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SPIROLAURENONE, A NEW SESQUITERPENOID CONTAINING BROMINE FROM LAURENCIA GLANDULIFERA KÜTZING*

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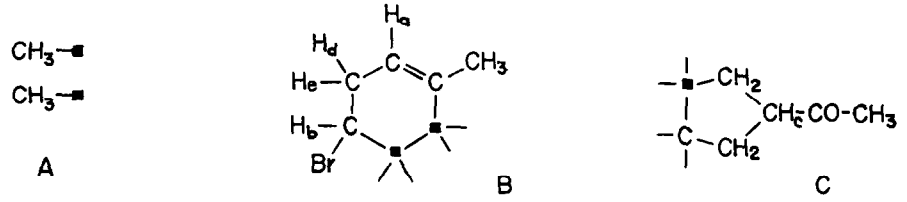
An extensive study (1) of the neutral essential oil from Laurencia glandulifera Kützing ('Oosozo' in Japanese; Rhodomelaceae) led to isolation of a new sesquiterpene ketone containing bromine in 0.003 % yield and designated as spirolaurenone. We wish to propose formula I, having a novel carbon skeleton, as the most faverable structure for the compound on the basis of the data described below.

Spirolaurenone (I), colorless oil, $(\alpha)_D$ -70.6° (c, 1.26; Chf), was analyzed for $C_{15}H_{23}OBr$ (M^+ 300, 298), positive to iodoform test and gave a semicarbazone, $C_{16}H_{26}ON_3Br$, m.p. 165-170°. The UV, IR and NMR (Fig. 1) spectra of I (λ_{max}^{EtOH} 288 mμ (ε 110); ν_{max}^{film} 3025, 1715, 1665, 1160, 837, 790, 760, 739 cm^{-1}; τ (CCl_4, 100 MHz), 9.05, 8.89 (each 3H, s) (partial structure A), 8.30 (3H, finely splitted m), 7.85 (3H, s), ca. 7.5 (2H, m, H_d and H_e), 7.15 (1H, m, W_H = 27 Hz, H_c), 5.75 (1H, t, J = 8.2 Hz, H_b), and 4.92 (1H, broad t, J = 4 Hz, H_a)) showed the presence of two tert. Me (probably gem dimethyl), an olefinic Me (CH_3-$\dot{C}$=CH-) and an acetyl group. One-proton triplet (H_b) at τ 5.75 could be attributed to the proton on carbon bearing the bromine atom.

Dehydrobromination of I with 2N KOH-EtOH (reflux 2 hr) afforded a good yield of a conjugated diene (II), $C_{15}H_{22}O$ (M^+ 218); $(\alpha)_D$ +23°; λ 270 mμ (ε 4700); ν 3040, 1710, 1595, 725 cm^{-1}; τ 9.03, 9.00, 7.93 (each 3H, s), 8.21 (3H, broad s), 5.2-4.2 (3 olefinic protons), no absorption near τ 5.7 (2). The UV spectrum strongly suggested that the dienyl group would be included in a

six-membered ring (3). Moreover, double resonance experiments in the NMR spectrum of I (Fig. 1) revealed that an olefinic proton H_a was coupled to both H_d and H_e (J = 4 and 4 Hz), which were further coupled to H_b (J = 8.2 and 8.2 Hz), indicating the presence of partial formula B in I. This was supported by the mass spectrum (m/e, relative abundance: 300 and 298, 15 (M^+); 218, 70 (M^+-HBr); 203, 24 ($M^+ - HBr - CH_3$); 175, 100 ($M^+ - HBr - COCH_3$); 159, 60; 133, 73; 119, 69; 105, 57; 91, 60), which will be discussed in detail in a full paper.



Treatment of I with $LiAlH_4$ in refluxing THF yielded a debromo alcohol (III), $C_{15}H_{26}O$ (ν 3350 cm^{-1}), which on oxidation with CrO_3-Py was converted into the corresponding ketone (IV), $C_{15}H_{24}O$ (M^+ 220); $[\alpha]_D$ -80°; ν 3020, 1710, 1165 cm^{-1}; τ 9.15, 9.10, 7.91 (each 3H, s), 8.31 (3H, broad s), and 4.85 (1H, m). The NMR spectrum of III (τ 9.13 (6H, s, two tert. Me), 8.3 and 4.9 (3H, broad s and 1H, m, respectively, $CH_3\overset{|}{C}=CH-$), 8.86 and 6.50 (3H, d, J = 6 Hz and 1H, finely splitted quintet, J = 6 Hz, respectively, $CH_3CH(OH)CH<$)) revealed the presence of a $CH_3COCH<$ grouping in I.

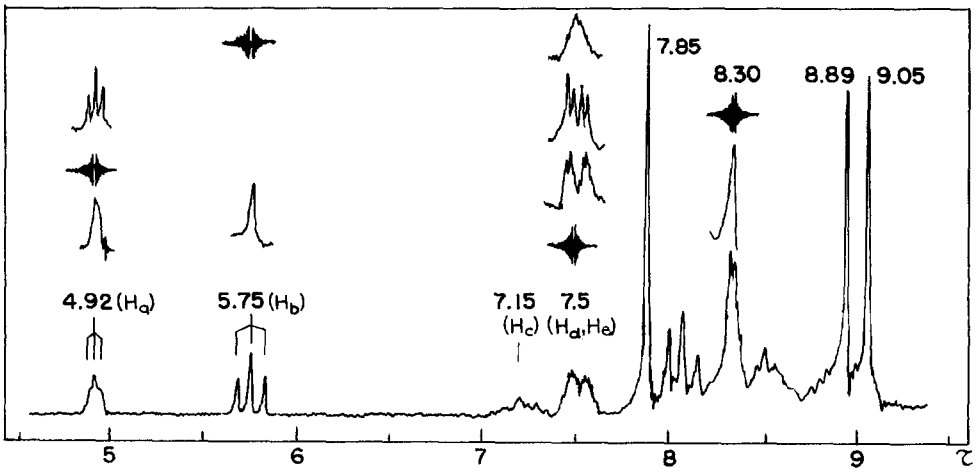
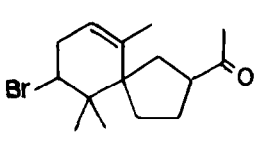
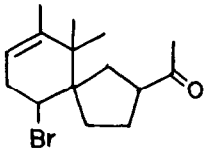


Fig. 1 NMR and NMDR spectra of spirolaurenone (I) (CCl_4, 100 MHz)

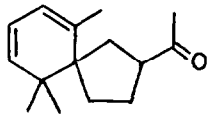
Catalytic hydrogenation of I over PtO_2 or Rh-PtO_2 in EtOH led to formation of a saturated alcohol (V), $C_{15}H_{28}O$ (ν 3350 cm^{-1}; τ 9.17, 9.05 (each 3H, s, two tert. Me), 9.18 (3H, d, J = 6 Hz, sec. Me), 8.88 and 6.55 (3H, d, J = 6 Hz and 1H, m, respectively, CH_3-CH(OH)-) which on CrO_3-Py oxidation gave a saturated ketone (VI), $C_{15}H_{26}O$ (M^+ 222); $[\alpha]_D$ ±0°; ν 1710 cm^{-1}; τ 9.17 (3H, d, J = 6 Hz), 9.15, 9.11, 7.94 (each 3H, s). Upon Baeyer-Villiger oxidation followed by hydrolysis, ketone VI was degraded to a secondary alcohol (VII), $C_{13}H_{24}O$ (ν 3320, 1070 cm^{-1}; τ 5.85 (1H, m; >CH(OH))), which still had one sec. Me (τ 9.14) and two tert. Me groups (τ 9.10, 9.05). Further oxidation of VII with CrO_3-Py led to formation of a five-membered cyclic ketone (VIII), $C_{13}H_{22}O$ (M^+ 194); ν 1745, 1410 cm^{-1}; τ 9.13 (3H, d, J = 6 Hz), 9.12, 9.01 (each 3H, s), 7.92 (2H, s, ■-CH_2-CO-). This ketone VIII produced the tetradeuterio derivative (M^+ 198) on deuteration (NaOH-D_2O), proving compound I to involve partial structure C. In view of the afore-mentioned structural units A, B and C as well as the molecular formula, only two formulas I and I' could be proposed as possible (planar) structures for spirolaurenone.



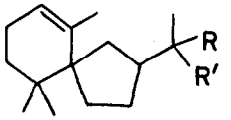
I



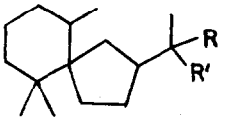
I'



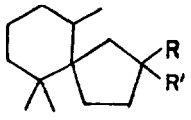
II



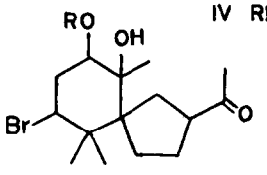
III R=H, R'=OH
IV RR'=O



V R=H, R'=OH
VI RR'=O



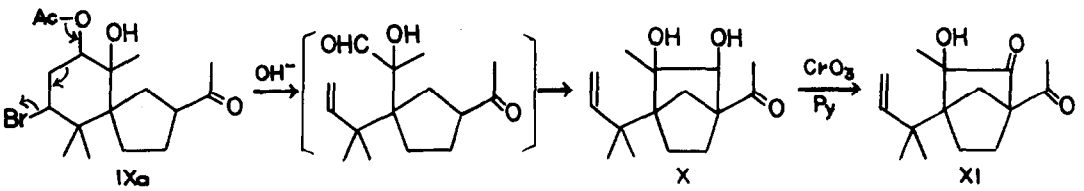
VII R=H, R'=OH
VIII RR'=O



IX R=H
IXa R=Ac

Oxidation of I with OsO_4 afforded a glycol (IX), $C_{15}H_{25}O_3Br$ (ν 3450, 1700 cm^{-1}; τ 8.98, 8.79, 8.75, 7.82 (each 3H, s), 6.54, 5.74 (each 1H, broad t)), which formed the corresponding monoacetate (IXa), $C_{17}H_{27}O_4Br$ (M^+ − $COCH_3$ 333, 331), m.p. 135-136°, $[\alpha]_D$ +54.4°; ν 3640, 1740, 1710 cm^{-1}; τ 8.96, 8.87, 8.78, 7.91, 7.83 (each 3H, s), 5.75 (1H, dd, J = 12 and 6 Hz, -CHBr-), and 5.31 (1H, dd, J = 10.5 and 6 Hz, -CH(OAc)-). The NMR spectrum of IXa revealed that the

OAc group was oriented at equatorial conformation and hence the tert. OH at axial. Comparison of the chemical shifts of tert. Me groups of V and VI with those of IX and IXa suggested that one of the tert. Me and the tert. OH groups would exist at 1,3-diaxial disposition. This implied formula I to be preferable to I', which would be supported by the following reaction. Monoacetate IXa was treated with 5% KOH-MeOH (reflux 5 min). Contrary to the expectation (simple hydrolysis), it resulted in formation of vinyl compound (X), $C_{15}H_{24}O_3$, (ν 3380, 3080, 1685, 1008, 912 cm^{-1}; τ 8.94, 8.88, 8.73, 7.91 (each 3H, s), 6.58 (1H, s, ■-C<u>H</u>(OH)-■), 5.15, 5.11 and 3.97 (each 1H, dd, J = 10, 1.7; 18, 1.7; and 18, 10 Hz, respectively, CH_2=CH-■)), which formed its monoacetate (Xa), τ 5.40 (1H, s; ■-CH(OAc)-■). Mild oxidation of X with CrO_3-Py produced five-membered cyclic ketone (XI) (ν 3500, 1745, 1699, 1010, 920 cm^{-1}; τ 5.03, 4.97, 4.10 (each 1H, dd, J = 18, 1.7; 10, 1.7; and 18, 10 Hz, respectively, CH_2=CH-■)). This abnormal reaction could be illustrated as follows:



All these results indicate that spirolaurenone is represented most favorably by formula I, which will also be explicable well from the standpoint of biogenesis.

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References

* Part XVII of "Constituents from Marine plants". Part XVI, T. Irie, M. Suzuki, E. Kurosawa and T. Masamune, <u>Tetrahedron</u> <u>26</u>, 3271 (1970)

(1) T. Irie, T. Suzuki, Y. Yasunari, E. Kurosawa and T. Masamune, <u>Tetrahedron</u> <u>25</u>, 459 (1969); T. Irie, M. Suzuki and T. Masamune, <u>ibid.</u> <u>24</u>, 4193 (1968)

(2) The NMR measurements were taken in CCl_4 on Hitachi H-60 spectrometer with TMS as an internal reference, unless otherwise stated

(3) Cf. R. T. O'Conner and L. A. Goldblatt, <u>Analyt. Chem.</u> <u>26</u>, 1727 (1954)