Table 2. *Main interatomic bond distances* (Å) *and angles* (°) *with e.s.d.'s in parentheses*

PO_4 tetrahedron

P	O(1)	O(2)	O(3)	O(4)
O(1)	1·493 (1)	112·3 (1)	106·5 (1)	115·6 (1)
O(2)	2·534 (2)	1·557 (2)	106·4 (1)	104·9 (1)
O(3)	2·450 (2)	2·501 (2)	1·566 (2)	110·9 (1)
O(4)	2·534 (2)	2·425 (2)	2·527 (2)	1·502 (1)

P—P 4·7195 (7)

$C_4H_{12}NO$ tetrahedral group

C(2)	C(1)	C(3)	C(4)	N
C(1)	1·515 (3)	108·9 (2)	111·6 (2)	108·0 (2)
C(3)	2·459 (3)	1·508 (3)	112·3 (2)	108·1 (2)
C(4)	2·502 (3)	2·507 (3)	1·510 (3)	107·7 (2)
N	2·435 (3)	2·429 (3)	2·425 (3)	1·494 (2)

C(3)—O 1·419 (3) C(2)—C(3)—O 110·6 (2)

Hydrogen bonds

O(N)—H···O	O(N)—H	H···O	O(N)—H—O	O(N)—O
O(2)—H(2)···O(4)	0·81 (3)	1·78 (3)	175 (3)	2·586 (2)
O(3)—H(3)···O	0·65 (2)	1·98 (2)	177 (3)	2·635 (2)
O—H···O(1)	0·75 (2)	1·93 (2)	173 (2)	2·673 (2)
O(*W*)—H(1*W*)···O(4)	0·76 (2)	2·12 (2)	172 (3)	2·868 (2)
O(*W*)—H(2*W*)···O(1)	0·74 (2)	2·07 (2)	167 (2)	2·797 (2)
N—H(1N)···O(4)	0·85 (2)	2·08 (2)	162 (2)	2·905 (2)
N—H(1N)···O(2)		2·53 (2)	127 (2)	3·120 (2)
N—H(2N)···O(1)	0·92 (3)	2·08 (3)	142 (2)	2·865 (2)
N—H(2N)···O		2·53 (3)	121 (1)	2·776 (2)
N—H(3N)···O(*W*)	0·89 (3)	1·89 (3)	176 (2)	2·773 (2)

H(1*W*)—O(*W*)—H(2*W*) 105 (3)

of tris(ethylenediammonium) bis(*cyclo*-triphosphate), $[NH_3(CH_2)_2NH_3]_3(P_3O_9)_2$ (Averbuch-Pouchot, Durif & Guitel, 1989). One quasi-linear hydrogen bond joins N to the water molecule, another one joins O to the PO_4 tetrahedron.

So the succession of $C_4H_{12}NO^+$ and O(*W*) ribbons and $H_2PO_4^-$ chains is stabilized by a three-dimensional network of hydrogen bonds and geometrical details of this hydrogen-bond scheme are listed in Table 2. Some characteristic features should be noted: there is no direct bonding between the different organic groups in a ribbon and no bonding at all between the ribbons or chains related by centrosymmetry.

References

AVERBUCH-POUCHOT, M. T., DURIF, A. & GUITEL, J. C. (1988). *Acta Cryst.* C**44**, 1416–1418.

AVERBUCH-POUCHOT, M. T., DURIF, A. & GUITEL, J. C. (1989). *Acta Cryst.* C**45**, 1320–1322.

Enraf–Nonius (1977). *Structure Determination Package*. Enraf–Nonius, Delft, The Netherlands.

ISABEV, Z., IBRAGIMOV, A., TALIPOV, S. A., SAIBOVA, M. T. & ARIPOV, T. F. (1981). *Russ. J. Inorg. Chem.* **26**, 1086–1088.

MAIN, P., LESSINGER, L., WOOLFSON, M. M., GERMAIN, G. & DECLERCQ, J.-P. (1977). *MULTAN77. A System of Computer Programs for the Automatic Solution of Crystal Structures from X-ray Diffraction Data*. Univs. of York, England, and Louvain, Belgium.

Acta Cryst. (1990). C**46**, 2384–2387

Structure of *N*-(3,6-Dimethoxy-17-methyl-4,5-epoxy-6,14α-etheno-7α-isomorphinanylcarbonyl)-L-phenylalanine Ethyl Ester Hydrochloride

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Abstract. $C_{33}H_{39}N_2O_6^+.Cl^-$, $M_r = 595·13$, orthorhombic, $P2_12_12_1$, $a = 10·678$ (1), $b = 11·365$ (1), $c = 24·664$ (2) Å, $V = 2993·1$ (5) Å^3, $Z = 4$, $D_x = 1·321$ g cm^{-3}, λ(Mo $K\alpha$) = 0·71073 Å, $\mu = 1·7$ cm^{-1}, $F(000) = 1264$, $T = 295$ K, $R = 0·052$ for 2450 observed reflections with $I > 2·5\sigma(I)$. The phenylalanine residue is found to have no significant effect on the geometry of the ethenoisomorphinan skeleton. The amide H is intramolecularly hydrogen bonded to the carbonyl O of the peptide moiety and not to the methoxy ether O. This results in an orientation of the peptide side chain more or less parallel to the piperidine moiety.

Introducton. The interaction of opioids with the opioid receptor has still not been clarified, inspite of several valuable receptor models (Kolb, 1987; and references cited therein). Conformational analysis in

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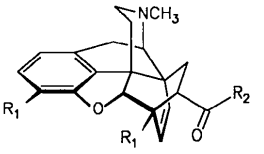
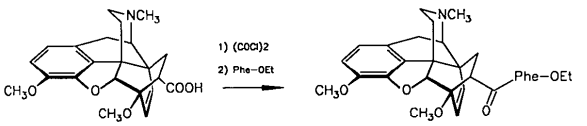
combination with pharmacological results is a helpful tool in the search for new information. Therefore, we synthesized new morphinan peptides [(1)-(4), Beyerman, Lie, Maat & Noordam-Weissdorf, 1982; (5)-(7), Cappon, Lie & Maat, 1990] based on the similarities between morphinans and endogenous opioid peptides, such as enkephalin, and the message-address concept (Chavkin & Goldstein, 1981), which suggests that the N-terminal amino acids in opioid peptides are responsible for the pharmacological stimulance and that some C-terminal amino acids are of importance for the receptor affinity. In these morphinan peptides we have coupled an ethenoisomorphinan-7-carboxylic acid as the message moiety to several enkephalin residues as the address moiety. Some of these compounds appear to



(1*a,b*) R_2 = Leu – OEt
(2*a,b*) R_2 = Phe – Leu – OEt
(3*a,b*) R_2 = Gly – Phe – Leu – OEt
(4*a,b*) R_2 = Phe – Leucinol
(5*a,b*) R_2 = Phe – OEt
(6*a,b*) R_2 = D – Phe – OEt
(7*a,b*) R_2 = Gly – Phe = OEt
a R_1 = OCH_3 *b* R_1 = OH

be potent analgesics with high receptor affinity (Smith, Medzihradsky & Woods, 1986). For a detailed interpretation of the structure–activity relationships we have carried out conformational analyses on parts of the molecules using molecular mechanics (Cappon, Lie & Maat, 1990). The X-ray analysis of the title compound (5*a*) is the first crystal structure reported in the field of morphinan peptides. Points of interest were the conformation of the skeleton, the influence of the peptide substituent on the geometry and the orientation of this substituent. Intramolecular hydrogen bonding is thought to play an important role in the orientation.

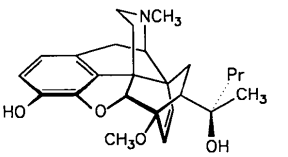
Experimental. The title compound has been synthesized from the Diels–Alder adduct of thebaine with ethyl acrylate and the ethyl ester of L-phenylalanine, and was crystallized as its hydrochloride salt from ethanol.



(5*a*)

Data were collected on an Enraf–Nonius CAD-4F diffractometer for a colourless transparent crystal (0·22 × 0·30 × 0·42 mm) mounted on a glass fibre. Unit-cell parameters and their e.s.d.'s were derived from a least-squares treatment of 25 SET4 reflections ($10 < \theta < 14°$). Intensity data for 4660 reflections (h −13:0, k −14:0, l 0:32; $\theta < 27{\cdot}5°$; Zr-filtered Mo $K\alpha$ radiation) were collected in the $\omega/2\theta$ scan mode with $\Delta\omega = (0{\cdot}60 + 0{\cdot}35\tan\theta)°$. Three reference reflections ($0\bar{2}4$, $\bar{1}\bar{2}0$ and $\bar{1}01$) indicated no decay during 70 h of X-ray exposure. The intensity data were corrected for Lp but not for absorption. The variance $\sigma^2(I)$ was calculated based on counting statistics plus an instability constant term $(0{\cdot}023I)^2$ as derived from the excess variance in the reference reflections (McCandlish, Stout & Andrews, 1975). The space group was derived from the observed systematic absences. The structure was solved by direct methods (*SHELXS*86; Sheldrick, 1986) and refined on F by full-matrix least squares with *SHELX*76 (Sheldrick, 1976). The two H atoms bonded to N atoms were located in a difference Fourier map and their positions refined. All other H atoms were introduced at calculated positions (C—H = 0·95 Å) and refined with fixed geometry with respect to their carrier atoms with two common isotropic thermal parameters. Refinement with weights, $w^{-1} = \sigma^2(F) + 0{\cdot}0005F^2$, converged at R = 0·052 [wR = 0·057; S = 1·11; 399 parameters; 2450 reflections, $(\Delta/\sigma)_{max}$ = 0·5]. A final difference Fourier map did not show residual peaks outside −0·30 and 0·36 e $Å^{-3}$. Scattering factors from Cromer & Mann (1968) and anomalous-dispersion terms from Cromer & Liberman (1970) were used. Final parameters are given in Table 1.* The programs *PLATON* and *PLUTON* (Spek, 1982) were used for the calculation of geometrical data and the plot respectively. All calculations were made on a microVAX-II.

Discussion. Fig. 1 shows the molecule with adopted numbering. Data on the geometry have been assembled in Table 2. The Cl anion is H bonded to the protonated N(17) [N(17)—H(17) 0·97 (5), H(17)···Cl 2·12 (5) Å, N(17)—H(17)···Cl 154 (4)°]. The conformation of the ethenoisomorphinan skeleton is very similar to that observed in the X-ray structure of 3-methoxyetorphine (van den Hende & Nelson, 1967).



Etorphine

* Lists of structure factors, anisotropic thermal parameters and H-atom parameters have been deposited with the British Library Document Supply Centre as Supplementary Publication No. SUP 53086 (21 pp.). Copies may be obtained through The Technical Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

Table 1. *Final coordinates and equivalent isotropic thermal parameters and their e.s.d.'s in parentheses*

$$U_{eq} = (1/3)\sum_i\sum_j U_{ij}a_i^*a_j^*\mathbf{a}_i.\mathbf{a}_j.$$

	x	y	z	U_{eq}(Å^2)
Cl	0·2833 (1)	0·2333 (1)	−0·06108 (7)	0·0607 (5)
O(1)	0·0181 (4)	0·7029 (4)	0·2413 (1)	0·055 (2)
O(2)	−0·0281 (3)	0·5807 (3)	0·1436 (1)	0·037 (1)
O(3)	−0·1554 (3)	0·6663 (3)	0·0423 (1)	0·040 (1)
O(4)	−0·0191 (3)	0·6701 (3)	−0·0819 (1)	0·049 (1)
O(5)	−0·3973 (4)	0·4488 (5)	−0·0888 (2)	0·085 (2)
O(6)	−0·4380 (4)	0·5539 (4)	−0·1624 (2)	0·067 (2)
N(1)	−0·1706 (4)	0·5330 (4)	−0·0775 (2)	0·038 (1)
N(17)	0·3469 (3)	0·3762 (3)	0·0383 (2)	0·031 (1)
C(1)	0·3359 (5)	0·6361 (5)	0·1904 (2)	0·046 (2)
C(2)	0·2413 (5)	0·6725 (5)	0·2249 (2)	0·048 (2)
C(3)	0·1167 (5)	0·6578 (5)	0·2130 (2)	0·041 (2)
C(4)	0·0881 (5)	0·5937 (4)	0·1670 (2)	0·034 (2)
C(5)	−0·0112 (4)	0·5268 (4)	0·0903 (2)	0·030 (1)
C(6)	−0·0351 (4)	0·6125 (4)	0·0430 (2)	0·031 (1)
C(7)	−0·0121 (4)	0·5311 (4)	−0·0083 (2)	0·029 (1)
C(8)	0·1302 (4)	0·5076 (4)	−0·0155 (2)	0·030 (2)
C(9)	0·3352 (4)	0·5087 (4)	0·0435 (2)	0·030 (1)
C(10)	0·3956 (4)	0·5524 (5)	0·0965 (2)	0·035 (2)
C(11)	0·3060 (5)	0·5720 (4)	0·1431 (2)	0·033 (2)
C(12)	0·1827 (4)	0·5447 (4)	0·1355 (2)	0·030 (2)
C(13)	0·1281 (4)	0·4874 (4)	0·0867 (2)	0·027 (1)
C(14)	0·1973 (4)	0·5436 (4)	0·0378 (2)	0·027 (1)
C(15)	0·1425 (4)	0·3535 (4)	0·0849 (2)	0·031 (1)
C(16)	0·2767 (5)	0·3147 (4)	0·0827 (2)	0·037 (2)
C(18)	0·1783 (4)	0·6749 (4)	0·0409 (2)	0·030 (1)
C(19)	0·0606 (4)	0·7087 (4)	0·0426 (2)	0·031 (1)
C(20)	−0·0675 (4)	0·5853 (4)	−0·0586 (2)	0·032 (2)
C(21)	0·4798 (4)	0·3359 (5)	0·0350 (2)	0·045 (2)
C(22)	0·0465 (8)	0·7922 (6)	0·2806 (3)	0·074 (3)
C(23)	−0·2590 (5)	0·6004 (6)	0·0611 (3)	0·060 (2)
C(24)	−0·2362 (5)	0·5703 (5)	−0·1264 (2)	0·041 (2)
C(25)	−0·1670 (6)	0·5429 (5)	−0·1788 (2)	0·051 (2)
C(26)	−0·1265 (6)	0·4175 (5)	−0·1872 (2)	0·051 (2)
C(27)	−0·0122 (6)	0·3764 (6)	−0·1667 (2)	0·057 (2)
C(28)	0·0299 (7)	0·2640 (7)	−0·1758 (3)	0·076 (3)
C(29)	−0·0419 (9)	0·1897 (7)	−0·2073 (3)	0·085 (3)
C(30)	−0·1536 (9)	0·2263 (7)	−0·2285 (3)	0·086 (3)
C(31)	−0·1966 (7)	0·3398 (6)	−0·2184 (3)	0·068 (3)
C(32)	−0·3645 (6)	0·5161 (5)	−0·1234 (3)	0·047 (2)
C(33)	−0·5698 (6)	0·5155 (7)	−0·1632 (3)	0·079 (3)
C(34)	−0·6501 (8)	0·6034 (9)	−0·1410 (4)	0·111 (4)

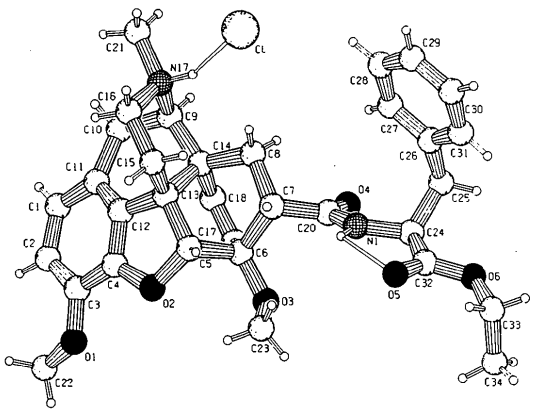


Fig. 1. View of the molecule with adopted numbering.

Table 2. *Bond distances* (Å) *and bond angles* (°) *for non-*H *atoms*

O(1)—C(3)	1·363 (7)	C(7)—C(8)	1·553 (6)
O(1)—C(22)	1·435 (8)	C(7)—C(20)	1·506 (6)
O(2)—C(4)	1·376 (6)	C(8)—C(14)	1·553 (6)
O(2)—C(5)	1·463 (6)	C(9)—C(10)	1·540 (7)
O(3)—C(6)	1·423 (5)	C(9)—C(14)	1·531 (6)
O(3)—C(23)	1·414 (7)	C(10)—C(11)	1·512 (7)
O(4)—C(20)	1·236 (6)	C(11)—C(12)	1·365 (7)
O(5)—C(32)	1·199 (8)	C(12)—C(13)	1·488 (6)
O(6)—C(32)	1·313 (8)	C(13)—C(14)	1·551 (6)
O(6)—C(33)	1·474 (8)	C(13)—C(15)	1·530 (6)
N(1)—C(20)	1·336 (6)	C(14)—C(18)	1·508 (6)
N(1)—C(24)	1·457 (7)	C(15)—C(16)	1·500 (7)
N(17)—C(9)	1·516 (6)	C(18)—C(19)	1·315 (6)
N(17)—C(16)	1·499 (6)	C(24)—C(25)	1·521 (7)
N(17)—C(21)	1·493 (5)	C(24)—C(32)	1·504 (8)
C(1)—C(2)	1·384 (7)	C(25)—C(26)	1·504 (8)
C(1)—C(11)	1·412 (7)	C(26)—C(27)	1·401 (9)
C(2)—C(3)	1·374 (8)	C(26)—C(31)	1·390 (9)
C(3)—C(4)	1·382 (7)	C(27)—C(28)	1·37 (1)
C(4)—C(12)	1·390 (7)	C(28)—C(29)	1·38 (1)
C(5)—C(6)	1·539 (6)	C(29)—C(30)	1·37 (1)
C(5)—C(13)	1·556 (6)	C(30)—C(31)	1·39 (1)
C(6)—C(7)	1·587 (6)	C(33)—C(34)	1·43 (1)
C(6)—C(19)	1·497 (6)		

C(3)—O(1)—C(22)	116·7 (5)	C(4)—C(12)—C(13)	110·0 (4)
C(4)—O(2)—C(5)	108·1 (3)	C(11)—C(12)—C(13)	126·0 (4)
C(6)—O(3)—C(23)	118·3 (4)	C(5)—C(13)—C(12)	101·7 (3)
C(32)—O(6)—C(33)	119·0 (5)	C(5)—C(13)—C(14)	112·4 (4)
C(20)—N(1)—C(24)	123·8 (4)	C(5)—C(13)—C(15)	112·6 (4)
C(9)—N(17)—C(16)	111·1 (3)	C(12)—C(13)—C(14)	105·2 (4)
C(9)—N(17)—C(21)	112·8 (3)	C(12)—C(13)—C(15)	114·8 (4)
C(16)—N(17)—C(21)	111·9 (4)	C(14)—C(13)—C(15)	109·8 (4)
C(2)—C(1)—C(11)	119·8 (5)	C(8)—C(14)—C(9)	116·9 (4)
C(1)—C(2)—C(3)	122·6 (5)	C(8)—C(14)—C(13)	109·3 (3)
O(1)—C(3)—C(2)	126·3 (5)	C(8)—C(14)—C(18)	104·0 (4)
O(1)—C(3)—C(4)	116·7 (5)	C(9)—C(14)—C(13)	106·3 (4)
C(2)—C(3)—C(4)	117·0 (5)	C(9)—C(14)—C(18)	112·4 (4)
O(2)—C(4)—C(3)	126·8 (5)	C(13)—C(15)—C(16)	112·9 (4)
O(2)—C(4)—C(12)	112·2 (4)	C(13)—C(14)—C(18)	107·7 (4)
C(3)—C(4)—C(12)	120·6 (5)	N(17)—C(16)—C(15)	111·5 (4)
O(2)—C(5)—C(6)	113·3 (4)	C(14)—C(18)—C(19)	114·8 (4)
O(2)—C(5)—C(13)	106·8 (3)	C(6)—C(19)—C(18)	116·1 (4)
C(6)—C(5)—C(13)	107·3 (3)	O(4)—C(20)—N(1)	121·9 (4)
O(3)—C(6)—C(5)	115·5 (4)	O(4)—C(20)—C(7)	122·6 (4)
O(3)—C(6)—C(7)	112·4 (3)	N(1)—C(20)—C(7)	115·5 (4)
O(3)—C(6)—C(19)	107·6 (4)	N(1)—C(24)—C(25)	114·2 (4)
C(5)—C(6)—C(7)	102·1 (3)	N(1)—C(24)—C(32)	106·1 (5)
C(5)—C(6)—C(19)	110·7 (4)	C(25)—C(24)—C(32)	113·6 (5)
C(7)—C(6)—C(19)	108·3 (4)	C(24)—C(25)—C(26)	116·8 (5)
C(6)—C(7)—C(8)	110·1 (3)	C(25)—C(26)—C(27)	121·1 (5)
C(6)—C(7)—C(20)	111·0 (4)	C(25)—C(26)—C(31)	121·6 (6)
C(8)—C(7)—C(20)	111·1 (4)	C(27)—C(26)—C(31)	117·2 (6)
C(7)—C(8)—C(14)	108·0 (3)	C(26)—C(27)—C(28)	122·4 (6)
N(17)—C(9)—C(10)	110·9 (4)	C(27)—C(28)—C(29)	118·7 (7)
N(17)—C(9)—C(14)	109·2 (3)	C(28)—C(29)—C(30)	120·9 (7)
C(10)—C(9)—C(14)	113·4 (4)	C(29)—C(30)—C(31)	120·1 (7)
C(9)—C(10)—C(11)	115·3 (4)	C(26)—C(31)—C(30)	120·7 (7)
C(1)—C(11)—C(10)	124·1 (5)	O(5)—C(32)—O(6)	123·7 (6)
C(1)—C(11)—C(12)	116·6 (5)	O(5)—C(32)—C(24)	124·2 (6)
C(10)—C(11)—C(12)	118·2 (4)	O(6)—C(32)—C(24)	112·0 (5)
C(4)—C(12)—C(11)	122·2 (4)	O(6)—C(33)—C(34)	111·2 (7)

This means that the influence of the phenylalanine substituent on the skeleton geometry is negligible. The conformation within the phenylalanine ethyl ester is rather flexible (Wei, Doherty & Einstein, 1972; Yamashita, Kato, Yamane & Ashida, 1982; Ishida, Tanabe & Inoue, 1983). Of the two conceivable intramolecular hydrogen bonds around the peptide bond, the one between the amide H and the carbonyl O of the phenylalanine ethyl ester residue [N(1)—H(10) 0·94 (5), H(10)···O(5) 2·13 (5) Å, N(1)—H(10)···O(5) 111 (4)°] is formed. This is of interest because formation of the other one, namely between the amide H and the 6-methoxy O achievable by rotation about C(7)—C(20), would dramatically alter the relative orientation of the phenylalanine and ethenoisomorphinan moieties. The present conformation is probably favoured for packing reasons. No intermolecular H bonds are found.

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References

BEYERMAN, H. C., LIE, T. S., MAAT, L. & NOORDAM-WEISSDORF, M. (1982). *Recl Trav. Chim. Pays-Bas*, **101**, 455–460.

CAPPON, J. J., LIE, T. S. & MAAT, L. (1990). *Recl Trav. Chim. Pays-Bas*, **109**, 413–418.

CHAVKIN, C. & GOLDSTEIN, A. (1981). *Proc. Natl Acad. Sci. USA*, **78**, 6543–6547.

CROMER, D. T. & LIBERMAN, D. (1970). *J. Chem. Phys.* **53**, 1891–1898.

CROMER, D. T. & MANN, J. B. (1968). *Acta Cryst.* A**24**, 321–324.

HENDE, J. H. VAN DEN & NELSON, N. R. (1967). *J. Am. Chem. Soc.* **89**, 2901–2905.

ISHIDA, T., TANABE, N. & INOUE, M. (1983). *Acta Cryst.* C**39**, 110–112.

KOLB, V. M. (1987). *Advances in Drug Research*, edited by B. TESTA, Vol. 16, p. 281. London: Academic Press.

MCCANDLISH, L. E., STOUT, G. H. & ANDREWS, L. C. (1975). *Acta Cryst.* A**31**, 245–249.

SHELDRICK, G. M. (1976). *SHELX*76. Program for crystal structure determination. Univ. of Cambridge, England.

SHELDRICK, G. M. (1986). *SHELXS*86. Program for the solution of crystal structures. Univ. of Göttingen, Federal Republic of Germany.

SMITH, C. B., MEDZIHRADSKY, F. & WOODS, J. H. (1986). *NIDA Res. Monogr.* **75**, 189–196.

SPEK, A. L. (1982). *The EUCLID Package*. In *Computational Crystallography*, edited by D. SAYRE, p. 528. Oxford: Clarendon Press.

WALKER, N. & STUART, D. (1983). *Acta Cryst.* A**39**, 158–166.

WEI, C. H., DOHERTY, D. G. & EINSTEIN, J. R. (1972). *Acta Cryst.* B**28**, 907–915.

YAMASHITA, O., KATO, Y., YAMANE, T. & ASHIDA, T. (1982). *Acta Cryst.* B**38**, 2657–2663.

Acta Cryst. (1990). C**46**, 2387–2389

Structure and Absolute Configuration of Two *ent*-Atisane Diterpenes from *Euphorbia fidjiana*

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Abstract. *ent*-(13*S*)-Hydroxyatis-16-en-3,14-dione, $C_{20}H_{28}O_3$, $M_r = 316{\cdot}4$, orthorhombic, $P2_12_12_1$, $a = 7{\cdot}335\ (2)$, $b = 12{\cdot}539\ (1)$, $c = 18{\cdot}325\ (1)$ Å, $V = 1685{\cdot}4$ Å^3, $Z = 4$, $D_x = 1{\cdot}247$ g cm^{-3}, λ(Mo $K\alpha$) = 0·71069 Å, $\mu = 0{\cdot}80$ cm^{-1}, $F(000) = 688$, $R = 0{\cdot}042$ for 1626 observed data [$I > 2{\cdot}5\sigma(I)$] at room temperature. *ent*-16α-Hydroxy-3-oxoatisan-17-yl 4-bromobenzoate, $C_{27}H_{35}BrO_4$, $M_r = 503{\cdot}5$, orthorhombic, $P2_12_12_1$, $a = 7{\cdot}029\ (2)$, $b = 11{\cdot}642\ (3)$, $c = 28{\cdot}626\ (6)$ Å, $V = 2342{\cdot}5$ Å^3, $Z = 4$, $D_x = 1{\cdot}427$ g cm^{-3}, λ(Mo $K\alpha$) = 0·71069 Å, $\mu = 17{\cdot}8$ cm^{-1}, $F(000) = 1056$, $R = 0{\cdot}034$ for 1801 observed data [$I > 3\sigma(I)$] at 170 K. These compounds are new diterpenoids whose stereochemistry has been determined.

Introduction. The Euphorbiaceae family is known as a source of antileukaemic and cocarcinogenic compounds (Kupchan, Uchida, Branfman, Dailey & Fei, 1976). Preparations of *Euphorbia fidjiana*, a Fijian plant known locally as vasa damu, have been used locally for the treatment of a variety of ailments. Extracts of the heartwood of *E. fidjiana* have yielded 15 diterpenoid compounds with atisane or seco-atisane skeletons (Lal, Cambie, Rutledge & Woodgate, 1990). The structure of two of these, *ent*-(13*S*)-hydroxyatis-16-en-3,14-dione (I) and *ent*-16α,17-dihydroxyatisan-3-one as the *p*-bromobenzoate (II), along with the NMR spectra establish the stereochemistry of the whole series. In addition the absolute configuration of (II) establishes the absolute stereochemistry of all of the compounds.

Experimental. Suitable single crystals were obtained from slow evaporation of hexane solutions. Crystal samples of dimensions 0·4 × 0·3 × 0·2 mm (I) and 0·5 × 0·2 × 0·2 mm (II) were mounted in random orientations on an Enraf–Nonius CAD-4 diffractometer. The lattice parameters and orientation matrix were obtained from 25 reflections in the range $22 < 2\theta < 26°$. The Laue symmetry is *mmm* and the space groups were uniquely determined by the systematic absences. The intensity data were collected using Zr-filtered Mo $K\alpha$ radiation (II) using the ω–2θ scan technique. Three reflections monitored every hour showed no non-statistical variations in intensity. Unique data sets were collected for each structure. The number of reflections surveyed was 2352 in the range $2 < 2\theta < 56°$ with h, k, l ranges 10, 17, 25 (I) and 2480 in the range $2 < 2\theta < 50°$ with h, k, l ranges

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