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## Molecular and Crystal Structure of a New 24-nor-Triterpenoid Carboxylic Acid from *Acanthopanax Trifoliatum*<sup>\*,\*</sup>

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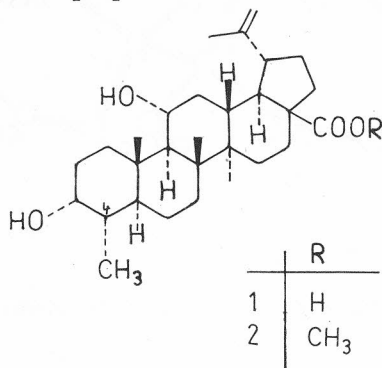
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The molecular and crystal structure of the new nortriterpene 24-nor-3 $\alpha$ ,11 $\alpha$ -dihydroxy-lup-20(29)-en-28-oic acid isolated from the Araliaceae *Acanthopanax trifoliatum* has been determined on the basis of X-ray analysis of its methyl ester.

### INTRODUCTION

Recently<sup>1-3</sup> we reported on the isolation and structure of some new triterpenes of the lupane series from the plant *Acanthopanax trifoliatum* (L.) Merr. (Araliaceae), used in the folk medicine of Southeast Asia as a drug with Ginseng-like activity<sup>4</sup>.

One of these constituents was a new 24-nor lupane derivative for which, on the basis of physical data, the structure 24-nor-3 $\alpha$ , 11 $\alpha$ -dihydroxy-lup-20(29)-en-28-oic acid (I) was proposed<sup>4</sup>.



<sup>\*</sup> Dedicated to Professor Mihailo Lj. Mihailović on the occasion of his 60th birthday.

<sup>\*</sup> Part 15 in the series *Natural Products from Vietnamese Plants*.  
For part 14 see lit. 1.

In this communication we describe the detailed molecular and crystal structure of this constituent by the X-ray analysis of its corresponding methyl ester 2.

#### EXPERIMENTAL

For the X-ray analysis a single crystal of 2<sup>1</sup>, 0.3 × 0.4 × 0.7 mm large, obtained from ether-*n*-hexane, was used. Crystal data: orthorhombic, space group P2<sub>1</sub>2<sub>1</sub>2<sub>1</sub>; unit cell  $a = 8.437(4)$ ,  $b = 22.340(8)$ ,  $c = 14.096(5)$  Å;  $Z = 4$ ;  $D_c = 1.179$  g/cm<sup>3</sup>.

The intensities of 2322 independent reflections up to  $2\theta = 48^\circ$  were collected in the  $\omega/2\theta$  scan mode on a Hilger and Watts four-circle diffractometer with graphite-monochromated MoK $\alpha$  radiation. The intensity data were corrected for Lorentz- and polarisation effects. Neither absorption nor extinction corrections were applied.

The structure was solved by direct methods with the computer program MULTAN 78<sup>5</sup>. The E-map revealed nearly all non-hydrogen atoms. The positions of the remaining non-hydrogen atoms were determined by a difference Fourier synthesis after some cycles of the fullmatrix least squares refinement with SHELX 76<sup>6</sup>. At the discrepancy factor of  $R = 0.098$  the hydroxyl H-atoms were located on a difference Fourier map while the remaining hydrogen atoms were generated geometrically. The final weighted anisotropic full-matrix refinement with fixed isotropic contributions of the H-atoms converged to  $R = 0.072$  for 1943 observed reflections with  $|F_o| > 3\sigma$ . The weighting scheme was  $\omega = 1/((\sigma(F_o))^2 + 0.00055/F_o)^2$ . The final atomic positional parameters are listed in Table I. Bond distances, bond angles and endocyclic torsion angles are given in Tables II, III and IV, respectively.\*

Figure 1 shows the molecular structure of 2. The 23-methyl group occupies the equatorial 4 $\alpha$ -position. The rings A, B, C and D are almost chairs, ring E adopts a

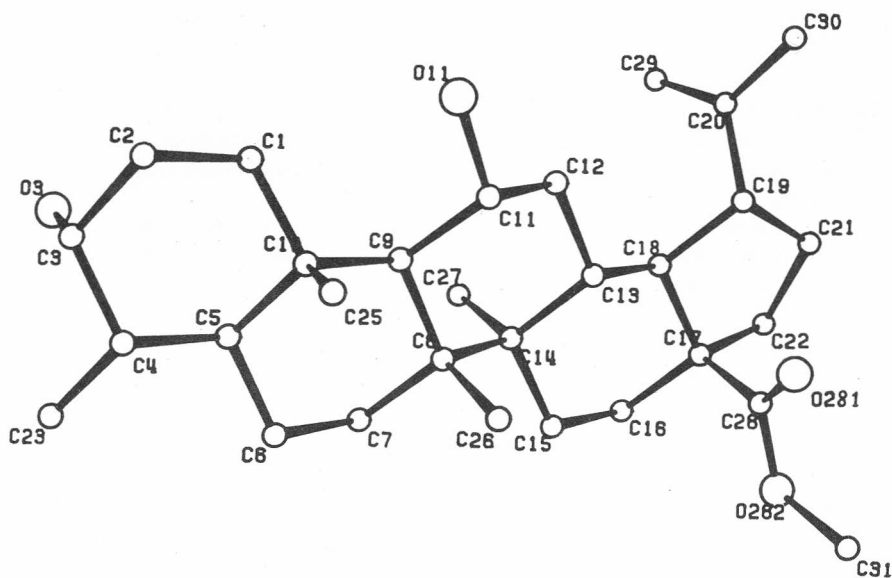


Figure 1. Molecular structure of the methyl ester 2.

\* Lists of anisotropic thermal parameters for non-hydrogen atoms, H-atom parameters and torsion angles have been deposited with the British Library Lending Division as Supplementary Publication No. SUP. Copies may be obtained through the Executive Secretary, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

TABLE I

Fractional Atomic Coordinates of 2 (e.s.d.'s in Parentheses) and Equivalent Isotropic Temperature Factors ( $\text{\AA}^2$ )  $U_{eq} = 1/3 \sum_i \sum_j U_{ij} a_i^* a_j^* a_i a_j$

Atom	x/a ( $\sigma$ )	y/b ( $\sigma$ )	z/c ( $\sigma$ )
C(1)	0.8043(7)	0.2473(2)	1.2888(4)
C(2)	0.8715(8)	0.2828(3)	1.3723(4)
C(3)	0.7697(7)	0.3365(3)	1.3984(4)
C(4)	0.5942(8)	0.3176(3)	1.4139(4)
C(5)	0.5325(6)	0.2837(3)	1.3261(4)
C(6)	0.3535(7)	0.2713(3)	1.3288(4)
C(7)	0.2983(7)	0.2478(3)	1.2324(4)
C(8)	0.3781(6)	0.1878(2)	1.2032(4)
C(9)	0.5650(6)	0.1956(2)	1.2103(4)
C(10)	0.6302(7)	0.2251(2)	1.3048(4)
C(11)	0.6399(6)	0.1348(2)	1.1835(4)
C(12)	0.5969(6)	0.1183(2)	1.0821(4)
C(13)	0.4182(6)	0.1118(2)	1.0707(4)
C(14)	0.3334(6)	0.1712(2)	1.0974(4)
C(15)	0.1501(6)	0.1615(2)	1.0869(4)
C(16)	0.0976(7)	0.1366(2)	0.9906(4)
C(17)	0.1842(6)	0.0768(2)	0.9710(4)
C(18)	0.3642(8)	0.0899(2)	0.9725(4)
C(19)	0.4412(7)	0.0338(2)	0.9292(4)
C(20)	0.5962(7)	0.0426(2)	0.8756(4)
C(21)	0.3088(7)	0.0084(3)	0.8617(4)
C(22)	0.1650(7)	0.0495(3)	0.8713(4)
C(23)	0.4962(9)	0.3726(3)	1.4383(5)
C(25)	0.6307(7)	0.1812(2)	1.3899(4)
C(26)	0.3150(7)	0.1391(2)	1.2716(4)
C(27)	0.3785(7)	0.2223(2)	1.0272(4)
C(28)	0.1326(8)	0.0289(3)	1.0398(5)
C(29)	0.6393(7)	0.0958(3)	0.8328(4)
C(30)	0.6930(8)	-0.0102(4)	0.8672(5)
C(31)	-0.0915(9)	-0.0210(3)	1.1052(5)
O(3)	0.7806(5)	0.3802(2)	1.3250(3)
O(11)	0.8126(4)	0.1363(2)	1.1886(3)
O(281)	0.2161(4)	-0.0060(2)	1.0815(3)
O(282)	-0.0265(5)	0.0278(2)	1.0494(3)

TABLE II  
Bond Distances (Å) with e.s.d.'s in Parentheses

C(1)-C(2)	1.528(8)	C(12)-C(13)	1.523(7)
C(1)-C(10)	1.567(8)	C(13)-C(14)	1.554(6)
C(2)-C(3)	1.521(9)	C(13)-C(18)	1.537(7)
C(3)-C(4)	1.555(8)	C(14)-C(15)	1.569(7)
C(3)-O(3)	1.426(7)	C(14)-C(27)	1.557(7)
C(4)-C(5)	1.541(8)	C(15)-C(16)	1.532(7)
C(4)-C(23)	1.521(9)	C(16)-C(17)	1.548(6)
C(5)-C(6)	1.536(7)	C(17)-C(18)	1.546(8)
C(5)-C(10)	1.576(7)	C(17)-C(22)	1.541(7)
C(6)-C(7)	1.529(8)	C(17)-C(28)	1.508(8)
C(7)-C(8)	1.556(7)	C(18)-C(19)	1.539(7)
C(8)-C(9)	1.589(7)	C(19)-C(20)	1.523(8)
C(8)-C(14)	1.582(7)	C(19)-C(21)	1.573(8)
C(8)-C(26)	1.550(7)	C(20)-C(29)	1.381(8)
C(9)-C(10)	1.584(7)	C(20)-C(30)	1.438(9)
C(9)-C(11)	1.544(6)	C(21)-C(22)	1.528(8)
C(10)-C(25)	1.549(7)	C(28)-O(281)	1.203(7)
C(11)-C(12)	1.520(7)	C(28)-O(282)	1.350(7)
C(11)-O(11)	1.459(6)	C(31)-O(282)	1.452(8)

17 $\beta$ -envelope conformation. The asymmetric parameter<sup>7</sup> is  $\Delta C_s^{17} = 1.8^\circ$ . The conformational parameters<sup>8</sup> are summarized in Table V. Bond distances and bond angles are close to the expected values. The H atom of the 3 $\alpha$ -hydroxyl group is involved in an intermolecular hydrogen bond with O(3)...O(281) = 2.863(7) Å (symmetry code (i) 1-x, 1/2+y, 5/2-z) connecting the molecules in b-direction. The molecular packing is given in Figure 2.

The above mentioned data confirm unequivocally the structure of 2 and, therefore, the native triterpenoid acid as 24-nor-3 $\alpha$ , 11 $\alpha$ -dihydroxy-lup-20(29)-en-28-oic acid (1). With such a structure, compound 1 represents the final stage of the biosynthetic demethylation pathway of 4,4-dimethylated lupanes to 24-nor compounds in *Acanthopanax trifoliatum*<sup>1</sup>.

TABLE III

*Bond Angles (°) with e.s.d.'s in Parentheses*

C(10)-C(1)-C(2)	113.7(5)	C(14)-C(13)-C(12)	110.4(4)
C(3)-C(2)-C(1)	112.7(5)	C(18)-C(13)-C(12)	114.8(4)
C(4)-C(3)-C(2)	110.9(5)	C(18)-C(13)-C(14)	110.7(4)
O(3)-C(3)-C(2)	109.2(5)	C(13)-C(14)-C(8)	108.6(4)
O(3)-C(3)-C(4)	110.4(4)	C(15)-C(14)-C(8)	110.9(4)
C(5)-C(4)-C(3)	110.0(5)	C(27)-C(14)-C(8)	111.6(4)
C(23)-C(4)-C(3)	109.3(6)	C(15)-C(14)-C(13)	108.2(4)
C(23)-C(4)-C(5)	113.3(5)	C(27)-C(14)-C(13)	111.1(4)
C(6)-C(5)-C(4)	113.6(5)	C(27)-C(14)-C(15)	106.4(4)
C(10)-C(5)-C(4)	112.6(5)	C(16)-C(15)-C(14)	114.7(4)
C(10)-C(5)-C(6)	111.6(5)	C(17)-C(16)-C(15)	109.5(4)
C(7)-C(6)-C(5)	109.8(4)	C(18)-C(17)-C(16)	107.3(4)
C(8)-C(7)-C(6)	113.6(5)	C(22)-C(17)-C(16)	117.1(4)
C(9)-C(8)-C(7)	108.6(4)	C(28)-C(17)-C(16)	111.2(5)
C(14)-C(8)-C(7)	110.4(4)	C(22)-C(17)-C(18)	101.0(4)
C(26)-C(8)-C(7)	106.9(4)	C(28)-C(17)-C(18)	114.1(4)
C(14)-C(8)-C(9)	108.8(4)	C(28)-C(17)-C(22)	105.9(5)
C(26)-C(8)-C(9)	112.2(4)	C(17)-C(18)-C(13)	111.3(4)
C(26)-C(8)-C(14)	109.9(4)	C(19)-C(18)-C(13)	119.5(4)
C(10)-C(9)-C(8)	116.3(4)	C(19)-C(18)-C(17)	104.8(4)
C(11)-C(9)-C(8)	107.1(4)	C(20)-C(19)-C(18)	117.0(5)
C(11)-C(9)-C(10)	115.4(4)	C(21)-C(19)-C(18)	103.6(4)
C(5)-C(10)-C(1)	104.7(4)	C(21)-C(19)-C(20)	110.8(5)
C(9)-C(10)-C(1)	109.6(4)	C(29)-C(20)-C(19)	123.6(5)
C(25)-C(10)-C(1)	108.0(4)	C(30)-C(20)-C(19)	115.0(5)
C(9)-C(10)-C(5)	108.9(4)	C(30)-C(20)-C(29)	121.3(7)
C(25)-C(10)-C(5)	112.4(4)	C(22)-C(21)-C(19)	107.1(5)
C(25)-C(10)-C(9)	112.8(5)	C(21)-C(22)-C(17)	103.6(4)
C(12)-C(11)-C(9)	110.2(4)	O(281)-C(28)-C(17)	127.2(7)
O(11)-C(11)-C(9)	112.1(4)	O(282)-C(28)-C(17)	111.4(5)
O(11)-C(11)-C(12)	106.8(4)	O(282)-C(28)-O(281)	121.3(6)
C(13)-C(12)-C(11)	111.0(4)	C(31)-O(282)-C(28)	116.4(5)

TABLE IV  
Endocyclic Torsion Angles ( $^{\circ}$ ) with e.s.d.'s in Parentheses

C(10)-C(1)-C(2)-C(3)	-56.3(9)
C(1)-C(2)-C(3)-C(4)	52.5(9)
C(2)-C(3)-C(4)-C(5)	-54.2(9)
C(3)-C(4)-C(5)-C(10)	60.3(8)
C(4)-C(5)-C(10)-C(1)	-59.4(8)
C(5)-C(10)-C(1)-C(2)	56.8(7)
C(10)-C(5)-C(6)-C(7)	-61.3(7)
C(5)-C(6)-C(7)-C(8)	61.4(8)
C(6)-C(7)-C(8)-C(9)	-53.0(7)
C(7)-C(8)-C(9)-C(10)	47.7(8)
C(8)-C(9)-C(10)-C(5)	-48.7(8)
C(9)-C(10)-C(5)-C(6)	54.2(8)
C(14)-C(8)-C(9)-C(11)	-61.4(6)
C(8)-C(9)-C(11)-C(12)	61.7(5)
C(9)-C(11)-C(12)-C(13)	-61.4(6)
C(11)-C(12)-C(13)-C(14)	59.0(6)
C(12)-C(13)-C(14)-C(8)	-58.1(5)
C(13)-C(14)-C(8)-C(9)	59.8(7)
C(18)-C(13)-C(14)-C(15)	53.2(7)
C(13)-C(14)-C(15)-C(16)	-52.8(7)
C(14)-C(15)-C(16)-C(17)	56.8(7)
C(15)-C(16)-C(17)-C(18)	-59.0(6)
C(16)-C(17)-C(18)-C(13)	63.0(6)
C(17)-C(18)-C(13)-C(14)	-61.5(7)
C(22)-C(17)-C(18)-C(19)	-43.4(9)
C(17)-C(18)-C(19)-C(21)	27.6(5)
C(18)-C(19)-C(21)-C(22)	-1.2(5)
C(19)-C(21)-C(22)-C(17)	-25.5(7)
C(21)-C(22)-C(17)-C(18)	41.9(8)

TABLE V  
Puckering Parameters for Rings

Ring	Q (Å)	$\phi$ ( $^{\circ}$ )	$\theta$ ( $^{\circ}$ )
A (1-2-3-4-5-10)	0.59	215	174
B (5-6-7-8-9-10)	0.57	130	172
C (8-9-11-12-13-14)	0.64	37	4
D (13-14-15-16-17-18)	0.60	93	6
E (17-18-19-21-22)	0.44	2	—

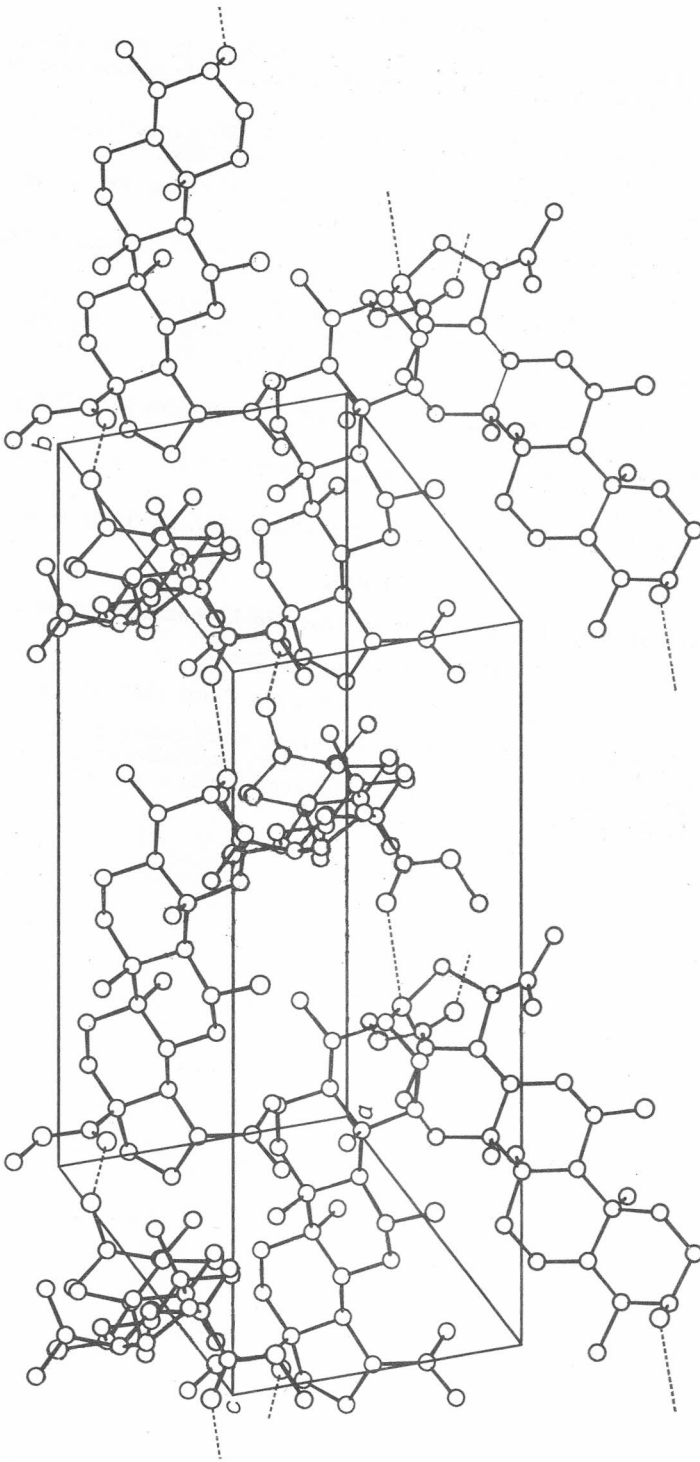


Figure 2. Molecular packing of 2.

## REFERENCES

1. M. Lischewski, Ph. D. Ty, L. Kutschabsky, D. Pfeiffer, H. V. Phiet, A. Preiss, T. V. Sung, and G. Adam, *Phytochemistry* **24** (1985) 2355.
2. Ph. D. Ty, M. Lischewski, H. V. Phiet, A. Preiss, T. V. Sung, J. Schmidt, and G. Adam, *Phytochemistry* **23** (1984) 2889.
3. Ph. D. Ty, M. Lischewski, H. V. Phiet, A. Preiss, Ph. V. Nguyen, and G. Adam, *Phytochemistry* **24** (1985) 867.
4. Lily M. Perry, *Medicinal Plants of East and Southeast Asia*, MIT Press Cambridge 1980 p. 40.
5. P. Main, S. E. Hull, L. Lessinger, G. Germain, J. P. Declercq, and M. M. Woolfson, Multan 78. *A System of Computer Programs for the Automatic Solution of Crystal Structure from X-ray Diffraction Data*, Univ. of York, England 1978.
6. G. M. Sheldrick SHELX 76. *Program for Crystal Structure Determination*. Univ. of Cambridge, England 1976.
7. W. L. Duax and D. A. Norton, *Atlas of Steroid Structure*, London, Plenum Press, London 1975.
8. C. Cremer and J. A. Pople, *J. Amer. Chem. Soc.* **97** (1975) 1354.

## SAŽETAK

**Molekulska i kristalna struktura nove 24-triterpenoid-karbonske kiseline izolirane iz**  
*Acanthopanax Trifoliatum*

*Leo Kutschabsky, Doris Pfeiffer, Manfred Lischewski, Pham Dinh Ty i Günter Adam*

Određena je kristalna i molekulska struktura metil-estera 24-nor-3 $\alpha$ 11 $\alpha$ -dihidro-lup-20(29)-en-28 karbonske kiseline. Supstanca kristalizira u ortorompskom sustavu, prostorna grupa P2<sub>1</sub>2<sub>1</sub>2<sub>1</sub>, parametri jedinične ćelije:  $a = 8.437(4)$ ,  $b = 22.340(8)$ ,  $c = 14.096(5)$ ,  $A$ ,  $Z = 4$ ,  $D_c = 1.179$  g cm<sup>-3</sup>.