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LEUCOTHOL A, AN ANTHRADITERPENOID FROM LEUCOTHOE GRAYANA MAX.

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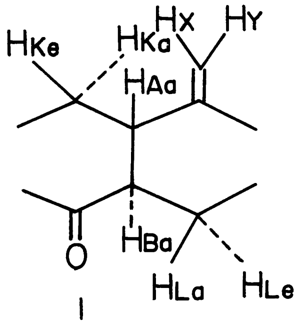
The structure of leucothol A, $C_{20}H_{30}O_3$, a minor constituent of Leucothoe grayana Max., has been determined as 2 by means of X-ray crystallographic analysis. Leucothol A is the first example of anthraditerpenoid.

A number of A-nor-B-homo-kauranoids (grayanoids) have been isolated from Leucothoe grayana Max. 1) We wish to describe here isolation and characterization of a new diterpenoid leucothol A2), which has an unprecedent diterpenoid skeleton, from the same plant.

Leucothol A, $C_{20}H_{30}O_3$3), mp 243°, ORD a = -178, was obtained by careful chromatography in $7.5 \times 10^{-4}\%$ yield from dried leaves and was shown by spectroscopic data to have following groups; three methyls (δ (pyridine-d_5, 100 MHz) 1.16, 1.40, and 1.47), a carbonyl (ν (nujol) 1703 cm^{-1}), a secondary hydroxyl (δ 4.10, 1H, t, J = 3 Hz) and a vinylidene group (ν 1640 cm^{-1}, δ 4.88 and 5.05, each 1H, s). The presence of a tertiary hydroxyl group was indicated by the



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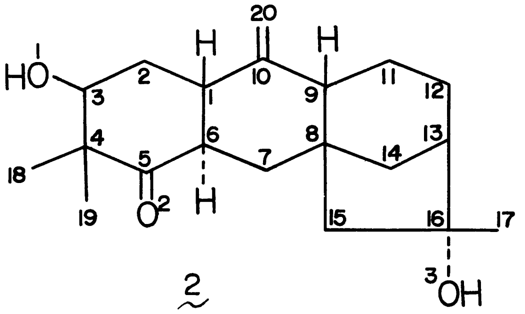

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formation of monoacetate3), mp 177-177.5°, which still exhibits hydroxyl absoption band at 3300 cm^{-1}. The NMR signals in the allyl and α-keto methine region further demonstrate the presence of the partial structure 1 in leucothol A. Protons H_A and H_B in 1 resonate at δ 2.86 and 2.67 respectively (J = 12 Hz) and the former couples further with H_{Ka} (J = 12 Hz), H_{Ke} (J = 4 Hz), H_X (J = 1 Hz) as well as H_Y (J = 1 Hz) and the latter with H_{La} (J = 12 Hz) as well as H_{Le} (J = 4 Hz).

Since the partial formula 1 is not in conformity with grayanane skeleton, leucothol A was subjected to X-ray crystallographic analysis4).

Table 1. The crystal data.

Crystal system	Orthorhombic
Space group	$P2_12_12_1$
a	11.216 Å
b	25.086
c	6.216
Z	4
Radiation	Cu Kα

Crystal data are summarized in Table 1. A Rigaku four-circle diffractometer was used to collect 1866 unique intensity data (0° < θ < 70°), which afforded 363 |E| values above 1.30. Fifty-seven phases were at first expressed by four symbols with the aid of the sum of angles formula and probable numerical values of phases were obtained by means of tangent formula using the above |E| values.5) From the E-map thus calculated the atomic coordinates of 23 carbon and oxygen atoms were readily obtained. After refinement of the atomic parameters by the block-diagonal-matrix least-squares method and subsequent D-synthesis, the locations of 30 hydrogen atoms were also found. Further refinement including hydrogen atoms yielded R = 5.05%. The final atomic coordinates are given in Table 2. The assignment of absolute configuration was done by taking account of the anomalous dispersion effect of oxygen atoms for Cu Kα radiation (Δ f" = 0.1). For the 20 quartets of hkl, $\bar{h}\bar{k}l$, $\bar{h}kl$, and $h\bar{k}l$ reflections with $\left| |F_c(hkl)| - |F_c(\bar{h}\bar{k}\bar{l})| \right|$ values above $3.0\sigma(|F_o|)$, the intensity measurement was made. The results are summarized in Table 3. The observed and calculated inequalities are in good agreement with each other, thus establishing the full structure of leucothol A including the absolute configuration as shown in Fig. 1 and the formula 2. This absolute configuration was supported also by the comparison of R factors for the 100 reflections having the largest $\Delta F_c/\sigma(|F_o|)$ values; the R factors were 3.87 and 3.93% for the structure shown in Fig. 1 and its antipode respectively. Thus, the new diterpene possesses a hitherto unknown anthraditerpenoid skeleton (leucothane skeleton), and it should be noted that the absolute configuration at C-1 is antipodal to that of known grayanoids.

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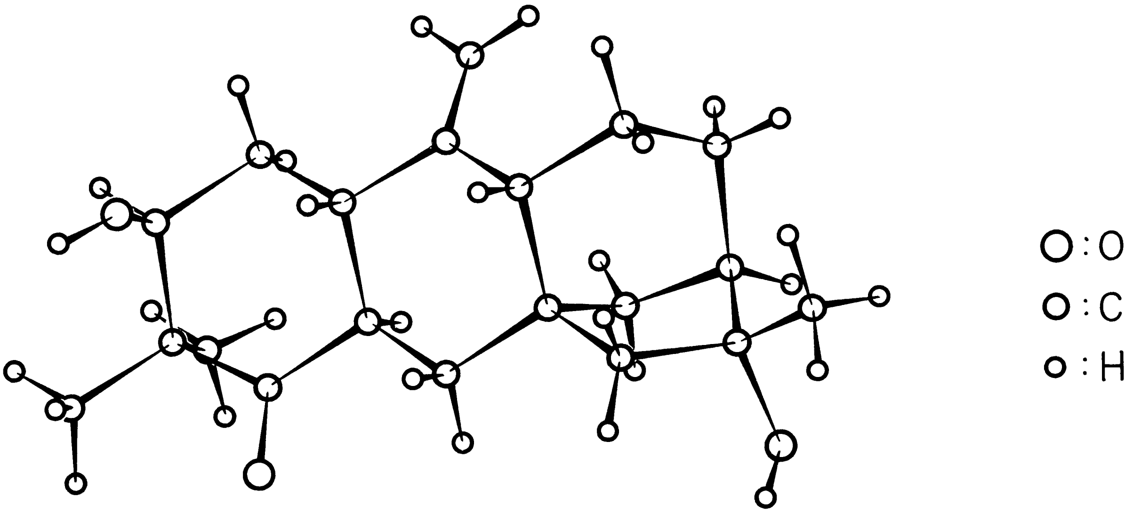

Fig. 1

Table 2. The final atomic coordinates.

Atom	x/a	y/b	z/c	Atom	x/a	y/b	z/c
O(1)	0.0314	0.3716	0.3368	C(10)	0.3750	0.4402	0.2988
O(2)	0.2430	0.2595	0.2746	C(11)	0.5637	0.4653	0.5216
O(3)	0.8029	0.3253	0.4253	C(12)	0.6722	0.4628	0.3737
C(1)	0.2748	0.3996	0.2783	C(13)	0.7111	0.4060	0.3169
C(2)	0.1748	0.4151	0.1234	C(14)	0.6046	0.3775	0.2133
C(3)	0.0772	0.3723	0.1249	C(15)	0.6099	0.3514	0.5843
C(4)	0.1226	0.3164	0.0572	C(16)	0.7361	0.3701	0.5132
C(5)	0.2323	0.3028	0.1918	C(17)	0.8092	0.3943	0.6963
C(6)	0.3293	0.3446	0.2154	C(18)	0.0253	0.2744	0.0883
C(7)	0.4246	0.3277	0.3757	C(19)	0.1606	0.3163	-0.1820
C(8)	0.5218	0.3694	0.4079	C(20)	0.3808	0.4840	0.1815
C(9)	0.4650	0.4242	0.4686				

Table 3. Bijvoet inequalities.[a)]

h	k	l	$\lvert F_c\rvert$	ΔF_c [b)]	$\lvert F_o\rvert$	ΔF_o [c)]	h	k	l	$\lvert F_c\rvert$	ΔF_c	$\lvert F_o\rvert$	ΔF_o
4	2	2	38.84	0.97	129.63	0.51	4	1	1	28.71	-0.54	96.24	-1.44
1	1	2	35.80	0.68	116.51	0.44	6	10	2	14.96	0.83	48.29	0.90
1	4	1	25.78	-0.59	82.57	-1.22	1	1	3	22.80	0.61	74.84	1.64
2	6	1	43.74	0.65	147.60	0.86	5	1	2	8.33	0.78	29.71	0.53
2	4	2	28.34	-0.63	97.42	-1.27	2	16	1	22.41	0.70	72.61	1.17
1	9	1	19.15	0.64	61.22	0.06	1	10	1	9.52	0.73	28.84	0.41
5	9	1	31.99	-0.71	107.22	-1.02	2	11	1	20.30	-0.55	67.28	-0.44
3	4	2	25.10	-0.61	85.78	-1.26	2	10	2	26.74	0.57	89.76	0.80
3	8	1	30.37	-0.60	103.28	-0.54	2	3	3	17.81	-0.61	59.19	-0.17
2	13	1	27.27	0.66	96.01	1.25	5	7	1	20.46	-0.56	70.01	-0.11

a) As $|F_o(hkl)|$ and $|F_o(\bar{h}\bar{k}\bar{l})|$ values, the average value of $|F_o(hkl)|$ and $|F_o(\bar{h}\bar{k}l)|$ and that of $|F_o(\bar{h}kl)|$ and $|F_o(h\bar{k}l)|$ are used respectively. The observed and calculated values are not on the same scale.

b) $\Delta F_c = |F_c(hkl)| - |F_c(\bar{h}\bar{k}\bar{l})|$ c) $\Delta F_o = |F_o(hkl)| - |F_o(\bar{h}\bar{k}\bar{l})|$

References and Notes

1) N. Hamanaka, H. Miyakoshi, A. Furusaki and T. Matsumoto, preceding paper, and references therein.

2) Presented at the 26th annual meeting of the Chemical Society of Japan on Apr. 1. 1972. Abst. Papers Vol. III 1242. After the presentation we were informed that Professors Hikino and Takemoto also isolated the same compound from the same plant (H. Hikino, private communication).

3) Satisfactory analytical data were obtained for this compound.

4) The symbolic addition procedure for acentric structure; J. Karle and I. L. Karle, Acta Crystallogr., 17, 1356 (1966).

5) All the calculations necessary for the analysis were carried out on a FACOM 230-60 computer at the Computer Center of Hokkaido University with our programs.

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