained from motienone (VII) by treatment with hydrogen chloride in acetic acid at room temperature. During this isomerisation the Cotton effect of rotatory dispersion curve of the substance was changed from negative ($[\phi]_{313m\mu}$ -800°) to positive ($[\phi]_{312m\mu}$ +2210°), indicating the presence of a 7-ene-3-one system in I; the double bond migrated from 7- to 8-position during the reaction. Such a migration has been observed in the bauerenone (5). Treatment of I with phosphorous pentachloride in petroleum ether afforded a hydrocarbon (XIII) $C_{30}H_{48}$, m.p. 154°, which on ozonolysis gave acetone and an amorphous five-membered ring ketone (ν_{max}^{KBr} 1745 cm^{-1}); hence the hydroxyl group has a 3β-configuration. Thus, motiol (I) is fern-7-ene-3β-ol.

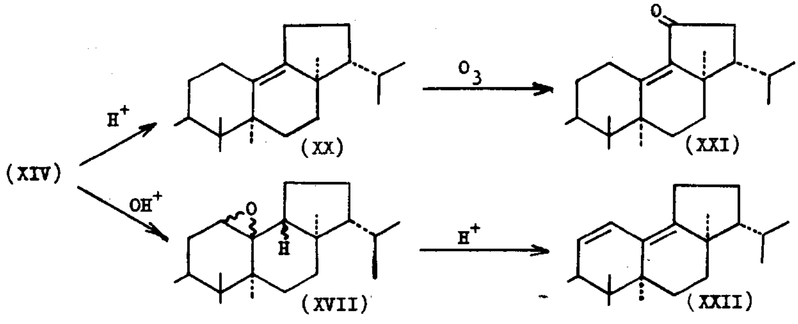


(I) R_1=OH, R_2=H
(IV) R_1=R_2=OH
(VIII) R_1=R_2=H

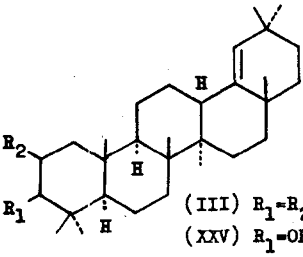
Neomotiol (II) $C_{30}H_{50}O$, m.p. 228°, $[\alpha]_D$ -24°, afforded the following derivatives as in the case of I: neomotiol acetate (XIV) $C_{32}H_{52}O_2$, m.p. 234°, $[\alpha]_D$ -24°; neomotienone (XV) $C_{30}H_{48}O$, m.p. 211°, $[\alpha]_D$ +50°, ν_{max}^{KBr} 1703 cm^{-1}; neomotiene (XVI) $C_{30}H_{50}$, m.p. 168°-9°, $[\alpha]_D$ -54°. The presence of a trisubstituted double bond in XIV was shown by the formation of an epoxide (XVII) with monoperphthalic acid and by IR (ν_{max}^{KBr} 824, 817 cm^{-1}) and NMR spectra (τ4.76). Acid isomerisation of XVI (hydrogen chloride in acetic acid at room temp.) gave isoneomotiene (XVIII) $C_{30}H_{50}$, m.p. 197°, $[\alpha]_D$ +2°, which was also obtained from motiene (VIII) by treatment with conc. hydrochloric acid in acetic acid. Optical rotation and m.p. of XVIII agreed with those of hopene-II (6); formation of hopene-II from fern-7-ene was the expected process (7). Physical constants of isomotienone (XIX) $C_{30}H_{48}O$, m.p. 154°-8°, $[\alpha]_D$ +53°, obtained from XV by treatment with acid also agreed with those of hopenone-II (6). Acid treatment of XIV gave isomotienol acetate (XX) $C_{32}H_{52}O_2$, m.p. 223°, $[\alpha]_D$ -136°. The IR spectrum of an α,β-unsaturated ketone (XXI)$C_{32}H_{50}O_3$, (ν_{max}^{KBr} 1695 and 1610 cm^{-1}, the latter being only slightly reduced intensity) produced by ozonization of XX indicates the presence of a cisoid chromophore having a carbonyl group in a five-membered ring. Mass spectra of II and XV have a significant peak at m/e 218 which suggests that the double bond is at C-12 and not at C-18 (8). Treatment of the epoxide (XVII) with acid gave a dienyl acetate (XXII) $C_{32}H_{50}O_2$, m.p. 261°, $[\alpha]_D$ +17°, λ_{max}^{EtOH} mμ (ε) 247 (14100), 256 (16800), 265 (10700), which was also obtained by oxidation of XIV with selenium dioxide. Slightly bathochromic shift of UV absorption of the diene (XXII) comparing with that of oleane-11,13(18)-diene would be caused by the five-membered ring (9). Dehydration of II with phosphorous pentachloride in petroleum ether afforded a hydrocarbon (XXIII) $C_{30}H_{48}$, m.p. 221°, $[\alpha]_D$ -3°, which on ozonolysis gave acetone and an amorphous five-membered ring ketone (ν_{max}^{KBr} 1745 cm^{-1}), indicating that II has a 3β-hydroxyl group. Thus, neomotiol (II) is hop-12-en-3β-ol.


(II) R=OH
(XIV) R=OAc

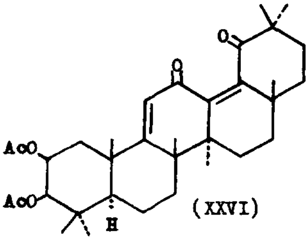

(XIX) R=O
(XVIII) R=H_2



That germanidiol (III) has an 1,2-glycolic function was suggested by consumption of periodate and lead tetraacetate. Acetylation of III with pyridine and acetic anhydride gave two monoacetates, m.p. 204° and 233°, and a diacetate $C_{34}H_{54}O_4$, m.p. 264°, $[\alpha]_D$ +36.8°. Reaction of III with acetone in the presence of sulfuric acid at room temperature gave an acetonide (XXIV) $C_{33}H_{54}O_3$, m.p. 201° (a vinyl proton signal at τ 4.75). Reaction of III with p-toluenesulfonyl chloride in pyridine followed by reduction with lithium aluminum hydride, gave a monohydroxy compound (XXV) $C_{30}H_{50}O$, m.p. 179°, $[\alpha]_D$ +20.4°, which was shown to be identical with germanicol by mixed m.p. determination and by comparison of IR spectra with an authentic specimen (10). M.p. of the derivatives of XXV are : ketone, m.p. 188°-9°; hydrocarbon, m.p. 172°; acid-isomerized hydrocarbon, m.p. 188°-9°; these compounds must be identical with germanicone (m.p. 189°) (11), olean-18-ene (m.p. 172°) (11) and olean-13(18)-ene (m.p. 186°) (12), respectively. Action of selenium dioxide on the diacetate gave a dienedione (XXVI) $C_{34}H_{48}O_6$, m.p. 228°, λ_{max}^{EtOH} 275 mμ (ε= 13000), ν_{max}^{KBr} 1685, 1635 cm^{-1}. The NMR spectrum of the acetonide (XXIV) has bands at τ 6.38 (1 H, doublet J=4.3 cps) and 5.92 (1 H, multiplet), whereas the spectrum of the diacetate possesses bands at τ 4.95 (1 H, doublet, J=4.3 cps) and 5.10 (1 H, multiplet). These coupling constants coupled with the ready formation of the acetonide suggest the 1,2-glycolic function has cis-configuration (13) and hence germanidiol (III) must be 2β-hydroxygermanicol.



(III) R_1=R_2=OH
(XXV) R_1=OH, R_2=H

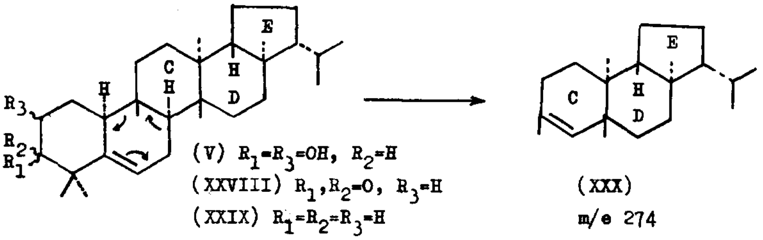


(XXVI)

Motidiol (IV) has also a trisubstituted double bond (τ4.75) and an 1,2-glycolic function (periodate consumption). The diol IV was converted to a monohydroxy compound $C_{30}H_{50}O$, m.p. 218°, by a series of reactions applied to the diol III. This monohydroxy compound was shown to be identical with motiol (I) by mixed m.p. determination and by comparison of IR spectra.

The diol IV formed acetonide $C_{33}H_{54}O_2$, m.p. 233°, the NMR spectrum of which shows signals at τ6.32 (1 H, doublet, J=4.2 cps) and 5.75 (1 H, multiplet), indicating that the glycolic function has a cis-configuration and hence the diol IV is 2β-hydroxymotiol.

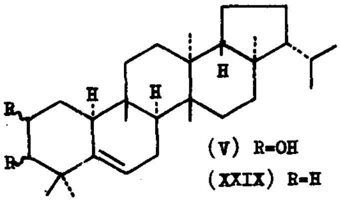
Adianenediol (V) $C_{30}H_{50}O_2$, m.p. 229.5°-231°, $[\alpha]_D$ +3°, formed a diacetate XXVII $C_{34}H_{54}O_4$, m.p. 210-11°, $[\alpha]_D$ -30°, and an acetonide $C_{33}H_{54}O_2$, m.p. 205°, under the same conditions as described above. The presence of an 1,2-glycolic function was also shown by consumption of lead tetraacetate. Tosylation of the diol V, followed by reduction with lithium aluminum hydride, afforded monohydroxy compound $C_{30}H_{50}O$, m.p. 211°-2°, which on oxidation with chromium trioxide, gave a ketone (XXVIII) $C_{30}H_{48}O$, m.p. 210°-11°, $[\alpha]_D$ +20°, ν_{max}^{KBr} 1706 cm^{-1}. Reduction of the ketone XXVIII afforded a hydrocarbon (XXIX) $C_{30}H_{50}$, m.p. 190°-91°, $[\alpha]_D$ +72°, which was shown to be identical with adian-5-ene by a mixed m.p. determination and by comparison of IR spectra with an authentic sample (4). The hydrocarbon could also be transformed into hopene-II by treatment with acid (7). That the 1,2-glycolic function is not present on the ring C, D or E was shown by analysis of the mass spectra of the diol V and its derivatives, XXVIII and XXIX. In all mass spectra a strong base peak was observed at m/e 274 which could be arised from a species such as XXX(14).



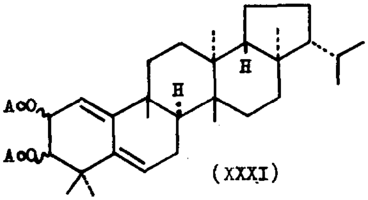
(V) $R_1=R_3=OH$, $R_2=H$
(XXVIII) $R_1,R_2=O$, $R_3=H$
(XXIX) $R_1=R_2=R_3=H$

(XXX)
m/e 274

Selenium dioxide oxidation of the diacetate XXVII gave a diene (XXXI) $C_{34}H_{52}O_4$, m.p. 228°-30°, which has an UV absorption maximum at 232 mμ (ε=13800), 240 (14800) and 248 (9800), indicative of the presence of an 1(10),5-diene chromophore. Hence the glycolic function must be at the 2,3-position. Ready formation of the acetonide and the coupling constant (J=4 cps) of the proton attached to the carbon atoms bearing the oxygen atom suggest a cis-relation of the two hydroxyl groups in the diol V, i.e. 2α,3α or 2β,3β; the latter configuration would be more probable since another diols, III and IV, have this configuration.



(V) R=OH
(XXIX) R=H



(XXXI)

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