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New Masked δ-Lithiocarbonyl Compounds: Preparation and Synthetic Applications[1]

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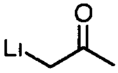
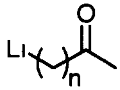
Abstract: The reaction of 2-(4-chlorobutyl)-1,3-dioxolanes (**1a-c**) or 2-(4-chlorobutyl)-2-ethyl-1,3-dithiane (**1d**) with an excess of lithium powder and a catalytic amount of naphthalene (8 mol %) in THF at -78°C leads to a solution of the corresponding masked lithium δ-enolates **2**, which react with different electrophiles (water, deuterium oxide, carbonyl compounds, carboxylic acid derivatives, dibenzyl disulfide or benzylideneaniline) to yield the expected products **3-15** In the presence of a catalytic amount of CuBr Me$_2$S the intermediate **2a** reacts with cyclohex-2-enone giving the compound **16a** through a conjugate addition The deprotection of compounds **10a**, **12a**, **16a** and **4b-6b** with 2 N HCl gives the expected functionalized carbonyl compounds **17a-19a** and **20b-22b**, respectively Finally, using silicon reagents it is possible to prepare alcohols **20a-25a**, dienic alcohols **26a-29a** and cyanooxepanes **30a-33a** from the *in situ* generated hydroxyaldehydes of the type **17a** with triethylsilane, allyltrimethylsilane and trimethylsilyl cyanide, respectively

Introduccion

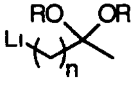
Functionalized organolithium compounds[2] are interesting reactive intermediates in organic synthesis because their reaction with electrophilic reagents allows the direct preparation of polyfunctionalized organic molecules. The most known and stable species of this type are doubtless the enolates **I**[3]. However, the corresponding β–, γ–, ... lithiocarbonyl compounds **II** are far less usual intermediates due to their outstanding instability[4]. Some masked β–[5] or γ–lithiocarbonyl[6,7] compounds of the type **III** have been recently prepared and used in synthetic organic chemistry. However, to our best knowledge only one example of the homologous intermediate **IV** (of the type **III** with n=4) has been very recently prepared (by treatment of the corresponding iodinated ketal with *tert*-butyllithium at -82°C) and used *in situ* for the synthesis of isocarbacyclin[8]. In this paper we report a general and easy way for the preparation of intermediates of the type **IV** by using a chlorine-lithium exchange reaction at low temperature catalyzed by naphthalene[7d,9], and their application in organic synthesis.



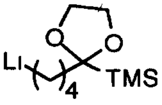
I



II, n>1



III, n=2,3

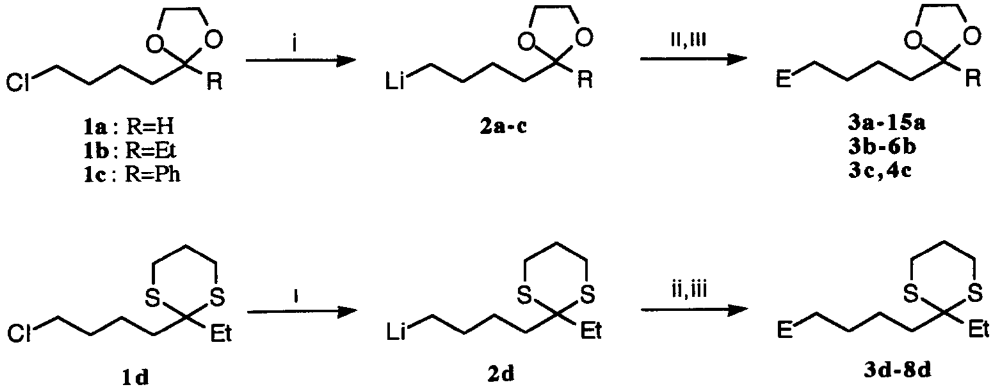


IV

Results and Discussion

The reaction of the chloroketal **1**[10] with an excess of lithium powder (*ca.* 1:10 molar ratio) and a catalytic amount of naphthalene (1:0.08 molar ratio) in THF at -78°C led after 3 h to a solution of the corresponding masked δ-lithiocarbonyl compounds **2**, which by treatment with different electrophiles yielded the expected functionalized ketals **3a-15a**, **3b-6b**, **3c** and **4c** (Scheme 1 and Table 1). As electrophilic reagents have been used, besides of water or deuterium oxide (Table 1, entries 1, 2, 15 and 19), carbonyl compounds (Table 1, entries 4-8, 16-18 and 20), carboxylic acid derivatives (Table 1, entries 9-13), as well as dibenzyl disulfide (Table 1, entry 3) and benzylideneaniline (Table 1, entry 14). The temperature in the lithiation step has to be kept at *ca.* -78°C in order to avoid partial or total decomposition of the intermediates **2**, mainly by abstraction of a proton from the reaction media[11]. Alternatively, the intermediate **2a** was prepared from 2-(4-iodobutyl)-1,3-dioxolane (**1e**)[12] by treatment with *tert*-butyllithium at -78°C[16]; however, the yield in the reaction with cyclohexanone was lower than in the method shown in Scheme 1 (Table 1, entry 8 and footnote f).

In order to study not only a possible different stability, but also a different protection of the carbonyl group we prepared the intermediate **2d** starting from the corresponding chlorinated dithiane **1d**[10] and following the same methodology as above. The reaction of this lithium δ-enolate with different electrophiles yielded the expected products **3d-8d** (Scheme 1 and Table 1, entries 21-26). We found the same stability for the intermediate **2d** in comparison to the behaviour observed for **2a-c**: in fact, in all cases, together with the reaction products, we always obtained variable amounts of the compounds arising from a lithium/hydrogen exchange through a proton abstraction from the reaction media[11].



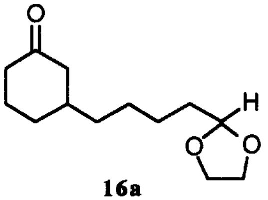
Scheme 1. *Reagents and conditions*: i, Li (excess), naphthalene (8 mmol%), -78°C; ii, $E^+ = H_2O$, D_2O, $(PhCH_2S)_2$, Pr^iCHO, Bu^tCHO, PhCHO, Et_2CO, PhCOMe, $(CH_2)_5CO$, $HCONMe_2$, $Pr^nCON(CH_2)_4$, $PhCON(CH_2)_4$, PhCN, EtOCOCl, PhCHNPh, -78 to 20°C; iii, H_2O.

Table 1. Reaction of masked δ-lithiocarbonyl compounds **2** with electrophiles

Entry	Inter-mediate	Electrophile	Product^{a} No.	E	Yield(%)^{b}	R_f^{c}
1	**2a**	H_2O	**3a**	H	82	0.62^{d}
2	**2a**	D_2O	**4a**	D	85^{e}	0.62^{d}
3	**2a**	$(PhCH_2S)_2$	**5a**	$PhCH_2S$	32	0.48^{d}
4	**2a**	Pr^nCHO	**6a**	Pr^nCHOH	62	0.50
5	**2a**	PhCHO	**7a**	PhCHOH	52	0.31
6	**2a**	Et_2CO	**8a**	Et_2COH	46	0.35
7	**2a**	PhCOMe	**9a**	PhC(OH)Me	44	0.48
8	**2a**	$(CH_2)_5CO$	**10a**	$(CH_2)_5COH$	79 (70)^{f}	0.41
9	**2a**	$HCONMe_2$	**11a**	HCO	34	0.33
10	**2a**	$Pr^nCON(CH_2)_4$	**12a**	Pr^nCO	47	0.28^{d}
11	**2a**	$PhCON(CH_2)_4$	**13a**	PhCO	61	0.63
12	**2a**	PhCN	**13a**	PhCO	45	0.63
13	**2a**	EtOCOCl	**14a**	EtOCO	42	0.28
14	**2a**	PhCHNPh	**15a**	PhCH(PhNH)	52	0.43^{d}
15	**2b**	D_2O	**3b**	D	73^{e}	0.70^{g}
16	**2b**	PhCHO	**4b**	PhCHOH	38	0.37
17	**2b**	Et_2CO	**5b**	Et_2COH	31	0.50
18	**2b**	PhCOMe	**6b**	PhC(OH)Me	42	0.57
19	**2c**	D_2O	**3c**	D	81^{e}	0.50
20	**2c**	$(CH_2)_5CO$	**4c**	$(CH_2)_5COH$	33	0.55
21	**2d**	H_2O	**3d**	H	83	0.71^{g}
22	**2d**	D_2O	**4d**	D	80^{e}	0 71^{g}
23	**2d**	Pr^nCHO	**5d**	Pr^nCHOH	72	0.43^{d}
24	**2d**	Bu^tCHO	**6d**	Bu^tCHOH	44	0.55^{d}
25	**2d**	PhCHO	**7d**	PhCHOH	21	0.37^{d}
26	**2d**	$(CH_2)_5CO$	**8d**	$(CH_2)_5COH$	32	0.30^{d}

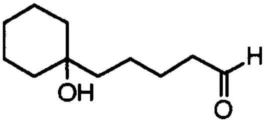
[a] All products were >95% pure (GLC and 300 MHz ^1H NMR). [b] Isolated yield after flash chromatography (silica gel, hexane/ethyl acetate) based on the starting material **1**. [c] Silica gel, hexane/ethyl acetate: 3/2. [d] Silica gel, hexane/ethyl acetate: 4/1. [e] >95% deuterium from mass spectrometry. [f] In parenthesis the yield starting from 2-(4-iodobutyl)1,3-dioxolane (**1e**) is given (see text). [g] Silica gel, hexane/ethyl acetate: 9/1.

Intermediates of the type **2** can also be used for conjugate addition to α,β-unsaturated carbonyl compounds in the presence of a copper(I) salt. Thus, for instance, the reaction of **2a** with cyclohex-2-enone in the presence of a catalytic amount (1:0.25 molar ratio) of copper(I) bromide-dimethyl sulfide complex afforded the corresponding product **16a** in 46% isolated yield.

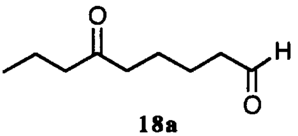


16a

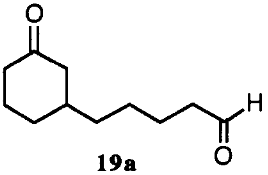
Compounds of the type **3-15** are functionalized protected carbonyl compounds, which can be easily deprotected yielding the corresponding carbonyl derivatives. As some examples, the treatment of compounds **10a**, **12a**, **16a** and **4b-6b** with a mixture of THF and 2 N HCl gave the expected functionalized carbonyl compounds **17a** (92%), **18a** (96%), **19a** (94%), **20b** (95%), **21b** (97%) and **22b** (92%), respectively, in very good yields.



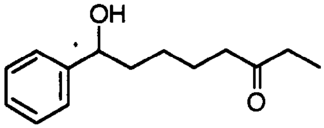
17a



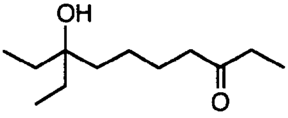
18a



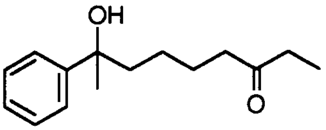
19a



20b

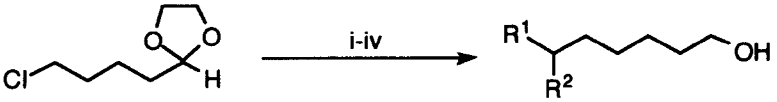


21b



22b

From the products obtained by reaction of the intermediates **2** with electrophiles followed by deprotection we found specially interesting the 6-hydroxyaldehydes of the type **17a** because of the possibility of obtaining oxepane derivatives by cyclization processes using silicon reagents. We first studied the *in situ* reaction of these systems with triethylsilane[17] in the presence of $BF_3 OEt_2$: once the reaction of the intermediate **2a** with different carbonyl compounds took place, as it was above described (Scheme 1), the acidic hydrolysis was performed as for **17a** and the crude hydroxyaldehyde was reacted with the mentioned mixture giving the alcohols **20a-25a** (Scheme 2 and Table 2, entries 1-6). In the process, together with the reduction of the aldehyde functionality, the transformation of the tertiary alcohol into the corresponding alkane took place[18].

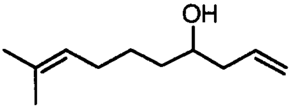


1a

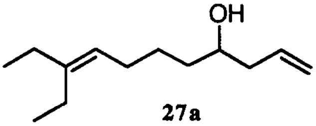
20a : $R^1=R^2=Et$
21a : $R^1-R^2=(CH_2)_4$
22a : $R^1-R^2=(CH_2)_5$
23a : $R^1=Me, R^2=Ph$
24a : $R^1=Et, R^2=Ph$
25a : $R^1=R^2=Ph$

Scheme 2. *Reagents and conditions*: i, Li (excess), $C_{10}H_8$ cat. (8% molar), -78°C; ii, R^1R^2CO, -78 to 20°C; iii, $HCl-H_2O$; iv, $Et_3SiH-BF_3 \cdot OEt_2$.

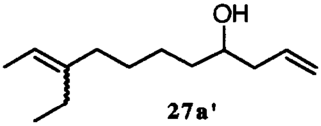
When the process shown in Scheme 2 was carried out using allyltrimethylsilane[19] instead of triethylsilane, the dienic alcohols **26a**-**29a** were isolated (Table 2, entries 7-10); only in the case of the product derived from 3-pentanone a mixture of the regioisomeric olefins **27a** and **27a'** (as a *Z/E* mixture) was obtained (Table 2, entry 8 and footnote e), resulting from the expected addition of the allyl group to the carbonyl group, followed by dehydration of the tertiary alcohol to the corresponding olefins[20].



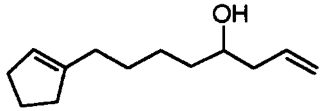
26a



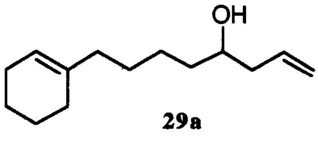
27a



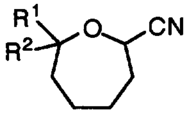
27a'



28a



29a



30a : $R^1=H, R^2=Ph$
31a: $R^1=R^2=Me$
32a: $R^1=R^2=Et$
33a : $R^1-R^2=(CH_2)_5$

Finally, we succeeded in obtaining the cyanooxepanes[21] **30a-33a** by using trimethylsilyl cyanide[22] as the silicon reagent and following the same methodology as described in Scheme 2 (Table 2, entries 11-14). In this case, after addition of the cyano group to the hydroxyaldehyde of the type **17a**, giving the corresponding cyanohydrin, an intramolecular dehydration led to the corresponding cyclic ethers. For the reaction with benzaldehyde the expected *cis/trans* mixture of **30a** was isolated and separated by flash chromatography (Table 2, entry 11 and footnote h).

Table 2. Obtention of alcohols **20a-29a** and oxepanes **30a-33a** from **1a** *via* the intermediate **2a**

Entry	Electrophile E+	Silicon reagent	Product[a] no.	yield (%)[b]	R_f[c]
1	Et_2CO	Et_3SiH	**20a**	23 (53)	0.35
2	$\overline{(CH_2)_4C}O$	Et_3SiH	**21a**	37	0.25
3	$\overline{(CH_2)_5C}O$	Et_3SiH	**22a**	38 (51)	0.33
4	PhCOMe	Et_3SiH	**23a**	41 (97)	0.30
5	PhCOEt	Et_3SiH	**24a**	43	0.37
6	Ph_2CO	Et_3SiH	**25a**	40	0.25[d]
7	Me_2CO	$Me_3SiCH_2CH=CH_2$	**26a**	31	0.52
8	Et_2CO	$Me_3SiCH_2CH=CH_2$	**27a+27a'**	34 (77)[e]	0.30[f,g]
9	$\overline{(CH_2)_4C}O$	$Me_3SiCH_2CH=CH_2$	**28a**	36	0.47
10	$\overline{(CH_2)_5C}O$	$Me_3SiCH_2CH=CH_2$	**29a**	29 (39)	0.39[f]
11	PhCHO	Me_3SiCN	**30a**[h]	36 (73)	0.36, 030[f,i]
12	Me_2CO	Me_3SiCN	**31a**	22	0.43[f]
13	Et_2CO	Me_3SiCN	**32a**	39 (89)	0.50[f]
14	$\overline{(CH_2)_5C}O$	Me_3SiCN	**33a**	34 (45)	0.45[f]

[a] All products were >95% pure (GLC and 300 MHz ^{1}H NMR). [b] Overall isolated yield after flash chromatography (silica gel, hexane/ethyl acetate) based on the starting chloroacetal **1a**; in parenthesis isolated yield after flash chromatography based on the intermediate hydroxyaldehyde of the type **17a**. [c] Hexane/ethyl acetate: 4/1. [d] Hexane/ethyl acetate: 3/2. [e] Relative **27a**/*cis*-**27a'**/*trans*-**27a'** ratio: *ca.* 1/1/1, from 75 MHz ^{13}C NMR. [f] Hexane/ethyl acetate: 9/1. [g] Compounds **27a** and both *cis/trans*-**27a'** could not be separated in TLC under these conditions. [h] *cis/trans*-Mixture (*ca.* 1/1 from GLC and 300 MHz ^{1}H NMR. [i] Corresponding to the already separated *trans* and *cis* diastereoisomers, respectively.

Experimental Part

General.- M.p.s are uncorrected and were measured on a Reichert thermovar apparatus. IR spectra were determined with a Pye Unicam SP3-200 spectrometer. ^{1}H and ^{13}C NMR spectra were recorded in a Bruker AC-300 (unless otherwise stated: Varian EM-360L at 60 MHz) using $CDCl_3$ as solvent and $SiMe_4$ as internal standard; chemical shifts are given in δ (ppm) and the coupling constants (*J*) are measured in Hz. MS (EI) were recorded with a Hewlett Packard EM/CG HP-5988A spectrometer. The purity of volatile distilled products and the chromatographic analyses (GLC) were determined with a Hewlett Packard HP-5890 instrument equiped with a flame ionization detector (FID) and a 12 m HP-1 capillary column (0.2 mm diam., 0.33 μm film thickness), using nitrogen (2 ml/min) as the carrier gas, $T_{injector}$= 270°C, T_{column}=80°C (3 min) and 80-270°C (15°C/min) (A conditions); the same instrument and conditions except T_{column}=60°C (3 min) and 60-270°C (15 °C/min) (B conditions), or a Konik Kromatix KNK 2000 equiped with a FID and a 2 m column (1/8 inch diam, Chromosorb Q 80/100, OV 17, 3% stationary phase), using nitrogen (40 ml/min) as the carrier gas, $T_{injector}$=325°C, T_{column}=80°C (3 min) and 80-320 (15°C/min) (C conditions); retention times (t_r) are given under these three conditions. Thin layer chromatography (TLC) was carried out on Scheleicher & Schnell F1500/LS 254 plates coated with a 0.2 mm layer of silica gel, using a mixture of hexane/ethyl acetate as eluant; R_f values (see Tables 1 and 2) are given under these conditions. Microanalysis was performed by the Microanalyses Service of the University of Alicante. High-resolution mass spectra (HRMS) were obtained on a VG Micromass ZAB-2F spectrometer at the University of La Laguna. Solvents were dried by standard procedures[23]. Starting chloroacetal **1a**, 5-chlorovaleronitrile, the electrophiles used in the reaction with intermediates **2** and the silicon as well as the other reagents were commercially available (Aldrich, Fluka) and were used as received.

Preparation of Starting Chlorinated Materials **1b-1d**.- δ-Chlorobutyl ethyl ketone and δ-chlorobutyl phenyl ketone were prepared[24] and ketalized[25a] or dithioketalized[25b] following the literature methods. Physical and spectral data follow.

δ-Chlorobutyl Ethyl Ketone[26]: t_r=7.6 min (C); ν_{max} (film) 1705 cm^{-1} (C=O); δ_H 1.05 (3 H, t, *J*=7.3, Me), 1.20-1.80 (4 H, m, CH_2CH_2CCl), 2.44 (2 H, q, *J*=7.3, CH_2Me), 2.46 (2 H, t, *J*=6.7, CH_2CH_2CO) and 3.53 (2 H, t, *J*=6.0, CH_2Cl); δ_C 7.5, 20.8, 31.7, 35.55, 41.0, 44.4 and 210.7; *m/z* 148 (M$^+$, 1%), 119 (20), 112 (13), 91 (23), 72 (12), 57 (100), 55 (62), 54 (46) and 41 (27).

δ-Chlorobutyl Phenyl Ketone[24]: t_r=12.4 min (C), m.p. 50-51°C (hexane/ether); ν_{max} (CCl_4) 3040, 1590 (Ph) and 1670 cm^{-1} (C=O); δ_H 1.80-2.00 (4 H, m, CH_2CH_2CCl), 3.02 (2 H, t, *J*=6.8, CH_2CO), 3.58 (2 H, t, *J*=6.2, CH_2Cl), 7.20-7.60 and 7.90-8.00 (5 H, 2 m, Ph); δ_C 21.45, 32.05, 37.55, 44.7, 127.95 (2C), 128.6 (2C), 133.05, 136.85 and 199.6; *m/z* 196 (M$^+$, 10%), 120 (44), 106 (13), 105 (100), 77 (64) and 51 (14).

2-(4-Chlorobutyl)-2-ethyl-1,3-dioxolane (**1b**): t_r=9.2 min (C); ν_{max} (film) 1070, 950 and 930 cm^{-1} (C-O); δ_H 0.90 (3 H, t, *J*=7.4, Me), 1.40-1.90 [8 H, m, $(CH_2)_3COCH_2$], 3.53 (2 H, t, *J*=6.7, CH_2Cl) and 3.93 (4 H, s, OCH_2CH_2); δ_C 8.0, 21.05, 29.75, 32.7, 35.7, 44.8, 64.9 (2C) and 111.65; *m/z* 163 (M$^+$-29, 58%), 101 (100), 91 (12), 57 (30) and 55 (23) (Found: M$^+$-H, 191.08342. $C_9H_{16}{}^{35}ClO_2$ requires M, 191.08388).

2-(4-Chlorobutyl)-2-phenyl-1,3-dioxolane (**1c**)[27]: t_r=13.1 min (C); ν_{max} (CCl_4) 3050, 3020, 1600 (Ph), 1180 and 1040 cm^{-1} (C-O); δ_H 1.20-2.00 [6 H, m, $(CH_2)_3CCl$], 3.47 (2 H, t, *J*=6.7, CH_2Cl), 3.70-3.90, 3.90-4.10 (4 H, 2 m, OCH_2CH_2) and 7.30-7.50 (5 H, m, Ph); δ_C 21.05, 32.55, 39.65, 44.8, 64.45 (2C), 110.15, 125.6 (2C), 127.8, 128.05 (2C) and 142.35; *m/z* 177 (M$^+$-63, 20%), 150 (10), 149 (100), 105 (76) and 77 (31) (Found: M$^+$-H, 241.08329. $C_{13}H_{16}{}^{37}ClO_2$ requires M, 241.08093).

2-(4-Chlorobutyl)-2-ethyl-1,3-dithiane (**1d**): t_r=12.6 min (C); δ_H 0.98 (3 H, t, *J*=7.4, Me), 1.50-1.65, 1.75-1.98 [2 and 8 H, respectively, 2 m, $(CH_2)_3CS_2CH_2$ and CH_2CH_2S], 2.75-2.85 (4 H, m, 2xCH_2S) and 3.56 (2 H, t, *J*=6.7, CH_2Cl); δ_C 8.55, 21.3, 25.3, 25.75 (2C), 30.75, 32.5, 36.75, 44.55 and 53.4; *m/z* 238 (M$^+$, 29%), 211 (24), 209 (52), 144 (100), 129 (10), 106 (11), 95 (15), 88 (47), 73 (28), 71 (11), 67 (11), 58 (15), 55 (17), 47 (11), 45 (25) and 41 (32).

Preparation of Starting 2-(4-Iodobutyl)-1,3-dioxolane (**1e**).- Once the corresponding precursor, 5-iodopentanal,was prepared following methodologies previously described[12-15], it was acetalized with ethyleneglicol and a catalytic amount of sulfuric acid[25a]. Physical and spectral data follow.

5-Iodopentanal[12,15]: t_r=7.26 min (B), R_f=0.67 (hexane/ethyl acetate: 9/1); ν_{max} (film) 2700 and 1710 cm^{-1} (HC=O); δ_H (60 MHz) 1.5-2.1 [4 H, m, $(CH_2)_2CI$], 2.5 (2 H, t, *J*=6.0, CH_2CO), 3.2 (2 H, t, *J*=6.0, CH_2I) and 9.25 (1 H, t, *J*=1.5, CHO); *m/z* 167 (M$^+$-45, <1%), 127 (14), 85 (100), 67 (17), 65 (11), 57 (11), 55 (11) and 41 (24).

2-(4-Iodobutyl)-1,3-dioxolane (**1e**): t_r=10.29 min (B), R_f=0.52 (hexane/ethyl acetate: 9/1); ν_{max} (film) 1120 and 1020 cm^{-1} (C-O); δ_H (60 MHz) 1.2-2.1 [6 H, m, $(CH_2)_3CI$], 3.15 (2 H,t, *J*=7.0, CH_2I), 3.6-4.0 (4 H, m, OCH_2CH_2) and 4.7 (1 H, t, *J*=4.0, CH); *m/z* 255 (M$^+$-1, 4%), 129 (11), 73 (100) and 45 (19).

Lithiation of Precursors 1. Preparation of Intermediates 2 and Reaction with Electrophiles. Isolation of Compounds 3a-15a, 3b-6b, 3c, 4c and 3d-8d. General Procedure.- To a green suspension of lithium (112 mg, 16 mmol) and naphthalene (20 mg, 0.16 mmol) in THF (5 ml) was added a solution of the chlorinated precursor **1a-d** (2 mmol) in THF (2 ml) at -78°C under an argon atmosphere. The reaction mixture was stirred for *ca.* 3 h at the same temperature. Then the corresponding electrophile (2.1 mmol; 0.5 ml in the cases of H_2O or D_2O) was added and the mixture was stirred overnight allowing the temperature to rise to 20°C[28]. Then, it was hydrolyzed with water (20 ml), neutralized with 2 N HCl and extracted with diethyl ether (2x20 ml). The organic layer was dried over anhydrous Na_2SO_4 and evaporated (15 Torr). The resulting residue was then purified by flash chromatography (silica gel, hexane/ethyl acetate) to afford the title compounds. The transformation of compound **1e** into the corresponding intermediate **2a** was carried out following the procedure already described[16]; the obtained solution was reacted with cyclohexanone as electrophile and the reaction worked up as above. Yields and R_f values are included in Table 1. Analytical, physical and spectral data follow.

2-Butyl-1,3-dioxolane (**3a**)[29]: t_r=3.29 min (A), b.p. 73-77°C/100 Torr (Kugelrohr); ν_{max} (film) 1130 and 1030 cm^{-1} (C-O); δ_H 0.90 (3 H, t, *J*=6.9, Me), 1.30-1.90 [6 H, m, $(CH_2)_3$], 3.80-4.00 (4 H, m, OCH_2CH_2) and 4.82 (1 H, t, *J*=4.7, CH); δ_C 13.55, 22.25, 25.85, 33.25, 64.4 (2C), 104.25; *m/z* 130 (M$^+$, <1%), 73 (100) and 45 (31).

2-(4-Deuteriobutyl)-1,3-dioxolane (**4a**): t_r=3.26 min (A); ν_{max} (film) 1130 and 1030 cm^{-1} (C-O); δ_H 0.89 (2 H, t, *J*=5.5, CH_2D), 1.00-1.90 [6 H, m, $(CH_2)_3$], 3.60-4.00 (4 H, m, OCH_2CH_2) and 4.85 (1 H, t, *J*=4.6, CH); δ_C 13.05 (t, *J*=19.2, CH_2D), 22.0, 25.65, 33.1, 64.15 (2C) and 104.0; *m/z* 131 (M$^+$, <1%), 74 (10), 73 (100), 71 (14), 58 (10), 45 (70), 43 (18), 42 (15) and 41 (15).

2-(4-Benzylthiobutyl)-1,3-dioxolane (**5a**): t_r=13.95 min (A); ν_{max} (film) 3060, 3020, 1600, 1490 (Ph), 1130 and 1030 cm^{-1} (C-O); δ_H 1.20-1.40, 1.40-1.80 [6 H, 2 m, $(CH_2)_3CS$], 2.40 (2 H, t, *J*=7.2, SCH_2CH_2), 3.68 (2 H, s, CH_2Ph), 3.80-4.00 (4 H, m, OCH_2CH_2), 4.81 (1 H, t, *J*=4.6, CHO) and 7.00-7.40 (5 H, m, Ph); δ_C 23.15, 28.95, 31.0, 33.25, 36.1, 64.7 (2C), 104.25, 126.7, 128.3 (2C), 128.65 (2C) and 138.45; *m/z* 252 (M$^+$, 4%), 161 (24), 99 (14), 91 (100), 73 (55), 65 (27) and 45 (36) (Found: M$^+$, 252.11854. $C_{14}H_{20}O_2S$ requires 252.11840).

2-(5-Hydroxy-6-methylheptyl)-1,3-dioxolane (**6a**): t_r=10.12 min (A); ν_{max} (film) 3450 (OH), 1130 and 1020 cm^{-1} (C-O); δ_H 0.90, 0.91 (6 H, 2 d, *J*=6.7, 2xMe), 1.15-1.85 [10 H, m, $(CH_2)_4$, C*H*Me and OH], 3.20-3.50 (1 H, m, C*H*OH), 3.70-4.10 (4 H, m, OCH_2CH_2) and 4.85 (1 H, t, *J*=4.7, CHO_2); δ_C 17.05, 18.8, 24.05, 25.9, 33.45, 33.8, 33.9, 64.8 (2C), 76.45 and 104.55; *m/z* 202 (M$^+$. <1%), 141 (17), 97 (11), 79 (11), 73 (100), 69 (10), 45 (18), 43 (10) and 41 (10) (Found: M$^+$, 202.15560. $C_{11}H_{22}O_3$ requires 202.15689).

2-(5-Hydroxy-5-phenylpentyl)-1,3-dioxolane (**7a**): t_r=13.30 min (A); ν_{max} (film) 3480 (OH), 3060, 3020, 1600, 1490 (Ph), 1130 and 1030 cm^{-1} (C-O); δ_H 1.20-1.90 [8 H, m, $(CH_2)_4$], 2.1 (1 H, br s, OH), 3.80-4.00 (4 H, m, OCH_2CH_2), 4.67 (1 H, t, *J*=9.1, $C\mathit{H}OH$), 4.80 (1 H, t, *J*=4.4, CHO_2) and 7.20-7.40 (5 H, m, Ph); δ_C 23.85, 25.65, 33.85, 38.9, 64.75 (2C), 74.4, 104.45, 125.85 (2C), 127.45, 128.15 (2C) and 144.8; *m/z* 218 (M$^+$-18, 2%), 105 (16), 99 (13), 91 (17), 79 (100), 78 (21), 77 (95), 73 (91), 51 (17), 45 (53), 43 (13) and 41 (12).

2-(5-Ethyl-5-hydroxyheptyl)-1,3-dioxolane (**8a**): t_r=10.80 min (A) ; ν_{max} (film) 3440 (OH), 1130 and 1040 cm^{-1} (C-O); δ_H 0.85 (6 H, t, *J*=7.5, 2xMe), 1.20-1.90 [12 H, m, $(CH_2)_4$ and $2xC\mathit{H}_2Me$], 2.05 (1 H, br s, OH), 3.80-4.00 (4 H, m, OCH_2CH_2) and 4.85 (1 H, t, *J*=4.7, CH); δ_C 7.7 (2C), 23.25, 24.55, 30.9 (2C), 35.75, 38.0, 64.75 (2C), 74.45 and 104.5; *m/z* 216 (M$^+$, <1%), 87 (14), 85 (12), 73 (100), 69 (11), 57 (35), 55 (13) and 41 (15).

2-(5-Hydroxy-5-phenylhexyl)-1,3-dioxolane (**9a**)[30]: t_r=13.39 min (A); ν_{max} (film) 3400 (OH), 3040, 3010, 1590 (Ph), 1120 and 1030 cm^{-1} (C-O); δ_H 1.00-2.05 [11 H, m with a s at 1.45, $(C\mathit{H}_2)_4C(OH)\mathit{Me}$], 2.80 (1 H, br s, OH), 3.60-3.95 (4 H, m, OCH_2CH_2), 4.69 (1 H, t, *J*=4.7, CHO), 7.13, 7.23 and 7.33 (1 H, 2 H and 2 H, respectively, t, t, d, respectively, *J*=7.5, Ph); δ_C 23.75, 24.15, 29.95, 33.55, 43.9, 64.65 (2C), 74.45, 104.4, 124.7 (2C), 126.3, 127.95 (2C) and 147.9; *m/z* 249 (M$^+$-1, <1%), 129 (20), 121 (65), 105 (27), 99 (11), 91 (19), 78 (12), 77 (31), 73 (100), 51 (10), 45 (48), 43 (75) and 41 (10).

2-[4-(1-Hydroxycyclohexyl)butyl]-1,3-dioxolane (**10a**)[9a]: t_r=12.38 min (A); ν_{max} (film) 3440 (OH), 1130 and 1030 cm^{-1} (C-O); δ_H 1.15-1.80 [19 H, m, $(CH_2)_4CO$, $5xCH_2$ ring and OH], 3.75-4.05 (4 H, m, OCH_2CH_2) and 4.85 (1H, t, *J*=5.05, CHO); δ_C 22.2 (2C), 22.75, 24.6, 25.8, 33.8, 37.35 (2C), 42.2, 64.7 (2C), 71.3 and 104.55; *m/z* 228 (M$^+$, <1%), 114 (28), 99 (49), 95 (11), 83 (14), 81 (41), 79 (15), 73 (100), 70 (19), 69 (14), 67 (15), 57 (17), 55 (42), 53 (11), 45 (54), 43 (24), 42 (11) and 41 (27).

2-(5-Oxopentyl)-1,3-dioxolane (**11a**)[31]: t_r=7.25 min (A); ν_{max} (film) 2700, 1715 (HC=O), 1140 and 1030 cm^{-1} (C-O); δ_H 1.40-1.80 [6 H, $(CH_2)_3CO_2$], 2.45 (2 H, td, *J*=7.3 and 1.5, CH_2CO), 3.40-4.00 (4 H, m, OCH_2CH_2), 4.85 (1 H, t, *J*=5.5, CHO_2) and 9.76 (1 H, t, *J*=1.5, CHO); δ_C 21.95, 23.5, 33.5, 43.75, 64.8 (2C), 104.15 and 202.4; *m/z* 158 (M$^+$, 2%), 73 (100) and 45 (25).

2-(5-Oxooctyl)-1,3-dioxolane (**12a**): t_r=10.17 min (A); ν_{max} (film) 1700 (C=O), 1130 and 1030 cm^{-1} (C-O); δ_H 0.84 (3 H, t, *J*=7.0, Me), 1.20-1.70 [8 H, m, $(CH_2)_3$ and $C\mathit{H}_2Me$], 2.30, 2.33 (4 H, 2t, *J*=7.4, $2xCH_2CO$), 3.70-3.90 (4 H, m, OCH_2CH_2) and 4.77 (1 H, t, *J*=4.6, CH); δ_C 13.7, 17.25, 23.6 (2C), 33.55, 42.55, 44.65, 64.8 (2C), 104.3 and 211.05; *m/z* 200 (M$^+$, <1%), 73 (100), 71 (11), 55 (11), 45 (29), 43 (25) and 41 (22).

2-(5-Oxo-5-phenylpentyl)-1,3-dioxolane (**13a**): t_r=13.51 (A), m.p. 45°C (diethyl ether/hexane); ν_{max} (melted) 3040, 1600 (Ph), 1660 (C=O), 1140 and 1030 cm^{-1} (C-O); δ_H 1.30-2.00 [6 H, m, $(CH_2)_3CO_2$], 2.97 (2 H, t, *j*=7.2, CH_2CO), 3.70-4.10 (4 H, m, OCH_2CH_2), 4.86 (1 H, t, *J*=4.4, CHO), 7.46, 7.55 and 7.85 (2 H, 1 H, 2H, respectively, t, t, d, respectively, *J*=7.2, Ph); δ_C 23.65, 24.05, 33.6, 38.35, 64.75 (2C), 104.3, 127.95 (2C), 128.45 (2C), 132.8, 136.95 and 200.05; *m/z* 234 (M$^+$, 3%), 105 (60), 77 (58), 73 (100), 51 (12) and 45 (19) (Found: M$^+$+H, 235.13267. $C_{14}H_{19}O_3$ requires 235.13342).

2-(4-Ethoxycarbonylbutyl)-1,3-dioxolane (**14a**)[32]: t_r=21.95 min (A); ν_{max} (film) 1720, 1240 (O=C-O), 1120 and 1020 cm^{-1} (C-O); δ_H 1.27 (3 H, t, *J*=7.0, Me), 1.30-1.90 [8 H, m, $(CH_2)_4$], 3.80-4.00 (4 H, m, OCH_2CH_2), 4.15 (2 H, q, *J*=7.0, $C\mathit{H}_2Me$) and 4.83 (1 H, t, *J*=4.6, CH); δ_C 14.15, 23.05, 24.1, 33.6, 34.85, 62.8, 64.7 (2C), 104.35 and 153.0; *m/z* 201 (M$^+$-1, <1%), 99 (91), 86 (20), 73 (100) and 45 (26).

2-(5-Phenyl-5-phenylaminopentyl)-1,3-dioxolane (**15a**): t_r=17.74 min (A); ν_{max} (film) 3490 (NH), 3040, 3010, 1600, 1500 (Ph), 1130 and 1020 cm^{-1} (C-O); δ_H 1.20-1.80 [8 H, m, $(CH_2)_4$], 3.50-4.00 (5 H, m, OCH_2CH_2 and NH), 4.21 (1 H, t, *J*=6.7, CHN), 4.73 (1 H, t, *J*=4.7, CHO), 6.41, 6.53, 6.98 (2 H, 1 H, 2 H, respectively, d, t, t, respectively, *J*=5.5, PhN) and 7.11-7.25 (5 H, m, PhC); δ_C 23.8, 26.1, 33.55, 38.7, 58.0, 64.75 (2C), 104.35, 113.15 (2C), 117.05, 126.3 (2C), 126.8, 128.45 (2C), 129.0 (2C), 144.1 and 147.35; *m/z* 311 (M$^+$, 5%), 183 (14), 182 (100), 104 (25), 91 (17), 77 (25), 73 (45) and 45 (22).

2-(4-Deuteriobutyl)-2-ethyl-1,3-dioxolane (**3b**): t_r=6.3 min (C); ν_{max} (film) 1080 and 1040 cm^{-1} (C-O); δ_H 0.90 (5 H, t *J*=7.4, CH_2D and Me), 1.20-1.50 (4 H, m, CH_2CH_2CD), 1.50-1.80 (4 H, m, 2xCH_2CO) and 3.93 (4 H, s, OCH_2CH_2); δ_C 8.1, 13.75 (t, *J*=19.15, CH_2D), 22.9, 25.95, 29.8, 36.4, 64.95 (2C), 112.15; *m/z* 130 (M$^+$-29, 57%), 101 (100), 99 (10), 86 (10), 58 (11) and 57 (28).

2-Ethyl-2-(5-hydroxy-5-phenylpentyl)-1,3-dioxolane (**4b**): t_r=14.8 min (C); ν_{max} (film) 3440 (OH), 3050, 3020, 1600, 1490 (Ph), 1070 and 950 cm^{-1} (C-O); δ_H 0.86 (3 H, t, *J*=7.4, Me), 1.20-1.80 [10 H, m, $(CH_2)_4$ and C*H*$_2$Me], 2.35 (1 H, br s, OH), 3.87 (4 H, s, OCH_2CH_2), 4.61 (1 H, dd, *J*=7.3 and 6.0, CHO) and 7.20-7.40 (5 H, m, Ph); δ_C 8.0, 23.55, 25.95, 29.65, 36.4, 38.9, 64.8 (2C), 74.3, 111.9, 125.8 (2C), 127.3, 128.25 (2C) and 144.85; *m/z* 236 (M$^+$-28, 1%), 173 (10), 101 (100), 99 (10) and 57 (11).

2-Ethyl-2-(5-ethyl-5-hydroxyheptyl)-1,3-dioxolane (**5b**): t_r=12.4 min (C); ν_{max} (film) 3480 (OH), 1070 and 950 cm^{-1} (C-O); δ_H 0.85 (6 H, t, *J*=7.4, 2x*Me*CH$_2$COH), 0.89 (3 H, t, *J*=7.3, *Me*CH$_2$CO$_2$), 1.20-1.70 [15 H, m, 3xC*H*$_2$Me, $(CH_2)_4$ and OH] and 3.93 (4 H, s, OCH_2CH_2);δ_C 7.7 (2C), 8.05, 23.6, 24.35, 29.75, 30.95 (2C), 36.6, 38.1, 64.9 (2C), 74.45 and 112.0; *m/z* 216 (M$^+$-28, 1%), 197 (10), 153 (10), 129 (11), 101 (100), 99 (10) and 57 (53).

2-Ethyl-2-(5-hydroxy-5-phenylhexyl)-1,3-dioxolane (**6b**): t_r=14.7 min (C); ν_{max} (film) 3460 (OH), 3060, 3020, 1600, 1490 (Ph), 1070 and 950 cm^{-1} (C-O); δ_H 0.78 (3 H, t, *J*=7.5, *Me*CH$_2$), 1.00-2.20 [14 H, m with a s at 1.45, MeC(OH)$(CH_2)_4CCH_2$], 3.79 (4 H, s, OCH_2CH_2), 7.11, 7.24 and 7.34 (1 H, 2 H and 2 H, respectively, t, t, d, *J*=7.4, Ph); δ_C 8.0, 23.95, 24.15, 29.7, 30.0, 36.4, 44.05, 64.8 (2C), 74.5, 111.9, 124.7 (2C), 126.35, 128.0 (2C) and 148.0; *m/z* 250 (M$^+$-28, 1%), 129 (19), 121 (18), 105 (12), 101 (100), 99 (10), 57 (16) and 43 (28).

2-(4-Deuteriobutyl)-2-phenyl-1,3-dioxolane (**3c**): t_r=10.5 min (C); ν_{max} (film) 3060, 3020 (Ph), 1050 and 980 cm^{-1} (C-O); δ_H 0.84 (2 H, t, *J*=6.0, CH_2D), 1.10-1.40 (4 H, CH_2CH_2CD), 1.89 (2 H, t, *J*=6.0, CH_2CO_2), 3.65-3.85, 3.90-4.10 (4 H, 2 m, OCH_2CH_2) and 7.20-7.50 (5 H, m, Ph); δ_C 13.65 (t, *J*=19.1, CH_2D), 22.7, 25.7, 40.3, 64.4 (2C), 110.5, 125.7 (2C), 127.65, 128.0 (2C) and 142.7; *m/z* 206 (M$^+$-1, <1%), 150 (12), 149 (100), 105 (32) and 77 (19) (Found: M$^+$+H, 208.14736. $C_{13}H_{18}DO_2$ requires 208.14478).

2-[4-(1-Hydroxycyclohexyl)butyl]-2-phenyl-1,3-dioxolane (**4c**): t_r=16.6 min (C); ν_{max} (film) 3440 (OH), 3040, 3020, 1590 (Ph), 1030 and 970 cm^{-1} (C-O); δ_H 0.90-1.70 [17 H, m, $(CH_2)_3COH$ and 5xCH_2 ring), 1.91 (2 H, t, *J*=7.5, CH_2CO_2), 3.70-3.85, 3.90-4.10 (4 H, 2 m, OCH_2CH_2) and 7.15-7.55 (5 H, m, Ph); δ_C 22.2 (2C), 22.85, 24.15, 25.8, 37.35 (2C), 40.45, 42.2, 64.4 (2C), 71.3, 110.4, 125.65 (2C), 127.65, 128.0 (2C) and 142.55; *m/z* 259 (M$^+$-45, <1%), 149 (100) and 105 (18).

2-Butyl-2-ethyl-1,3-dithiane (**3d**): t_r=9.8 min (C); δ_H 0.85, 0.87 (3 H each, 2 t, *J*=6.4 and 6.9, respectively, 2xMe), 1.15-1.45, 1.65-1.95 [10 H, 2 m, $(CH_2)_3CS_2CH_2$ and C*H*$_2$CH$_2$S] and 2.60-2.80 (4 H, m, 2xCH_2S);

δ_C 8.5, 13.75, 22.7, 25.35, 25.65 (2C), 25.8, 30.50, 37.15 and 53.50; *m/z* 204 (M^+, 39%), 175 (64), 147 (100), 129 (10), 107 (12), 111 (13), 88 (75), 73 (48), 71 (14), 67 (13), 59 (29), 58 (11), 55 (39), 53 (12), 47 (20), 46 (23), 45 (43), 43 (15) and 41 (70).

2-(4-Deuteriobutyl)-2-ethyl-1,3-dithiane (**4d**): t_r=9.8 min (C); δ_H 0.85 (2 H, t, *J*=5.8, CH_2D), 0.89 (3 H, t, *J*=7.3, Me), 1.20-1.40, 1.65-2.00 [10 H, 2 m, $(CH_2)_3CS_2CH_2$ and CH_2CH_2S] and 2.60-2.80 (4 H, m, 2xCH_2S); δ_C 8.45, 13.45 (t, *J*=19.2, CH_2D), 22.55, 25.3, 25.6 (2C), 25.7, 30.45, 37.1 and 53.4; *m/z* 205 (M^+, 31%), 176 (44), 175 (11), 148 (10), 147 (57), 107 (16), 88 (100), 75 (10), 73 (40), 59 (19), 55 (20), 45 (20) and 41 (18).

2-Ethyl-2-(5-hydroxy-6-methylheptyl)-1,3-dithiane (**5d**): t_r=13.6 min (C); ν_{max} (film) 3380 cm^{-1} (OH); δ_H 0.90, 0.91 (6 H, 2 d, *J*=6.8, Me_2CH), 0.97 (3 H, t, *J*=7.3, $MeCH_2$), 1.00-1.70, 1.80-2.00 [14 H, 2 m, $(CH_2)_4$, CH_2Me, CH_2CH_2S and CHCOH], 2.75-2.85 (4 H, m, 2xCH_2S) and 3.30-3.40 (1 H, m, CHO); δ_C 8.65, 17.05, 18.7, 23.95, 25.45, 25.8 (2C), 26.2, 30.7, 33.45, 33.85, 37.55, 53.65 and 76.4; *m/z* 276 (M^+, 8%), 147 (78), 142 (13), 141 (58), 130 (36), 129 (33), 128 (59), 115 (15), 113 (10), 107 (15), 106 (11), 95 (14), 88 (13), 75 (11), 74 (11), 73 (65), 71 (29), 69 (10), 67 (16), 59 (13), 57 (25), 55 (82), 53 (12), 47 (14), 46 (13), 45 (45), 43 (100) and 41 (83).

2-Ethyl-2-(5-hydroxy-6,6-dimethylheptyl)-1,3-dithiane (**6d**): t_r=14.0 min (C); ν_{max} (film) 3440 cm^{-1} (OH); δ_H 0.89 (9 H, s, Me_3C), 0.97 (3 H, t, *J*=7.4, $MeCH_2$), 1.05-1.65, 1.75-2.00 [13 H, 2 m, $(CH_2)_4COH$, CH_2Me and CH_2CH_2S], 2.75-2.85 (4 H, m, 2xCH_2S) and 3.15-3.20 (1 H, m, CHO); δ_C 8.5, 23.8, 25.45 (3C), 25.65 (2C), 27.05, 30.55, 31.05, 34.65, 37.45, 53.55 and 76.35; *m/z* 290 (M^+, 8%), 147 (100), 113 (13), 107 (21), 100 (12), 97 (11), 95 (12), 88 (15), 87 (13), 85 (24), 81 (10), 79 (13), 77 (14), 73 (33), 71 (17), 69 (20), 67 (22), 59 (16), 57 (95), 55 (41), 53 (11), 47 (15), 46 (10), 45 (28), 43 (31), and 41 (78).

2-Ethyl-2-(5-hydroxy-5-phenylpentyl)-1,3-dithiane (**7d**): t_r=16.3 min (C); ν_{max} (film) 3410 (OH), 3080, 3060, 3040, 1600 and 1490 cm^{-1} (Ph); δ_H 0.95 (3 H, t, *J*=7.4, Me), 1.10-2.00 [13 H, m, $(CH_2)_4$, CH_2Me, CH_2CH_2S and OH], 2.70-2.85 (4 H, m, 2xCH_2S), 4.67 (1 H, t, *J*=6.0, CHO) and 7.25-7.35 (5 H, m, Ph); δ_C 8.7, 23.8, 25.5, 25.85 (2C), 25.95, 30.8, 37.5, 38.8, 53.7, 74.5, 125.85 (2C), 127.5, 128.4 (2C) and 144.75; *m/z* 310 (M^+, 20%), 147 (50), 107 (44), 106 (11), 105 (24), 91 (13), 79 (100), 78 (12), 77 (65), 73 (21), 55 (17), 51 (10), 46 (11), 45 (16) and 41 (21).

2-Ethyl-2-[4-(1-hydroxycyclohexyl)butyl]-1,3-dithiane (**8d**): t_r=15.5 min (C); ν_{max} 3400 cm^{-1} (OH); δ_H 0.90 (3 H, t, *J*=7.3 Me), 1.10-1.60, 1.75-1.95 [23 H, 2 m, $(CH_2)_4CS_2CH_2$, 5xCH_2 ring, CH_2CH_2S and OH] and 2.65-2.75 (4 H, m, 2xCH_2S); δ_C 8.65, 22.15 (2C), 23.0, 24.45, 25.45, 25.75, 25.8 (2C), 30.7, 37.35 (2C), 37.6, 42.15, 53.7 and 71.25; *m/z* 302 (M^+, 6%), 149 (10), 147 (61), 122 (12), 115 (13), 114 (24), 113 (38), 107 (16), 106 (11), 101 (12), 99 (39), 97 (13), 95 (17), 88 (10), 85 (17), 81 (76), 79 (35), 77 (10), 75 (11), 74 (19), 73 (43), 71 (14), 69 (15), 67 (34), 59 (14), 57 (21), 55 (100), 53 (21), 47 (19), 46 (25), 45 (36), 43 (30), 42 (16) and 41 (80).

Isolation of 2-[4-(3-Oxocyclohexyl)butyl]-1,3-dioxolane (**16a**).- Once the intermediate **2a** was prepared as it was above described starting from **1a** (2 mmol scale), copper(I) bromide-dimethyl sulphide complex (0.5 mmol) was added to the obtained mixture at -78°C and it was stirred at this temperature for 30 min. Then, cyclohex-2-enone (2.1 mmol) was added and it was worked up as it was described in the above general procedure (the hydrolysis was carried out with a saturated aqueous solution of ammonium chloride instead of hydrochloric acid) to give the title compound: t_r=12.77 min (A), R_f=0.58 (hexane/ethyl acetate: 3/2); ν_{max} (film) 1705 (C=O), 1130 and 1030 cm^{-1} (C-O); δ_H 1.10-2.50 [17 H, m, $(CH_2)_4$, 4xCH_2 and CH ring], 3.80-4.00 (4

H, m, OCH_2CH_2) and 4.84 (1 H, t, *J*=4.7, CHO); δ_C 24.05, 25.25, 26.55, 31.25, 33.75, 36.5, 38.9, 41.5, 48.15, 64.85 (2C), 104.5 and 212.0; *m/z* 226 (M^+, 2%), 97 (10), 79 (10), 73 (100), 69 (10), 67 (14), 55 (38), 53 (12), 45 (61), 43 (16), 42 (25) and 41 (38).

Deprotection of Dioxolanes **10a, 12a, 16a** *and* **4b-6b** *with Hydrochloric Acid. Isolation of Compounds* **17a-19a** *and* **20b-22b**. *General Procedure.*- A solution of the corresponding dioxolane (0.5 mmol) in THF (10 ml) and 2 N hydrochloric acid (10 ml) was stirred for 2 h at room temperature. The resulting solution was extracted with diethyl ether (3x10 ml), the organic layer washed with water, dried with anhydrous Na_2SO_4 and evaporated (15 Torr) to give the pure title compounds. Yields are given in the text. Analytical, physical and spectral data follow.

4-[1-(Hydroxycyclohexyl)]pentanal (**17a**): t_r=10.14 min (A), R_f=0.48 (hexane/ethyl acetate: 3/2); ν_{max} (film) 3400 (OH) and 1710 cm^{-1} (C=O); δ_H(60 MHz) 0.9-2.1 (19 H, m, $9xCH_2$ and OH) and 9.5-9.7 (1 H, deformed t, CHO); *m/z* 156 (M^+-28, 1%), 100 (12), 99 (100), 95 (41), 85 (11), 83 (10), 81 (52), 79 (13), 67 (18), 57 (13), 55 (34), 53 (10), 43 (16) and 41 (24).

6-Oxononanal (**18a**): t_r=7.42 min (A), R_f=0.40 (hexane/ethyl acetate: 4/1); ν_{max} (film) 2700 (aldehydic CH), 1760 and 1700 cm^{-1} (C=O); δ_H 0.84 (3 H, t, *J*=7.3, Me), 1.10-1.45, 1.45-2.00 (6 H, 2 m, CH_2Me and $CH_2CH_2CH_2CO$), 2.15-2.60 (6 H, m, $3xCH_2CO$) and 9.65 (1 H, deformed t, CHO); δ_C 13.7, 17.2, 21.5, 23.05, 42.25, 43.65, 44.7, 202.2 and 207.9; *m/z* 156 (M^+, 2%), 113 (13), 95 (14), 86 (20), 85 (21), 71 (80), 67 (54), 58 (20), 57 (19), 55 (22), 43 (100), 42 (17) and 41 (75).

5-(3-Oxocyclohexyl)pentanal (**19a**): t_r=10.63 min (A), R_f=0.57 (hexane/ethyl acetate: 3/2); ν_{max} (film) 2700 (aldehydic CH) and 1710 cm^{-1} (C=O); δ_H 1.00-2.00 [11 H, m, $(CH_2)_2CH(CH_2)_3CCO$], 2.0-2.8 (6 H, m, $3xCH_2CO$) and 9.69 (1 H, br s, CHO); δ_C 21.95, 25.15, 26.15, 31.15, 36.2, 38.75, 41.4, 43.7, 48.05, 202.4, and 211.75; *m/z* 182 (M^+, 4%), 97 (29), 93 (10), 91 (30), 79 (25), 78 (10), 77 (30), 73 (25), 69 (17), 67 (23), 65 (18), 54 (11), 53 (33), 51 (11), 45 (21), 44 (22), 43 (22), 42 (52) and 41 (100).

8-Hydroxy-8-phenyloctan-3-one (**20b**): t_r=12.5 min (C), R_f=0.45 (hexane/ethyl acetate: 3/2); ν_{max} (film) 3420 (OH), 3060, 3020, 1600, 1490 (Ph) and 1700 cm^{-1} (C=O); δ_H 1.02 (3 H, t, *J*=7.4, Me), 1.15-1.90 [6 H, m, $(CH_2)_3CC$=O], 2.00-2.30 (1 H, br s, OH), 2.38 (4 H, q and t, *J*=7.4 and 7.2 respectively, CH_2Me and CH_2C=O, respectively), 4.65 (1 H, dd, *J*=7.4 and 5.8, CHO) and 7.2-7.4 (5 H, m, Ph); δ_C 7.75, 23.55, 25.35, 35.85, 38.75, 42.15, 72.25, 125.8 (2C), 127.45, 128.4 (2C), 144.75 and 211.75; *m/z* 220 (M^+, 2%), 173 (11), 118 (16), 114 (42), 107 (78), 105 (27), 91 (24), 85 (100), 79 (56), 77 (49), 72 (42) and 57 (36) (Found: M^++2H, 222.16132. $C_{14}H_{22}O_2$ requires 222.16198).

8-Etyl-8-hydroxydecan-3-one (**21b**): t_r=11.1 min (C); R_f=0.52 (hexane/ethyl acetate: 3/2); ν_{max} (film) 3450 (OH) and 1705 cm^{-1} (C=O); δ_H0.85 (6 H, t, *J*=7.5, $2xMeCH_2COH$), 1.05 (3 H, t, *J*=7.3, $MeCH_2C$=O), 1.15-1.70 [11 H, $(CH_2)_2C(OH)(CH_2)_3$], 2.42 (2 H, q, *J*=7.3, $MeCH_2C$=O) and 2.45 (2 H, t, *J*=7.2, CH_2CH_2C=O); δ_C 7.65 (2C), 7.75, 22.95, 24 35, 30.85 (2C), 35.8, 37.85, 42.2, 74.55 and 211.9; *m/z* 182 (M^+-18, <1%), 153 (16), 87 (24), 85 (21), 72 (10), 57 (100) and 43 (11) (Found: M^+-H, 199.17061. $C_{12}H_{23}O_2$ requires 199.16981).

8-Hydroxy-8-phenylnonan-3-one (**22b**): t_r=12.7 min (C), R_f=0.60 (hexane/ethyl acetate: 3/2); ν_{max} (film) 3460 (OH), 3060, 3020, 1600, 1490 (Ph) and 1705 cm^{-1} (C=O); δ_H 0.90 (3 H, t, *J*=7.3, $MeCH_2$), 1.0-1.80 [9 H, m with a s at 1.44, $(CH_2)_3C(OH)Me$], 2 15-2.30 (5 H, m, $2xCH_2C$=O and OH), 7.13, 7.22 and 7.32 (1 H, 2 H and 2 H, respectively, t, t, d, respectively, *J*=7.4, Ph); δ_C 7.65, 23.5, 23.95, 30 0, 35.6, 42.05, 43.75, 74.3, 124.6 (2C), 126.25, 127.9 (2C), 147.8 and 211.7; *m/z* 234 (M^+, <1%), 121 (100), 114 (16), 105 (20), 91 (10), 77 (11), 57 (16) and 43 (43).

Transformation of in situ Generated Hydroxyaldehydes of the Type **17a** *into Alcohols* **20a-29a** and *Cyanooxepanes* **30a-33a** *via Silicon Reagents. General Procedure.*- Once the intermediate **2a** was allowed to react with different carbonyl compounds and the reaction mixture hydrolyzed with 2 N hydrochloric acid as described above for compounds of the type **17a** (2 mmol scale), the crude product was dissolved in dry dichloromethane (15 ml). To the resulting solution was added the corresponding silicon reagent (4 mmol) and $BF_3 OEt_2$ (6 mmol) at -78°C under an argon atmosphere and the mixture was stirred 1 h at the same temperature. Then it was stirred overnight allowing the temperature to rise to 20°C. The resulting mixture was hydrolyzed with a saturated aqueous solution of $NaHCO_3$, extracted with dichloromethane (2x15 ml) and the organic layer was dried over anhydrous Na_2SO_4 and evaporated (15 Torr). The obtained residue was then chromatographed (silica gel, hexane/ethyl acetate) to give the title compounds. Yields and R_f values are included in Table 2. Analytical, physical and spectral data follow.

6-Ethyloctan-1-ol (**20a**)[33]: t_r=8.3 min (C); ν_{max} (film) 3360 (OH) and 1060 cm^{-1} (C-O); δ_H 0.83 (6 H, t, *J*=7.2, 2xMe), 1.00-1.80 [14 H, m, $(CH_2)_2CH(CH_2)_4COH$] and 3.64 (2 H, t, *J*=6.7, CH_2O); δ_C 18.8 (2C), 25.4 (2C), 26.2, 26.5, 32.7, 32.8, 40.3 and 63.1; *m/z* 156 (M^+-2, 1%), 111 (90), 84 (26), 71 (11), 70 (32), 69 (100), 55 (48), 43 (21) and 41 (29).

5-Cyclopentylpentan-1-ol) (**21a**)[34]: t_r=9.4 min (C); ν_{max} (film) 3340 (OH) and 1070 cm^{-1} (C-O); δ_H 0.8-1.8 [18 H, m, $(CH_2)_4CO$, $4xCH_2$ and CH ring and OH] and 3.64 (2 H, t, *J*=6.6, CH_2O); δ_C 25.1 (2C), 26.0, 28.5, 32.65 (2C), 32.75, 36.1, 40.0 and 62.9; *m/z* 138 (M^+-18, 3%), 110 (13), 109 (18), 96 (65), 95 (67), 83 (23), 82 (100), 81 (48), 69 (46), 68 (67), 67 (93), 66 (12), 55 (40), 54 (18), 53 (11) and 41 (48).

5-Cyclohexylpentan-1-ol (**22a**)[35]: t_r=9.23 min (A); ν_{max} (film) 3300 (OH) and 1040 cm^{-1} (C-O); δ_H 0.80-1.00, 1.00-1.45, 1.45-1.85 [19 H, 3 m, $(CH_2)_4CO$, $5xCH_2$ and CH ring], 2.03 (1 H, br s, OH) and 3.61 (2 H, t, *J*=6.6, CH_2O); δ_C 26.0, 26.35 (2C), 26.6 (2C), 26.65, 32.7, 33.35, 37.4, 37.55 and 62.85; *m/z* 168 (M^+-2, 1%), 109 (18), 97 (12), 96 (49), 95 (13), 83 (46), 82 (54), 81 (43), 79 (13), 69 (19), 68 (16), 67 (51), 55 (100), 54 (13), 53 (15), 43 (11), 42 (11) and 41 (80).

6-Phenylheptan-1-ol (**23a**): t_r=12.3 min (C); ν_{max} (CCl_4) 3360 (OH), 3080, 3060, 3020 and 1600 cm^{-1} (Ph); δ_H 1.10-1.40, 1.40-1.70 [9 H, 2 m, $(CH_2)_4COH$], 1.23 (3 H, d, *J*=6.9, Me), 2.60-2.80 (1 H, m, C*H*Ph), 3.58 (2 H, t, *J*=6.5, CH_2O) and 7.10-7.30 (5 H, m, Ph); δ_C 22.3, 25.75, 27.45, 32.65, 38.3, 39.85, 62.95, 125.75, 126.9 (2C), 128.25 (2C) and 147.75; *m/z* 192 (M^+, 26%), 159 (15), 131 (18), 118 (32), 117 (13), 106 (24), 105 (100), 104 (12), 103 (18), 91 (33), 79 (18) and 77 (21).

6-Phenyloctan-1-ol (**24a**)[36]: t_r=12.5 min (C); ν_{max} (CCl_4) 3420 (OH), 3080, 3060, 3020 and 1600 cm^{-1} (Ph); δ_H 0.75 (3 H, t, *J*=7.3, Me), 1.05-1.40, 1.40-1.80 [11 H, 2 m, $(CH_2)_4CHCH_2$ and OH], 2.25-2.50 (1 H, m, C*H*Ph), 3.56 (2 H, t, *J*=6.5, CH_2O) and 7.05-7.35 (5 H, m, Ph); δ_C 12.15, 25.75, 27.35, 29.7, 32.6, 36.4, 47.75, 62.9, 125.75, 127.95 (2C), 128.1 (2C) and 145.85; *m/z* 206 (M^+, 24%), 159 (38), 131 (11), 119 (45), 117 (59), 115 (14), 92 (10) and 91 (100) (Found: M^+, 206.16788. $C_{14}H_{22}O$ requires 206.16707).

6,6-Diphenylhexan-1-ol (**25a**): t_r=15.2 min (C); ν_{max} (film) 3720 (OH), 1600 and 1490 cm^{-1} (Ph); δ_H 1.10-1.70 [7 H, m, $(CH_2)_3CO$ and OH], 2.03 (2 H, m, C*H*$_2$CPh), 3.54 (2 H, t *J*=6.4, CH_2O), 3.87 (1 H, t, *J*=7.7, C*H*Ph) and 6.80-7.40 (10 H, m, 2xPh); δ_C 25.65, 27.7, 32.45, 35.55, 51.2, 62.7, 125.95 (2C), 127.75 (4C), 128.3 (4C) and 145.1 (2C); *m/z* 254 (M^+, 18%), 168 (32), 167 (100), 166 (10), 165 (44), 152 (25) and 91

(14).

9-Methyldeca-1,8-dien-4-ol (**26a**): t_r=8.5 min (C); ν_{max} (film) 3360 (OH), 3060 and 1630 cm^{-1} (HC=C); δ_H 1.20-1.55 (5 H, m, CH$_2$CH$_2$COH), 1.59, 1.68 (3 H each, 2 s, 2xMe), 1.90-2.40 (4 H, m, 2xCH$_2$C=C), 3.60 (1 H, m, CHO), 5.05-5.30 and 5.75-6.00(3 H and 1H, respectively, 2 m, olefinic H); δ_C 17.6, 25.6, 25.8, 27.9, 36.3, 41.9, 70.6, 108.0, 124.4, 131.6 and 134.8; *m/z* 168 (M$^+$, 10%), 127 (28), 109 (85), 84 (10), 83 (20), 82 (100), 81 (16), 79 (11), 69 (24), 67 (66), 57 (15), 55 (43), 53 (10), 43 (19) and 41 (57).

9-Ethylundeca-1,8-dien-4-ol (**27a**) *and (cis/trans-9-Ethylundeca-1,9-dien-4-ol* (**27a'**): t_r=10.3 min (C) [37]; ν_{max} (film) 3360 (OH), 3060 and 1640 cm^{-1} (HC=C); δ_H 0.94 (6 H, t, *J*=7.4, 2xMe), 0.97 (6 H, t, *J*=7.4, 2xMe), 1.10-1.50 (19 H, m, 8xCH$_2$ and 3xOH), 1.57 (6 H, d, *J*=6.6, 2xMeC=C), 2.00-2.40 (20 H, m, 10xCH$_2$C=C), 3.64 (3 H, m, 3xCHO), 5.00-5.25 and 5.75-5.90 (9 H and 3 H, respectively, 2 m, olefinic H); δ_C 12.8, 12.85, 12.9, 12.95, 13.15, 13.2, 22.65, 23.15, 25.45, 25.75, 26.15, 17.4, 28.15, 28.2, 29.1, 29.5, 29.75, 36.45, 36.55, 36.7, 36.75, 41.9, 41.95, 117.1, 117.7, 118.05, 122.35, 134.9, 141.8 and 143.05; *m/z* 196 (M$^+$, 24%), 155 (10), 149 (14), 137 (42), 121 (11), 111 (12), 110 (48), 109 (12), 107 (25), 97 (19), 96 (29), 95 (100), 93 (23), 84 (11), 83 (12), 82 912), 81 (96), 80 (12), 79 (48), 77 (12), 71 (14), 69 (39), 68 (15), 67 (71), 65 (11), 57 (23), 55 (77), 53 (24), 44 (12), 43 (31), 42 (38) and 41 (86) (Found: M$^+$, 196.18283. C$_{13}$H$_{24}$O requires 196.18272).

8-(1-Cyclopentenyl)oct-1-en-4-ol (**28a**): t_r=10.9 min (C); ν_{max} (CCl$_4$) 3400 (OH), 3080, 3040 and 1640 cm^{-1} (HC=C); δ_H 1.10-2.45 (17 H, m, 8x alifatic CH$_2$ and OH), 3.65 (1 H, m, CHO), 5.05-5.20 (2 H, m, CH$_2$=C), 5.31 and 5.70-5.95 (1 H each, s and m, respectively, 2xCH=C); δ_C 23.4, 25.45, 27.75, 31.05, 32.35, 35.0, 36.6, 41.9, 70.6, 118.0, 123.15, 134.85 and 144.7; *m/z* 194 (M$^+$, 9%), 153 (22), 135 (98), 134 (11), 133 (12), 119 (15), 108 (28), 107 (20), 95 (17), 94 (34), 93 (72), 91 (25), 81 (34), 80 (33), 79 (100), 77 (19), 69 (12), 67 (78), 65 (10), 57 (11), 55 (20), 53 (13), 43 (12) and 41 (36).

8-(1-Cyclohexenyl)oct-1-en-4-ol (**29a**): t_r=11.24 min (A); ν_{max} (film) 3360 (OH), 3060 and 1630 cm^{-1} (HC=C); δ_H 1.20-2.40 (19 H, 9x alifatic CH$_2$ and OH), 3.60-3.70 (1 H, m, CHO), 5.10-5.20 (2 H, m, CH$_2$=C), 5.4 and 5.75-5.95 (1 H each, 2 m, 2xCH=C); δ_C 22.5, 22.95, 25.1, 25.25, 27.55, 28.15, 36.55, 37.85, 41.8, 70.6, 117.75, 120.6, 134.8 and 137.6; *m/z* 208 (M$^+$, 8%), 167 (16), 149 (47), 95 (20), 93 (39), 91 (29), 81 (51), 79 (78), 77 (31), 67 (60), 65 (16), 57 (17), 55 (24), 53 (24), 44 (15), 42 (69) and 41 (100).

trans-2-Cyano-7-phenyloxepane (*trans*-**30a**)[38]: t_r=11.76 min (A); ν_{max} (film) 3060, 3020, 1600, 1490 (Ph), 1110 and 1020 cm^{-1} (C-O); δ_H 1.20-2.50 (8 H, m, 4xCH$_2$), 4.66 (1 H, dd, *J*=10.25 and 5.77, CHCN), 4.83 (1 H, dd, *J*=10.54 and 2.15, C*H*Ph) and 7.0-7.4 (5 H, m, Ph); δ_C 24.35, 27.7, 34.75, 36.7, 65.55, 78.35, 119.45, 126.9 (2C), 127.65, 128.45 (2C) and 142.15; *m/z* 201 (M$^+$, 27%), 200 (30), 172 (40), 133 (10), 117 (10), 115 (10), 107 (19), 106 (19), 105 (100), 104 (15), 91 (34), 90 (10), 85 (35), 83 (60), 80 (23), 79 (22), 77 (50), 69 (17), 55 (16), 54 (17), 51 (21), 50 (10), 47 (13), 42 (17) and 41 (24) (Found: M$^+$, 201.11626. C$_{13}$H$_{15}$NO requires 201.11536).

cis-(2-Cyano-7-phenyloxepane (*cis*-**30b**)[38]: t_r=12.18 min (A); ν_{max} (film) the same as for *trans*-**30a**; δ_H 1.20-2.30 (8 H, m, 4xCH$_2$), 4.60, 4.63 (2 H, 2 dd, *J*=5.15, 2.5 and *J*=3.8, 2.5, respectively, CHOCH) and 7.10-7.40 (5 H, m, Ph); δ_C 24.85, 29.05, 34.75, 38.2, 67.5, 82.6, 119.15, 125.6 (2C), 127.5, 128.35 (2C) and 142.5; *m/z* 201 (M$^+$, 23%), 200 (27), 172 (44), 158 (10), 133 (15), 117 (16), 115 (13), 107 (15), 106 (19), 105 (100), 104 (15), 96 (10), 91 (34), 85 (16), 83 (25), 79 (25), 78 (21), 77 (55), 66 (14), 55 (15), 54 (16), 51 (23), 42 (21) and 41 (21).

2-Cyano-7,7-dimethyloxepane (**31a**): t_r=8.7 min (C); ν_{max} ($CDCl_3$) 2220 (CN), 1130 and 1080 cm^{-1} (C-O); δ_H 1.24, 1.25 (3 H each, 2 s, 2xMe), 1.27-2.10 (8 H, m, 4xCH_2) and 4.33 (1 H, dd, *J*=10.5 and 1.5, CH); δ_C 22.1, 27.0, 28.2, 28.5, 35.85, 40.7, 61.3, 77.5 and 120.0; *m/z* 138 (M$^+$-15, 61%), 124 (20), 110 (11), 97 (13), 96 (29), 67 (11), 59 (55), 58 (22), 55 (19), 54 (16), 43 (100), 42 (19) and 41 (32).

2-Cyano-7,7-diethyloxepane (**32a**): t_r=10.5 (C); ν_{max} (CCl_4) 2240 (CN), 1120 and 1080 cm^{-1} (C-O); δ_H 0.80, 0.88 (3 H each, 2 t, *J*=7.5, 2xMe), 1.10-1.60, 1.85-2.05 (8 H and 4 H, respectively, 2 m, 6xCH_2) and 4.30-4.40 (1 H, m, CH); δ_C 7.55, 8.4, 21.8, 27.9, 28.15, 28.8, 35.75, 37.15, 60.95, 82.15 and 119.6; *m/z* 152 (M$^+$-29, 100%), 97 (10), 96 (11), 57 (53) and 55 (10).

2-Cyano-1-oxaspiro[6,5]dodecane (**33a**): t_r=10.45 min (A), m.p. 80-81°C (hexane/diethyl ether); ν_{max} (melted) 2260 (CN), 1090 and 1070 cm^{-1} (C-O); δ_H 0.80-2.00 (18 H, m, 9xCH_2) and 4.20-4.30 (1 H, m, CH); δ_C 21.45, 21.7, 22.05, 25.7, 28.85, 35.0, 35.6, 37.0, 40.45, 60.8, 77.9 and 119.7; *m/z* 193 (M$^+$, 6%), 164 (15), 151 (14), 150 (100), 137 (27), 98 (18), 97 (10), 81 (18), 80 (11), 78 (10), 69 (14), 67 (18), 55 (54), 54 (13), 53 (12), 42 (21) and 41 (39) (Found: C, 74.2; H, 9.9; N, 6.9. $C_{12}H_{19}NO$ requires C, 74.57; H, 9.90; N, 7.25).

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References and Notes

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12. This starting material was prepared from tetrahydropyran by the following route: i, NaI-MeCOCl, 0°C, 2 d (80%)[13]; ii, MeOH-2 N HCl, 2 d (75%)[14]; iii, PCC, CH_2Cl_2 (81%)[15]; iv, $HO(CH_2)_2OH$-H_2SO_4 cat., PhH reflux, 5 h (85%) (see Experimental Part).
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37. Compounds **27a** and **27a'** could not be separated in GLC under these conditions (see also footnote g in Table 2).
38. The stereochemistry of this compound was assigned by comparison with the literature data (see ref 7c and references cited therein).