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DITERPENES FROM *EUPHORBIA PEPLUS*

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Key Word Index—*Euphorbia peplus*; Euphorbiaceae; diterpenes; ingenanes; jatrophanes; pepluane.

Abstract—Chemical investigation of *Euphorbia peplus* from two different collection sites revealed almost identical profiles of secondary metabolites affording ingenanes, jatrophanes and a tetracyclic diterpene with a new carbon skeleton for which the name pepluane is proposed. © 1998 Elsevier Science Ltd. All rights reserved

INTRODUCTION

The genus *Euphorbia* is the largest in the Spurge family, comprising over 1000 species [1]. Most of the representatives are characterized by the occurrence of a highly irritant latex [2]. The irritant properties are due to polycyclic diterpenes, mainly with a tigliane or an ingenane skeleton [3, 4]. *Euphorbia peplus* (Petty Spurge) is a temperate annual weed up to 40 cm high, originally native to Europe and North Africa but today of almost cosmopolitan distribution. *E. peplus* thrives well in urban environments, and can even be spotted in lightwells opening onto underground lines. Unlike many hardy *Euphorbias*, it has no ornamental value and is considered a plague for gardeners, on account of its unattractive forms and its invasive diffusion. However, the plant has been used medicinally for the treatment of asthma and catarrh and as a purgative [5]. It belongs to the section Tithymalus, subsection Esula the species of which are usually irritant. Previous chemical investigation afforded ingenane derivatives [5]. We report our results with samples collected in Chile and Germany.

RESULTS AND DISCUSSION

The whole plant extract of *E. peplus* from Chile contained the jatrophanes **1–3**, the tetracyclic diterpene with a new skeleton **7** and the ingenanes **8** and **9**. A sample from Germany afforded in addition the jatrophanes **4–6**. The ^{1}H NMR data of compound **1** indicated a polyester with five acetate groups and a nicotinoate group (Table 1). The ^{13}C NMR spectrum showed, in addition to the signals for the ester groups, those for a keto group, two double bonds, one exocyclic and one *trans* disubstituted, and six oxygenated sp^3-carbons, of which four were secondary and two tertiary. On taking into account the multiplicities of the residual signals (four methyl-, two methylene- and two methyne groups and a quartenary carbon) the parent polyol required a molecular composition $C_{20}H_{34}O_7$ and thus was a bicyclic diterpene. The presence of a *trans* double bond indicated a macrocyclic compound, most likely a jatrophane. By spin decoupling only short sequences could be extracted from the ^{1}H NMR spectrum. Further information, which allowed the connection of these fragments, was obtained from an HMBC spectrum. Starting with the proton signals for the *gem*-dimethyl groups which showed all possible two or three bonds correlations, i.e. mutual and to C-9–C-11, the sequences C-7–C-9 and C-11–C-13 were connected. Similarly, the cross peaks between the signals for H-17 and C-5 and C-7, H-16 and C-1–C-3, H-1 and C-2–C-4, C-14 and C-15 and H-20 and C-12–C-14 incorporated all fragments into the assumed skeleton. The cross peak between the H-9 signal and that for the nicotinoate carbonyl ensured the relative position of the nicotinoate and, thus, of all ester groups. Stereochemical aspects are discussed below. The ^{1}H- and ^{13}C-NMR spectra of compounds **2–6** (Tables 1 and 2) were similar to each other and in part to that of **1**. The ^{13}C NMR data indicated that the keto group of **1** was absent while two further oxygen bearing sp^3-carbons were present. The main differences between the spectra of **2** and those of **3–6** were the chemical shift and the splitting of H-8, which in the latter appeared as an upfield shifted doublet (due to the coupling with a broadened, D_2O exchangeable signal). The recognition of spin

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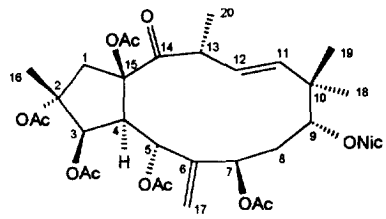

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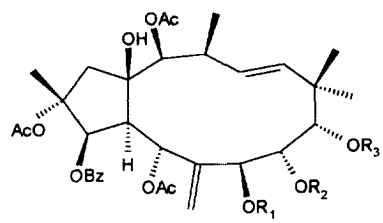
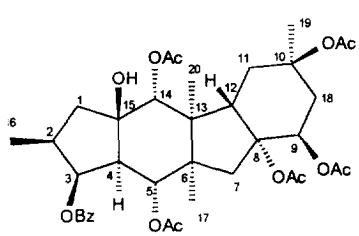


	2	**3**	**4**	**5**	**6**
R_1	Ac	iBu	iBu	Ac	Ac
R_2	Ac	H	H	H	H
R_3	Ac	Nic	Ac	Nic	Ac



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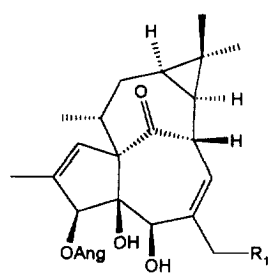


	8	**9**
R_1	H	OAc

systems was hindered as several signals, which appeared only as slightly broadened singlets, indicated apparently isolated spin systems—even those for the C-7–C-9 fragment with three consecutive CHOR groups (as already mentioned before, H-8 appeared as doublet due to the coupling with the OH proton). Obviously the corresponding dihedral angles were nearly 90° (also between H-13 and H-14). The connection of single fragments (including the assignment of the relative positions of secondary ester groups) was again deduced from the results of HMBC experiments. All of the results obtained for compounds **3**–**5** are listed in Table 3. The stereochemistry at all chiral centres and the preferred conformations were deduced from the results of NOE-difference spectroscopy (Table 4). Detailed discussion of conformational behaviour will be published elsewhere, but a few important aspects are summarized here. It is noteworthy that all signals in the spectra appeared sharp, though the twelve-membered ring is highly flexible. Only a few jatrophanes with a 6,17-exocyclic double bond are known and all possess *trans*-fused rings. Usually they are highly oxydized bearing substituents at C-3, C-5, C-7, C-9, and C-14 but also at C-2 and C-

Table 1. ^{1}H NMR data of jatrophanes **1–6** (400 MHz, $CDCl_3$)

H	1	2	3	4	5	6
1α	3.80 *dd*	2.68 *brd*	2.86 *brd*	2.65 *brd*	2.84 *brd*	2.69 *brd*
1β	1.95 *d*	2.22 *d*	2.08 *d*	2.17 *d*	2.07 *d*	2.15 *d*
3	5.41 *dd*	5.87 *d*	5.92 *d*	5.84 *d*	5.97 *d*	5.89 *d*
4	2.94 *dd*	3.29 *dd*	3.75 *dd*	3.36 *dd*	3.76 *dd*	3.38 *dd*
5	5.93 *brs*	5.80 *brd*	5.80 *brd*	5.74 *brd*	5.80 *brd*	5.75 *brd*
7	4.98 *brdd*	5.50 *brs*	5.39 *brs*	5.27 *brs*	5.29 *brs*	5.18 *brs*
8	2.16 *m*	5.26 *brs*	4.14 *d*	4.03 *d*	4.15 *d*	4.04 *d*
9	5.06 *dd*	4.96 *s*	5.08 *s*	4.71 *s*	5.11 *s*	4.72 *s*
11	5.94 *d*	5.86 *d*	6.17 *d*	5.94 *d*	6.13 *d*	5.90 *d*
12	5.63 *dd*	5.65 *dd*	5.67 *dd*	5.59 *dd*	5.65 *dd*	5.57 *dd*
13	3.51 *dq*	2.65 *dq*	2.88 *dq*	2.69 *d q*	2.82 *d q*	2.68 *dq*
14		5.10 *s*	5.15 *s*	5.10 *s*	5.14 *s*	5.10 *s*
16	1.49 *s*	1.55 *s*	1.48 *s*	1.52 *s*	1.47 *s*	1.51 *s*
17	5.18 *brs*	4.90 *brs*	4.83 *brs*	4.91 *brs*	4.77 *brs*	4.86 *brs*
17	5.14 *d*	4.50 *d*	4.44 *d*	4.48 *d*	4.47 *d*	4.51 *d*
18	1.10 *s*	0.94 *s*	1.07 *s*	1.01 *s*	1.08 *s*	1.01 *s*
19	1.15 *s*	1.35 *s*	1.37 *s*	1.29 *s*	1.36 *s*	1.29 *s*
20	1.17 *d*	1.15 *d*	1.17 *d*	1.14 *d*	1.17 *d*	1.14 *d*
8-OH	—		2.95 *d*	3.03 *d*	2.85 *d*	2.94 *d*
15-OH	—	3.59 *brs*	3.67 *brs*	3.63 *brs*	3.67 *brs*	3.64 *brs*
OAc	2.15 *s*	2.16 *s*	2.21 *s*	2.15 *s*	2.22 *s*	2.15 *s*
	2.14 *s*	2.14 *s*	2.11 *s*	2.08 *s*	2.11 *s*	2.10 *s*
	2.13 *s*	2.11 *s*	2.04 *s*	2.05 *s*	2.05 *s*	2.08 *s*
	2.12 *s*	2.07 *s*		2.00 *s*	1.47 *s*	2.07 *s*
	1.62 *s*	2.00 *s*			—	2.01 *s*
	—	1.92 *s*	—	—		
OBz		8.07 *AA′*	8.05 *AA′*	8.07 *AA′*	8.06 *AA′*	8.09 *AA′*
	—	7.44 *BB′*	7.42 *BB′*	7.43 *BB′*	7.42 *BB′*	7.44 *BB′*
		7.57 *C*	7.56 *C*	7.57 *C*	7.57 *C*	7.57 *C*
O*i*Bu	—		2.00 *qq*	2.56 *qq*	—	—
	—		0.93 *d*	1.23 *d*	—	—
	—	—	0.47 *d*	1.19 *d*	—	—
ONic	9.21 *brd*	—	9.30 *brd*	—	9.32 *brd*	—
	8.22 *ddd*	—	8.36 *ddd*	—	8.37 *ddd*	
	7.37 *ddd*		7.43 *brd*		7.41 *dd*	—
	8.79 *dd*	—	8.22 *dd*	—	8.83 *dd*	—

J (Hz): comp. **1**: 1α,1β = 11,12 = 16; 1α,3 = 1.5; 3,4 = 8,9 = 4; 4,5 = 5,17′ = 1; 7,8 = 7,8′ = 6; 8′,9 = 8; 12,13 = 9.5; 13,20 = 7; comps. **2–6**: 1α,1β = 15; 3,4 = 6; 4,5 = 4; 5,17′ = 1; 11,12 = 16; 12,13 = 9; 13,20 = 7; comps. **3–5**: 8,OH = 11.5; O*i*Bu: 2,3 = 2,4 = 7; ONic: 2,4 = 4,6 = 2; 2,5 = 1; 4,5 = 8; 5,6 = 5.

8, and sometimes at C-1 and C-13. Known derivatives with the same substitution pattern indicate invariable stereochemistry which is independent of substitution at C-2, C-3, C-4, C-5 and C-7. The twelve-membered ring can adopt different conformation, depending on the substitution pattern. Concerning the southern part of the molecule, they are best described in terms of the orientation of the 6,17-exomethylene group, being perpendicular (C-17 above; conformation I) or parallel (conformation II) to the mean plane of the twelve-membered ring. As a consequence, the coupling $J_{4,5}$ has either large (9–11 Hz, conf. I) or small (0–4 Hz, conf. II) values. The configuration at C-13 dictates the conformation of the northern part of the molecule. The methyl group is in a quasiequatorial position while H-13 and H-12 are in antiperiplanar orientation. This implies that the *trans* double bond and the methyl groups at C-10 are inverted in the conformers. Notably, the couplings $J_{7,8}$ and $J_{8,9}$ are not influenced, being always almost zero in all 7, 8, 9 three substituted derivatives. The jatrophanes **1–6** adopt the conformation II and possess identical stereochemistry at all chiral centres except at C-13. It is remarkable, that the known jatrophanes with the 6,17-exocyclic double bond and identical substitution pattern adopt conformation I, e.g. kansuinin B [6], esulon A [7] and enukokurin [8] with $J_{4,5}$ = 9–10.5 Hz. The conformation II is characterized by the NOE effects between H-4 and H-7 and H-5 and H-8 and no interaction between H-5 or H-7 with the exomethylenic H-17 (Table 4). The configuration at C-13 was deduced from the effects between H-13 and H-5 (compound **1**) and H-4 and H-13 (compound **4**). Further important effects observed with compound **4** were between 15-

Table 2. ^{13}C NMR data of compounds **1**–**7** (400 MHz, $CDCl_3$)

C	1	2	3	4	5	6	7
1	46.9 *t*	50.4 *t*	49.7 *t*	50.4 *t*	49.4 *t*	50.0 *t*	44.6 *t*
2	86.6 *s*	88.3 *s*	88.5 *s*	88.4 *s*	88.5 *s*	88.4 *s*	35.9 *d*
3	78.2 *d*	80.5 *d*	80.5 *d*	80.3 *d*	80.7 *d*	80.5 *d*	76.2 *d*
4	49.4 *d*	44.6 *d*	44.8 *d*	44.5 *d*	44.7 *d*	44.5 *d*	48.3 *d*
5	68.7 *d*	71.5 *d*	71.9 *d*	71.7 *d*	71.9 *d*	71.7 *d*	69.6 *d*
6	146.1 *s*	143.4 *s*	144.0 *s*	144.4 *s*	143.3 *s*	143.7 *s*	48.9 *s*
7	68.2 *d*	67.8 *d*	68.1 *d*	67.9 *d*	69.2 *d*	68.9 *d*	39.9 *t*
8	34.8 *t*	70.6 *d*	70.3 *d*	70.1 *d*	70.1 *d*	69.9 *d*	87.1 *s*
9	75.7 *d*	80.2 *d*	86.8 *d*	86.1 *d*	86.2 *d*	85.8 *d*	67.2 *d*
10	40.6 *s*	40.7 *s*	40.4 *s*	40.0 *s*	40.4 *s*	40.0 *s*	79.8 *s*
11	138.6 *d*	134.1 *d*	133.8 *d*	133.9 *d*	133.8 *d*	133.9 *d*	31.1 *t*
12	130.5 *d*	131.3 *d*	131.5 *d*	130.9 *d*	131.6 *d*	131.1 *d*	46.5 *d*
13	43.7 *d*	37.3 *d*	37.5 *d*	37.5 *d*	37.5 *d*	37.5 *d*	51.1 *s*
14	211.2 *s*	79.4 *d*	79.4 *d*	79.2 *d*	79.4 *d*	79.3 *d*	73.6 *d*
15	92.6 *s*	83.8 *s*	84.4 *s*	84.0 *s*	84.4 *s*	84.0 *s*	84.0 *s*
16	17.9 *q*	23.7 *q*	23.6 *q*	22.6 *q*	23.6 *q*	23.6 *q*	16.3 *q*
17	111.4 *t*	110.1 *t*	109.1 *t*	109.4 *t*	109.0 *t*	109.3 *t*	16.4 *q*
18	26.9 *q*	27.0 *q*	27.5 *q*	27.3 *q*	27.1 *q*	27.0 *q*	36.2 *t*
19	22.3 *q*	26.4 *q*	23.0 *q*	23.1 *q*	23.1 *q*	23.2 *q*	28.5 *q*
20	19.6 *q*	23.6 *q*	23.5 *q*	23.6 *q*	23.5 *q*	23.3 *q*	16.0 *q*
OAc	170.5 *s*	170.6 *s*	171.1 *s*	171.9 *s*	171.1 *s*	171.8 *s*	171.0 *s*
	170.2 *s*	170.4 *s*	170.4 *s*	170.6 *s*	170.4 *s*	170.6 *s*	170.2 *s*
	169.5 *s*	169.7 *s*	168.5 *s*	170.3 *s*	168.5 *s*	170.4 *s*	169.8 *s*
	169.4 *s*	169.7 *s*	—	168.4 *s*	168.0 *s*	168.5 *s*	169.7 *s*
	168.9 *s*	168.9 *s*	—	—	—	168.2 *s*	168.9 *s*
	—	168.1 *s*	—	—	—	—	—
	22.1 *q*	22.3 *q*	22.5 *q*	22.3 *q*	22.5 *q*	22.3 *q*	22.2 *q*
	21.3 *q*	21.9 *q*	21.1 *q*	21.0 *q*	21.1 *q*	21.0 *q*	22.1 *q*
	21.2 *q*	21.0 *q*	20.5 *q*	20.7 *q*	20.5 *q*	20.9 *q*	21.4 *q*
	21.1 *q*	20.8 *q*	—	20.5 *q*	20.2 *q*	20.7 *q*	20.9 *q*
	20.6 *q*	20.6 *q*	—	—	—	20.5 *q*	20.9 *q*
	—	20.5 *q*	—	—	—	—	—
OBz	—	164.8 *s*	164.8 *s*	164.8 *s*	164.9 *s*	164.9 *s*	129.3 *s*
	—	130.0 *s*	130.1 *s*	129.7 *s*	129.9 *s*	129.7 *s*	128.2 *s*
	—	129.7 *d*	129.6 *d*	129.6 *d*	129.7 *d*	129.7 *d*	133.0 *d*
	—	128.4 *d*	128.4 *d*	128.4 *d*	128.4 *d*	128.4 *d*	165.5 *d*
	—	133.2 *d*	133.1 *d*	133.1 *d*	133.2 *d*	133.2 *d*	130.3 *d*
O*i*Bu	—	—	174.1 *s*	174.6 *s*	—	—	—
	—	—	33.5 *d*	33.9 *d*	—	—	—
	—	—	19.1 *q*	19.3 *q*	—	—	—
	—	—	17.4 *q*	18.4 *q*	—	—	—
ONic	164.1 *s*	—	165.7 *s*	—	165.6 *s*		
	151.0 *d*	—	151.6 *s*	—	151.4 *s*	—	—
	125.7 *s*	—	125.0 *d*	—	125.0 *d*	—	—
	136.9 *d*	—	137.6 *d*	—	137.3 *d*	—	—
	123.3 *d*	—	123.3 *d*	—	123.3 *d*	—	—
	153.7 *d*	—	154.0 *d*	—	154.1 *d*	—	—

OH and H-5, between H-5 and H-12 and between H-7 and H-11. The calculated conformations [9] of compounds **1** and **4** (Fig. 1) are in excellent agreement with the experimental results. The parallel orientation of the estergroups at C-7 and C-9, which is clearly visible in the represented conformation, is reflected in the unusual chemical shifts of the signals for the ester groups at C-7 (Table 1) which are influenced by the aromatic ring current effect of the nicotinoate at C-9, e.g. a methyl group of isobutyrate at δ 0.47 in comp. **3** and the acetate at δ 1.47 in comp. **5**. This explains also the NOE effect between H-7 and H-2/4 of the nicotinoate at C-9 observed with compound **1** (Table 4 and Fig. 1).

In addition to the above compounds, the tetracyclic diterpene **7** with a new carbon skeleton was obtained. The ^1H NMR spectrum (Table 5) indicated that five acetates, a benzoate and a tertiary hydroxy group

Table 3. HMBC results for compounds **1** and **3–5**

H	**1**	**3***
1α	2, 3, 4, 14	2
1β	15	15
3	1, 2, 15, CO_{Ac}	1, 2, 15, CO_{OBz}
4	3, 14	
5	3, 4, 6, 17, CO_{Ac}	3, 4, 6
7	6, 9, 17, CO_{Ac}	6, 17, CO_{iBu}
9	7, 11, CO_{Nic}	7, 8, 10, 11, CO_{Nic}
11	10, 13, 18, 19	10
12	10, 13	10, 13, 20
13	11, 12, 14, 20	12
14		1, 4, 12, 15, 20, CO_{Ac}
16	1, 2, 3	1, 2
17	5, 7	5, 7
17′	5, 7	5, 7
18	9, 10, 11, 19	9, 10, 11, 19
19	9, 10, 11, 18	9, 10, 11, 18
20	12, 13, 14	12, 13, 14
15-OH		1

* Analogous results were observed with compounds **4** and **5**.

(D_2O-exchangeable signal at δ 3.07 *brs*) were present. The ^{13}C NMR spectrum (Table 2) confirmed the above results indicating four secondary and three tertiary oxygen-functionalized carbons. The multiplicities of the residual signals, four methyl groups, four methylene groups, three methyne and two quartenary carbons, gave for the parent polyol a molecular composition $C_{20}H_{34}O_7$ and required a tetracyclic compound. Assuming a diterpene derived from a common precursor, the unusual number of methyl groups indicated that a methyl group was incorporated in the ring system. Spin decoupling led only to short sequences. The conectivities of fragments were realized through the long range correlations observed in a highly informative HMBC spectrum (Table 5). The placement of two methyls (C-17 and C-20) at adjacent junction positions of the rings B and C was supported by the cross peaks between the proton signals for these methyl groups and two identical (C-6 and C-13) and two different carbon signals (H-17/C-5 and C-7 and H-20/C-12 and C-14). As H-14 correlates with C-1 and C-15 and H-18 with C-10, C-11 and C-19 all carbons but one were placed in a sequence. The last carbon (C-8) showed correlations to H-7, H-9 and H-12 and completed the tetracyclic system. Further correlations which are listed in Table 5 excluded alternative connectivities of the fragments. The stereochemistry was deduced from the results of NOE experiments which are also listed in Table 5. In particular, the interactions between 8-OAc and H-18 and between 10-OAc and H-12 required *trans*-fused C/D rings, while those between H-17 and H-20 and H-5 and H-12 are only possible with *cis*-fused B/C rings. Finally, the effects between 15-OH and H-5 and between H-20 and H-4 secured the *trans* stereochemistry of A/B rings. All of the results are in excellent agreement with the calculated conformation which is represented in Fig. 2 [9]. We have named the basic compound without functional groups pepluane. Biogenetically it may have been formed as shown in Scheme 1. Starting with a jatropha-6(17),12-diene the basic skeleton of a paraliane [10] is formed. The oxidation of a methyl group at C-10 would give the precursor for the rearrangement leading to the appropriate pepluane, while the vicinal 8α,9β-diol could be formed via the 8β,9β-epoxide.

Previous investigation of *E. peplus* afforded only

Table 4. NOE results for compounds **1** and **4**

H	**1***	**4**
3	4(5), 16, 17′(1)	4(4)
4	3(6), 5(4), 7(9)	3(5), 5(4), 7(7), 13(4)
5		4(5), 7(1), 8(8), 12(3), 15-OH(1)
7	4(8), 5(4), 11(1), 12(1), $Nic_{2/4}$(1)	4(9), 5(1), 8(3), 11(6)
8		5(6), 7(1), 9(2), 19
9	8(1), 11(1), 19	8(3), 18, 19, 8-OH(3)
11		7(1), 13(2)
12	7(1), 18, 20	5(2), 19
13	5(3), 11(4)	—
14	—	15-OH(1), 13(3), 20
16	1β(3), 3(5)	OBz_{AA}(3), 3(4), 1β(6)
17′	3(2)	OBz_{AA}(2)
18	7(2), 12(10), 19	11(7), 9(7), 9-OAc, 19
19	9(8), 11(7), 18	12(10), 9(8), 8(9), 18
20	12(2)	12(3), 14(6)
8-OH	—	9(2)
15-OH	—	OBz_{AA}′(4), 5(1), 14(1)

*No selectivity due to the overlapping of H-5 and H-11 signals; cumulative effects observed with H-4(4), H-7(4), H-8(2), H-9(2), H-13(5).

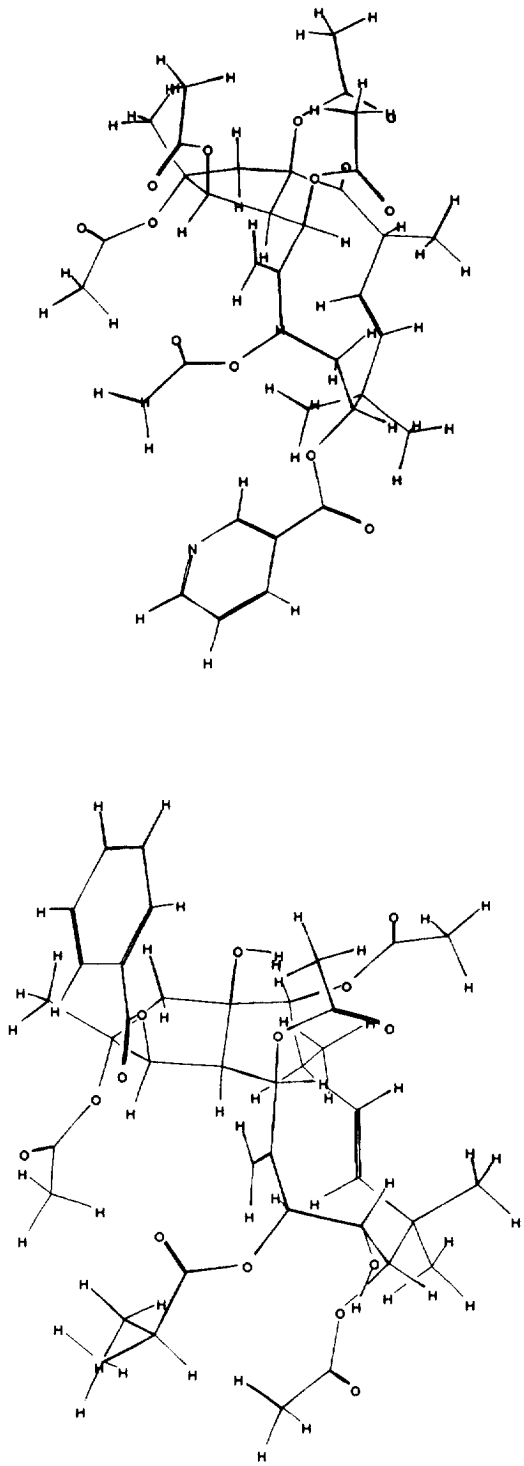


Fig. 1. Calculated conformations of the jatrophanes **1** (top) and **4** (bottom) indicating the inverted orientation of the *trans* double bond and the close spatial proximity of H-5 and H-13 in **1** and of H-4 and H-13 in **4**.

ingenane derivatives [4]. Because of the irritant properties of certain diterpenes from the Euphorbiaceae, very often the investigations were bioactivity-guided. The jatrophanes belong to a group of non-irritant diterpenes and thus could have been overlooked. The accumulation of macrocyclic and non-irritant polycyclic diterpenoids in plants from the genus *Euphorbia* may actually be higher than assumed. Detailed investigation of related taxa could give further taxonomically important information.

EXPERIMENTAL

Air dried whole plant material collected on 25 January 1994 in Hualpen, at the mouth of the river Bio Bio, VIII Region, Chile (herbarium specimen deposited at the University of Concepcion, Chile [CONC]) was extracted at room temp. with a mixt. of petrol–MTB (methyl-*tert*-butyl ether)–MeOH (1:1:1). After removal of waxy material by treatment with MeOH at −20° the filtrate was evpd and sepd by open-column reversed-phase-chromatography (RP8, 30 × 100 mm) with mixts comprising MeOH and H_2O into 4 frs. Fr 1 (MeOH–H_2O, 1:1) contained carbohydrates and other polar compounds and was not further characterized. Fr. 4 gave a mixture of triterpenes. Fr 2 (MeOH–H_2O, 3:2) and 3 (MeOH–H_2O, 4:1) were combined and sepd by CC with mixts of petrol–MTB–MeOH of increasing polarity. Further separation by HPLC and/or TLC gave 12 mg **1**, 5 mg **2**, 14 mg **3**, 7 mg **7**, 3 mg **8** and 6 mg **9** (the conditions of final separation are given with each compound).

Air dried whole plant material collected in 1993 in Berlin, Germany (herbarium specimen deposited in the Institute for Organic Chemistry, Technical University Berlin) was extracted at room temp. with a mixt. of petrol–MTB (methyl-*tert*-butyl ether)–MeOH (1:1:1). After removal of waxy material by treatment with MeOH at −20° the filtrate was evpd. The gummy residue was sepd by CC using mixts comprising of petrol–MTB–MeOH of increasing polarity. The resulting frs were combined in three crude frs A–C, which were further sepd by HPLC. Fr. A (MeOH–H_2O 7:3; always RP 8; 250 × 16 mm) gave 3 mg **8**. Fr. B (MeOH–H_2O 7:3) gave four mixts which were further sepd by TLC to give 5 mg **3**, 8 mg **4**, 4 mg **6**, 3 mg **7**, 7 mg **8**, and 2 mg **9**. The HPLC of fr. C (MeOH–H_2O 13:7) gave four mixts which were further sepd by TLC to give 7 mg **1**, 12 mg **2**, 3 mg **3**, 5 mg **5** and 8 mg **6** (the conditions of final separation are given with each compound).

Known compounds were identified by comparing their spectral data with those of authentic material or with literature data.

(2R*,3R*,4S*,5R*,7R*,9R*,13R*,15R*)-2,3,5,7,15-*Pentaacetoxy*-9-*nicotinoyloxy*-14-*oxojatropha*-6(1),11*E*-*diene* (**1**). TLC: petrol–MTB (1:1) $R_f = 0.11$; MS *m/z* (rel. int.): 699.289 $[M]^+$ (100) (calc. for $C_{36}H_{45}NO_{13}$ 699.289), 657 $[M-\text{ketene}]^+$ (16), 597 $[657-\text{AcOH}]^+$ (4), 474 $[597-\text{NicOH}]^+$ (4), 124 $[\text{NicOH}+1]^+$ (60), 106 $[\text{Nic}]^+$ (38); Nic = C_5H_4NCO.

(2R*,3R*,4S*,5R*,7S*,8S*,9S*,13S*,14S*,15R*)-

Table 5. ^{1}H NMR, NOE and HMBC data of the pepluane **7** (400 MHz, $CDCl_3$)

H		NOE	HMBC
1α	2.13 *dd*		
1β	1.52 *dd*		15
2	2.53 *m*	1α(3), 3(7)	—
3	5.76 *dd*	2(6), 4(5)	1, 15, CO_{OBz}
4*	2.38 *dd*		5
5	5.83 *d*	12(2), $OBz_{AA'}$(1)	6, 17, $CO_{5\text{-}OAc}$
7β	2.45 *d*		5, 8, 12, 13
7α	1.57 *d*		5, 6, 17
9	5.80 *brd*	18β(2)	8, 10, 12, $CO_{9\text{-}OAc}$
11α	1.62 *dd*		12
11β*	2.40 *ddd*		10, 13
12	4.14 *dd*	5(5), 11β(2), 14(2), OH(2), 10-OAc	8, 10, 11, 13, 14, 20
14	5.03 *s*	11β(3), 12(4), 20, OH(2)	6, 15, $CO_{14\text{-}OAc}$
16	1.05 *d*	1β(2), 2(3), $OBz_{AA'}$(1)	1, 2, 3
17	1.07 *s*	4(10), 20, 5-OAc, 8-OAc	5, 6, 7, 13
18α	1.78 *brd*		8, 9, 18
18β*	2.41 *ddd*		8, 10
19	1.56 *s*	11β(3), 18β(5)	10, 11, 19
20	0.89 *s*	7α(5), 11α(5), 14(7), 17, 8-OAc, 14-OAc,	6, 12, 13, 14
OH	3.07 *brs*	1β(2), 5(4), 10-OAc, 12(2), 14(1), $OBz_{AA'}$(3)	14, 15
5-OAc	1.95 *s*	5(1), 3(1)	$CO_{5\text{-}OAc}$
8-OAc	2.12 *s*	18	$CO_{8\text{-}OAc}$
9-OAc	1.65 *s*	5(2), 10-OAc, $OBz_{AA'}$(2), $OBz_{BB'}$(2)	$CO_{9\text{-}OAc}$
10-OAc	2.06 *s*	12(1), 9-OAc, $OBz_{AA'}$(2), $OBz_{BB'}$(2)	$CO_{10\text{-}OAc}$
14-OAc	2.03 *s*		$CO_{14\text{-}OAc}$
OBz	7.94 AA′	5(1), OH(4), 9-OAc, 10-OAc	CO_{OBz}
	7.35 BB′		
	7.53 C		

*Multiplicities and couplings of the signals for H-4, H-11β and H-18α taken from the spectrum in C_6D_6.

J(Hz): 1α,1β = 14; 1α,2 = 5; 1β,2 = 4,5 = 12; 2,3 = 11β,12 = 6; 2,16 = 7.5; 3,4 = 4.5; 7α,7β = 16; 9,18β = 5; 11α,11β = 11α,12 = 13; 11β,18β = 1; 18α,18β = 17.

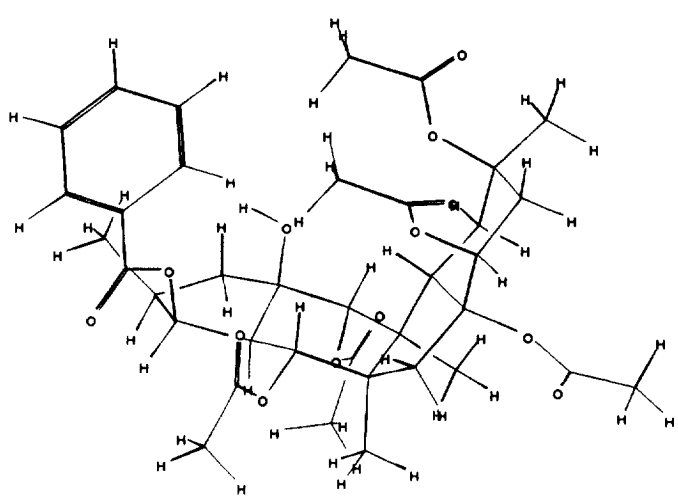
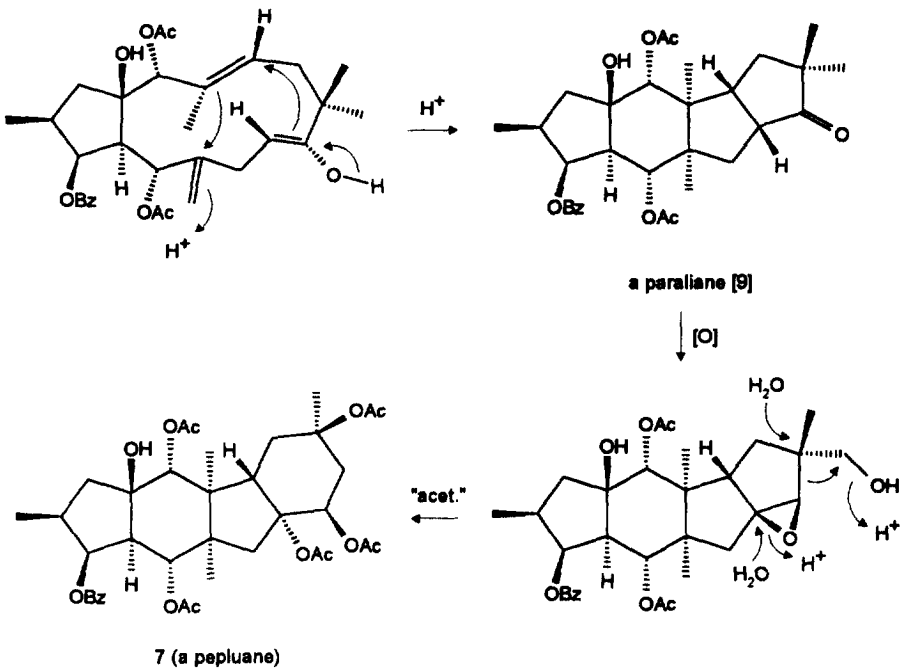


Fig. 2. Calculated conformation of the pepulane **7**.



Scheme 1. The proposed biogenesis of the pepluane 7 starting from a suitable substituted jatrophane.

2,5,7,8,9,14-*Hexaacetoxy*-3-*benzoyloxy*-15-*hydroxy*-*jatropha*-6(17),11*E*-*diene* (**2**). TLC: petrol–MTB (2:3) $R_f = 0.39$ (2×); MS *m/z* (rel. int.): 758.315 $[M]^+$ (1) (calc. for $C_{39}H_{50}O_{15}$ 758.315), 698 $[M-AcOH]^+$ (1), 638 $[698-AcOH]^+$ (1), 596 $[638-ketene]^-$ (1), 578 $[638-AcOH]^+$ (3), 536 $[596-AcOH]^+$ (6), 476 $[536-AcOH]^+$ (9), 414 $[536-PhCOOH]^+$ (11), 372 $[414-ketene]^+$ (15) 354 $[476-PhCOOH]^+$ (14), 312 $[372-AcOH]^+$ (16), 294 $[354-AcOH]^+$ (19), 105 $[PhCO]^+$ (100).

(2R*,3R*,4S*,5R*,7S*,8S*,9S*,13S*,14S*,15R*)-2,5,14-*Triacetoxy*-3-*benzoyloxy*-8,15-*dihydroxy*-7-*isobutyroyloxy*-9-*nicotinoyloxyjatropha*-6(17),11*E*-*diene* (**3**). TLC: petrol–MTB (2:3) R_f 0.30 (2×); MS *m/z* (rel. int.): 807.347 $[M]^+$ (9) (calc. for $C_{43}H_{53}NO_{14}$ 807.347), 747 $[M-AcOH]^+$ (3), 720 $[M+1-(CH_3)_2CHCOOH]^+$(2), 687 $[747-AcOH]^+$ (2), 660 $[720-AcOH]^+$ (3), 600 $[660-AcOH]^+$ (2), 478 $[600-PhCOOH]^+$ (4), 443 (4), 435 (4), 354 (6), 312 (5), 124 $[NicOH+1]^+$ (33), 106 $[Nic]^+$ (31), 105 $[PhCO]^+$ (100).

(2R*,3R*,4S*,5R*,7S*,8S*,9S*,13S*,14S*,15R*)-2,5,9,14-*Tetraacetoxy*-3-*benzoyloxy*-8,15-*dihydroxy*-7-*isobutyroyloxyjatropha*-6(17),11*E*-*diene* (**4**). TLC: petrol–MTB, 2:3, $R_f = 0.44$(2×); MS *m/z* (rel. int.): 744.336 $[M]^+$ (1) (calc. for $C_{39}H_{52}O_{14}$ 744.336), 726 $[M-H_2O]^+$ (1), 684 $[M-AcOH]^+$ (13), 624 $[684-AcOH]^+$ (10), 596 $[638-ketene]^+$ (11), 578 $[638-AcOH]^+$ (7), 536 $[624-i\text{BuOH}]^+$ (12), 502 $[624-PhCOOH]^+$ (10), 476 $[536-AcOH]^+$ (12), 414 $[536-PhCOOH]^+$ (11), 372 $[414-ketene]^+$ (10) 354 $[476-PhCOOH]^+$ (8), 105 $[PhCO]^+$ (100), 71 $[i\text{Bu}]^+$(86); *i*Bu = $(CH_3)_2CHCO$.

(2R*,3R*,4S*,5R*,7S*,8S*,9S*,13S*,14S*,15R*)-2,5,7,14-*Tetraacetoxy*-3-*benzoyloxy*-8,15-*dihydroxy*-9-*nicotinoyloxyjatropha*-6(17),11*E*-*diene* (**5**). TLC: petrol–MTB, 1:1, $R_f = 0.04$; MS *m/z* (rel. int.): 779.315 $[M]^+$ (81) (calc. for $C_{41}H_{49}NO_{14}$ 779.315), 720 $[M+1-AcOH]^+$ (45), 660 $[720-AcOH]^+$ (38), 600 $[660-AcOH]^+$ (18), 538 $[660-PhCOOH]^+$ (15), 124 $[NicOH+1]^+$ (51), 106 $[Nic]^+$ (37), 105 $[PhCO]^+$ (100).

(2R*,3R*,4S*,5R*,7S*,8S*,9S*,13S*,14S*,15R*)-2,5,7,9,14-*Pentaacetoxy*-3-*benzoyloxy*-8,15-*dihydroxyjatropha*-6(17),11*E*-*diene* (**6**). TLC: petrol–MTB, (1:1) $R_f = 0.10$ (3×); MS *m/z* (rel. int.): 716.304 $[M]^+$ (9) (calc. for $C_{37}H_{48}O_{14}$ 716.304), 656 $[M-AcOH]^+$ (44), 596 $[656-AcOH]^+$ (50), 536 $[596-AcOH]^+$ (60), 494 $[536-ketene]^+$ (25), 476 $[536-AcOH]^+$ (52), 354 $[476-PhCOOH]^+$ (67), 294 $[354-AcOH]^+$ (68), 105 $[PhCO]^+$ (100).

(2S*,3S*,4R*,5R*,6R*,8R*,9R*,10R*,12S*,13S*,14R*,15R*)-5,8,9,10,14-*Pentaacetoxy*-3-*benzoyloxy*-15-*hydroxypepluane* (**7**). TLC: petrol–MTB (2:3) $R_f = 0.39$ (2×); MS *m/z* (rel. int.): 640 $[M-AcOH]^+$ (0.5), 598 $[640-ketene]^+$ (6), 580 $[640-AcOH]^+$ (2), 538 $[580-ketene]^+$ (52), 520 $[580-AcOH]^+$ (17), 478 $[538-AcOH]^+$ (15), 460 $[520-AcOH]^+$ (35), 400 $[460-AcOH]^+$ (2), 338 $[460-PhCOOH]^+$ (33), 320 $[338-H_2O]^+$ (2), 105 $[PhCO]^+$ (34).

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