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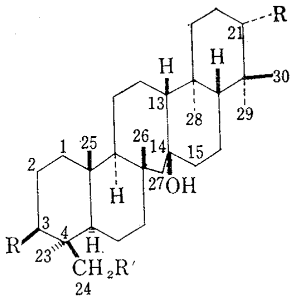
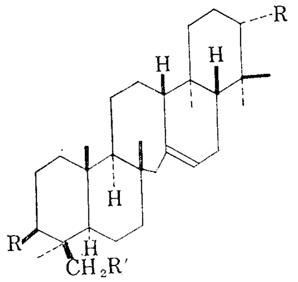
Tohogenol and Tohogeninol

The isolation of five triterpenoids, serratediol, its monoacetate, 21-episerratenediols, serratriol and tohogenol from *Lycopodium serratum* were described[1,2] and the structures of the first three have been established beyond doubt.[2~4] In this communication we add to those the sixth triterpenoid constituent of the plant, tohogeninol, and present the structures of tohogenol and tohogeninol as I and III, respectively.



I : R=OH, R′=H
II : R=OAc, R′=H
III : R=R′=OH
IV : R=R′=OAc



V : R=OAc, R′=H
VI : R=R′=OAc

Tohogenol (I), m.p. 242~244°, $C_{30}H_{52}O_3 \cdot {}^1\!/_2H_2O$ forms the diacetate (II), m.p. 305~306°, $[\alpha]_D$ +28°, $C_{34}H_{56}O_5$, (mol. wt. : found[*1] 569, Calcd. 544.7), IR ν_{max}^{Nujol} cm^{-1} : 1721, 1250 (OAc). The nuclear magnetic resonance spectrum of tohogenol diacetate suggests the presence of seven C-methyl groups at 9.16 (9H), 9.13 (6H), 9.07 (3H) and 9.04 τ (3H), together with acetyl protons at 7.96 τ (6H) and $\rangle C\underline{H}$-OAc at 5.5 τ (2H, multiplet) which defines the functions of two oxygen atoms in the tohogenol molecule as the secondary hydroxyl groups. The absence of a vinylic proton signal associated with the fact that the compound gave negative test to tetranitromethane indicates the compound is saturated. That the third oxygen atom in tohogenol provided a tertiary hydroxyl group, though the infrared spectrum of the diacetate (II) in Nujol mull did not exhibit any appreciable absorption in the hydroxyl region, was suggested by its infrared spectrum in hexachlorobutadiene, which clearly showed absorption at 3559, 3436w cm^{-1}. This assignment was confirmed by the following reactions.

Oxidation of tohogenol with chromium trioxide-pyridine complex afforded a diketone, m.p. 235~237°, $[\alpha]_D$ +99°(c=1.67, $CHCl_3$), $C_{30}H_{48}O_3$, IR ν_{max}^{Nujol} cm^{-1} : 3484 (OH), 1704, 1684 (CO). $[\phi]_{314m\mu}$ +3580°, $[\phi]_{305m\mu}$ +3500°, $[\phi]_{271m\mu}$ −1220°, which by reduction with sodium and propanol regenerated tohogenol as identified by the direct comparisons of the alcohols and their derived diacetates. The presence of hydroxyl group in the diketone was demonstrated by its strong absorption at 3484 cm^{-1} (Nujol). The diketone, when heated under reflux in 3% alcoholic hydrochloric acid for 30 min., was smoothly dehydrated to give, in quantitative yield, a tetranitromethane positive anhydrocompound, m.p. 209~210°, $C_{30}H_{46}O_2$, which was now proved to be identical with serratenedione[3] (mixed m.p., IR, NMR, ORD and TLC comparisons). These findings coupled with the nuclear magnetic resonance evidence that the diketone shows no absorption below 7.2 τ establish the hydroxyl group to be tertiary thus defining its orientation in the serratane skeletone at C_{14}. The configuration of this hydroxy group must be β, since, if not, either concerted elimination of 13β-H and 14α-OH or a carbonium ion formation at C_{14} would be expected to produce not only serratenedione but isoserratenedione.[4] Therefore,

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[*1] Molecular weight was measured by osmometric method.

1) Y. Inubushi, Y. Tsuda, H. Ishii, M. Hosokawa, T. Sano : Yakugaku Zassi, **82**, 1339 (1962); Y. Inubushi, Y. Tsuda, H. Ishii, T. Sano, M. Hosokawa, T. Harayama : *Ibid.* **84**, 1108 (1964).
2) Y. Inubushi, Y. Tsuda, T. Sano, R. Nakagawa : This Bulletin, **13**, 104 (1965).
3) Y. Inubushi, T. Sano, Y. Tsuda : Tetrahedron Letters, No. 21, 1303 (1964).
4) Y. Tsuda, T. Sano, K. Kawaguchi, Y. Inubushi : Tetrahedron Letters, No. 20, 1279 (1964).

tohogenol must be represented by the formulation (I) (serratan-3β,14β,21α-triol). In accordance with this consideration, dehydration of tohogenol diacetate (II) and reacetylation of the resulting partly hydrolysed product quantitatively yielded serratenediol diacetate (V) (IR comparison).

The other triterpenoid, tohogeninol, was isolated as its triacetate (IV), m.p. 256~258°, $[\alpha]_D$ +118° (c=1.01, $CHCl_3$), $C_{36}H_{58}O_7$, NMR: $-\overset{|}{\underset{|}{C}}-CH_3$ 9.13 (9H), 9.09 (3H), 9.02 τ (6H); $-O-CO-\underline{CH_3}$ 7.95 τ (9H); $-\overset{|}{\underset{|}{C}}-C\underline{H}_2-OAc$ 5.76 τ (AB quartet J=12 c.p.s., δ_{AB}=18 c.p.s.); $>C\underline{H}-OAc$ 5.43 τ (2H, multiplet). Alkaline hydrolyis of the triacetate gave the tetra-ol, tohogeninol (III), m.p. 311~312°, $C_{30}H_{52}O_4$.

The saturated nature of the compound was shown by its negative test to tetranitromethane and by the absence of a vinylic proton in the nuclear magnetic resonance spectrum of the triacetate. The infrared spectrum of the triacetate (IV) in Nujol mull indicated, besides the ester absorption at 1724 cm^{-1} and 1250 cm^{-1}, the strong hydroxyl absorptoin at 3497 cm^{-1}, thus accounting for the four oxygen functions in tohogeninol as one primary, two secondary and one tertiary hydroxyl groups. Treatment of the triacetate with 3% alcoholic hydrochloric acid and reacetylation of the product, as described in tohogenol, resulted, in excellent yield, an anhydro-compound, m.p. 247~249°, completely indentical with serratriol (serrat-14-en-3β,21α,24-triol) triacetate (VI)*2 (mixed m.p., IR and TLC comparisons). Hence, on analogy with tohogenol, the structure (III) was advanced to tohogeninol.

The biosynthetic problem whether these saturated alcohols are the products by hydration of the corresponding unsaturated compounds or they are intermediates of the serratene derivatives from α-onocerin analogs may be interesting to investigate.

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*2 The structure of serratriol will be reported in a separate paper in preparation.

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Thermal Decomposition of Azidoformate with the Retention of Configuration

It was reported very recently by Smolinsky, *et al.*[1] that the thermal decomposition of $S(+)$-2-methylbutyl azidoformate ($S(+)$-II) prepared from $S(-)$-2-methyl-1-butanol ($S(-)$-I) led to the formation of 4-ethyl-4-methyl-2-oxazolidinone ((+)-III), $[\alpha]_D^{25}$ +0.354° (C_2H_5OH), which was hydrolysed with alkali to give (+)-2-amino-2-methyl-1-butanol ((+)-IV), $[\alpha]_D^{25}$ +3.39° (C_2H_5OH).

From the suggested reaction mechanism and the fact that III thus obtained showed the optical activity, this nitrene insertion reaction was assumed to proceed with retention

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[1] G. Smolinsky, B.I. Feuer: J. Am. Chem. Soc., 86, 3085 (1964).