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(E)-γ-BISABOLEN-8,9-EPOXIDE AND ISOCYCLOEUDESMOL, TWO NEW SESQUITERPENOIDS FROM THE MARINE RED ALGA *LAURENCIA NIPPONICA* YAMADA(1)

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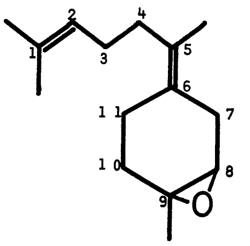
Two new sesquiterpenoids, *(E)*-γ-bisabolen-8,9-epoxide and isocycloeudesmol, have been isolated from *L. nipponica* Yamada (Rhodophyta, Rhodomelaceae) and their structures have been determined by spectroscopic and chemical evidences.

We have been continuously investigating the constituents from *L. nipponica* Yamada, an abundant alga around Hokkaido, Japan. In previous reports(2), halogenated chamigrenes, aromatic sesquiterpenes and cyclic ethers of C_{15}-straight carbon skeleton having the terminal conjugated enyne or allene moiety from this alga have been described and the distribution aspects of these compounds in this alga were found to be dependent upon the growth localities. We wish to report here that this alga also produces two new non-halogenated sesquiterpenoids, *(E)*-γ-bisabolen-8,9-epoxide (1)(3) and isocycloeudesmol (2) together with *(E)*-γ-bisabolene (3)(4) and (+)-selin-4,7(11)-diene (4)(5). The compound (1) seems to be the precursor of halogenated chamigrenes and aromatic sesquiterpenoids(6) and the compound (2) is related to selinane ring system by formation of cyclopropane ring.



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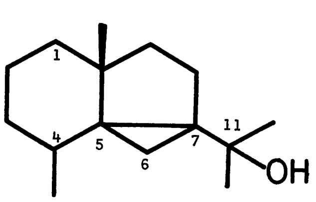

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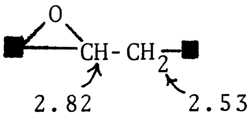
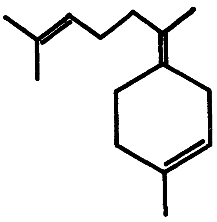
Repeated neutral alumina (Merck, Activity II-III) column chromatography of the neutral essential oil from the methanol extract of the lyophilized *L. nipponica* collected at Moheji, in the vicinity of Hakodate, Hokkaido, in May, resulted in the isolation of *(E)*-γ-bisabolene (3, 1.4% of the neutral essential oil), (+)-selin-4,7(11)-diene (4, 0.3%), *(E)*-γ-bisabolen-8,9-epoxide (1, 2.6%) and isocycloeudesmol (2, 0.6%).

(E)-γ-bisabolen-8,9-epoxide (1); unstable colorless oil, $[\alpha]_D$ +37.3° (c; 2.20 $CHCl_3$), $C_{15}H_{24}O$, *m/e* 220 (M^+), 151 ($M^+- C_5H_9$), 107 (parent peak) and 93; $\nu_{max}^{CHCl_3}$ 3020, 1670, 1382, 1265, 1206, 1102, 975, 840 and 782 cm^{-1}; ^1H NMR (CCl_4) δ 1.26 (3H, s), 1.57 (3H, br. s), 1.59 (3H, br. s), 1.65 (3H, br. s), ca 1.95 (6H, m), 2.53 (2H, br. s), 2.82 (1H, t, J=2.5 Hz) and 5.01 (1H, m); ^{13}C NMR ($CDCl_3$) δ 17.5 (q), 18.3 (q), 22.9 (q), 22.9 (t), 25.7 (q), 27.1 (t), 28.5 (t), 30.5 (t), 34.1 (t), 57.6 (s), 59.6 (d), 124.3 (d), 125.1 (s), 127.7 (s), 131.3 (s). In its IR spectrum, the compound (1) did not show the absorption due to hydroxyl and carbonyl group and thus oxygen function was found to be involved in ether linkage. The presence of oxirane ring in molecule was strongly suggested by its ^1H NMR [δ 2.82 (1H, t, J=2.5 Hz)], ^{13}C NMR [δ 57.6 (s) and 59.6 (d)] and IR [1265-782 cm^{-1}] spectra and moreover, its proton spin decoupling studies showed the presence of the following partial structure.



The structure of 1 was confirmed by the chemical degradation. Treatment of 1 with $TiCl_3$-$LiAlH_4$[7)] in refluxing THF gave unsaturated hydrocarbon, $C_{15}H_{24}$, which was identical with the authentic specimen of *(E)*-γ-bisabolene (3)[4)] on comparison of the spectral properties and retention time on GLC (PG 20M at 150°C) and assigment of *E*-configuration to 5-double bond in 1 was confirmed by the application of NOE; irradiation at δ 1.59 of 5-CH_3 resulted in a 21% enhancement of integrated frequency of methylene protons at δ 2.53. The stereochemistry of the oxirane ring is now in progress.

Isocycloeudesmol (2), mp; 99.5-100.5°C (hexane-isopropyl ether), $[\alpha]_D$ +21.5° (c; 2.10, $CHCl_3$), $C_{15}H_{26}O$ (Found; C, 81.25, H, 11.81%, requires; C, 81.02, H, 11.79%); *m/e* 222 (M^+), 207 ($M^+- CH_3$), 204 ($M^+- H_2O$) and 59 (C_3H_7O); $\nu_{max}^{CHCl_3}$ 3590



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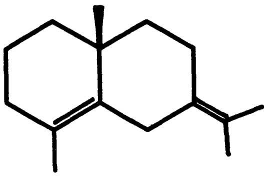

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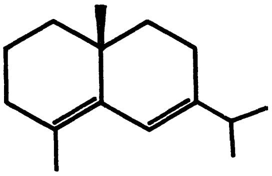

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3450, 3060, 1465, 1375, 1365, 1140, 1105, 1100 and 945 cm^{-1}; ^1H NMR (CCl_4) δ 0.36 (1H, d, J=5 Hz), 0.48 (1H, d, J=5), 0.81 (1H, s, -O<u>H</u>), 1.02 (3H, s), 1.04 (3H, d, J=7.5), 1.27 (3H, s), 1.37 (3H, s) and 2.28 (1H, m); ^{13}C NMR ($CDCl_3$) δ 12.6 (t), 17.8 (t), 19.4 (q), 24.0 (q), 27.4 (q), 27.9 (d), 28.5 (t), 31.6 (q), 32.4 (t), 36.5 (t), 37.6 (t), 41.8 (s), 41.9 (s), 44.0 (s) and 71.7 (s). The presence of cyclopropane ring in molecule was suggested by high field resonance at δ 0.36 and 0.48 in NMR spectrum and by a weak band at 3060 cm^{-1} in IR spectrum. The lone oxygen atom is seen to be alcohol by the IR bands at 3590 and 3450 cm^{-1} and its tertiary nature is disclosed by ^{13}C NMR multiplicity [δ 71.7 (s)] and by the failure of 2 to form an acetate with acetic anhydride and pyridine. Moreover, the presence of 1-hydroxy-1-methylethyl group is suggested by ^1H NMR [δ 1.27 and 1.37 (each 3H, s)], ^{13}C NMR and the mass [*m/e* 59 (C_3H_7O)] spectra. These spectral data mentioned above require that the remaining ten carbons must be carbotricyclic system having one secondary methyl, one tertiary methyl and 1-hydroxy-1-methylethyl. The assignment of isocycloeudesmol (2) to selinane ring system was made based on the facile conversion of 2 to (+)-δ-selinene (5) as follows.

Treatment of 2 with *p*-TsOH in warm benzene for 1 h resulted in nearly quantitative dehydration and cleavage of cyclopropane ring to (+)-δ-selinene (5)[8], which had the physical characteristics (NMR, IR and $[\alpha]_D$) identical with those of the authentic specimen. The location of cyclopropane ring on selinane system for isocycloeudesmol was made by the aid of ^1H and ^{13}C NMR spectra. One secondary methyl, one tertiary methyl, 1-hydroxy-1-methylethyl, six methylenes and four quaternary carbons (*vide ante*) including two protons on cyclopropane ring were accommodated only by the formation of cyclopropane ring among C-5, 6 and 7 on selinane skeleton as formula 2, which could distinctly elucidate all of the physical and chemical properties of isocycloeudesmol. The confirmation of the structure has been also obtained by the mild treatment of 2 with *p*-TsOH. Treatment of 2 with *p*-TsOH in benzene at room temp. for 1 h gave (+)-selin-4,7(11)-diene (4) and (+)-δ-selinene (5) in 30% and 10% yield, respectively[9]. This result undoubtedly supported the structure of isocycloeudesmol (2), but its stereochemistries at C-4, 5 and 7 have not been clarified and now in progress.

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