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The Picolyl Group, an Electroactive Protection Group for Alcohols *

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The quality of the picolyl group as electroactive protecting group is being investigated. 4- (*1*) and 2-picolyl ethers (*2*) are formed in 63 to 83 % yield by a *Williamson* synthesis from butanol, decanol and the picolyl chlorides. With 1,4-pentanediol the chemoselectivity for the protection of the primary to the secondary hydroxyl group is 4.3 to 4.6:1. In *N,N*-dimethylformamide–1 % methanol *1* and *2* are cleaved at −2.5 to −2.7 V (s.c.e.) ** to yield 45–92 % butanol or decanol. In the acidic electrolyte, 0.5 M HBF_4-methanol, deprotection occurs already at −1.35 to −1.4 V in 70 % yield. By coelectrolysis of *1,2* and *p*-cyanobenzyl 2-ethylhexyl ether (*6*) in the acidic electrolyte exclusively *1,2* can be cleaved, while in neutral medium only *6* is selectively deprotected.

In organic synthesis the hydroxyl group is conveniently protected as an ether against elimination, substitution or oxidation. The ether is frequently a better protecting group than the ester because it is more stable towards acids and bases. Often benzyl ethers are used, which can be cleaved by hydrogenation, chemical or cathodic reduction.[2] The electrochemical cleavage at controlled potential is an attractive method for the selective deprotection of diols with different protecting groups. This has been demonstrated in the synthesis of a 1,3-dialkoxy lipid with the tritylone (=9,10-dihydro-10-oxo-9-phenyl-9-anthracenyl) and the *p*-cyanobenzyl residue as protecting groups.[3] In order to extend the number of electroactive protecting groups for potential selective deprotection we looked more closely at the picolyl group, which has already been used for the protection of carboxylic acids,[4] alcohols [5] and thiols.[6] As electron attracting groups facilitate the cathodic cleavage,[7] it should be reduced more easily than the benzyl group.

RESULTS

In the *Williamson* synthesis of picolyl ethers, two equivalents of an alkoxide are reacted with picolyl chloride hydrochloride,[8] as the free picolyl chloride is unstable. This reaction mode, however, is unsuitable for protective use, as at most 50 % of the alcohol are converted to the ether (eqn. (1)). To consume only one equivalent of alcohol, the picolyl chlorides were generated from their hydrochlorides just before use [9] and reacted with the stoichiometric amount of sodium alkoxide in dioxane/HMPA (Table 1). The phase transfer catalyzed [10] etherification that has been successfully applied in methylation [11,12] and benzylation [12,13] failed in this case. The two phase system, decanol in CH_2Cl_2/Bu_4NI and 2-picolyl chloride hydrochloride in 50 % aqueous NaOH, produced after 10 h of intense stirring only 25 % *2b*. An excess of alkylation reagent as described in Refs. 12 and 13 was not applied because of the instability of the picolyl chlorides against base.

The reduction potentials of the picolyl ethers were determined by differential pulse polarography [14] in 0.1 M Bu_4NClO_4–*N,N*-dimethylformamide (DMF). With −2.6, −2.73 V

* See Ref. 1.
** All potentials unless otherwise stated *vs.* s.c.e.

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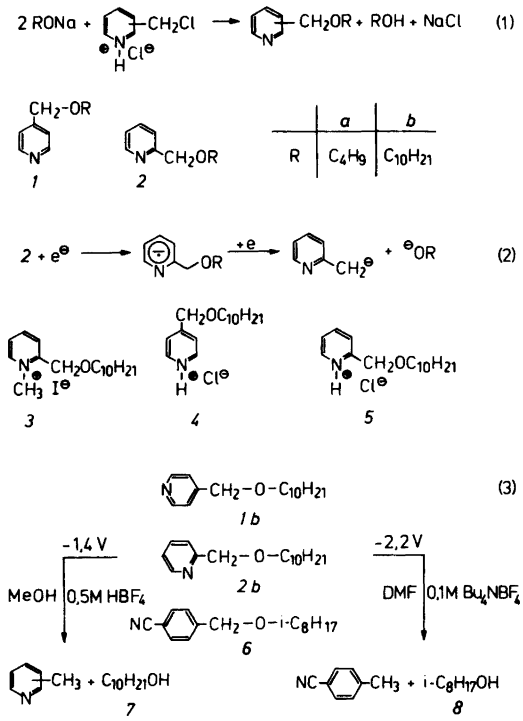


Table 1. Preparation of picolyl ethers.

Alcohol	Picolyl chloride	Picolyl ether	Yield (%)
Butanol	4–	*1a*	83
Butanol [a]	2–	*2a*	63
Decanol	4–	*1b*	70
Decanol	2–	*2b*	67

[a] Etherification with 2.5 equiv. of alcohol.

for *2a* and −2.54 V for *1a* they are fairly negative and range between the benzyl, −3.1 V,[15] and the *p*-cyanobenzyl group, −2.2 V.[3] The preparative cathodic reduction at −2.7 V in 0.1 M Bu_4NClO_4–DMF cleaved *2a* to 38 % and *1a* to 60 % butanol. As reaction path the cleavage of *1* or *2* to an alkoxide and a picolyl anion *via* a picolyl anion radical is assumed (eqn. (2)).[15] The moderate yields in butanol could be due to a decomposition of *1* or *2* by the strongly basic picolyl anion. To suppress such a possible side reaction, methanol was added as proton donor. Indeed in 0.1 M Bu_4NClO_4–DMF–1 % metha-

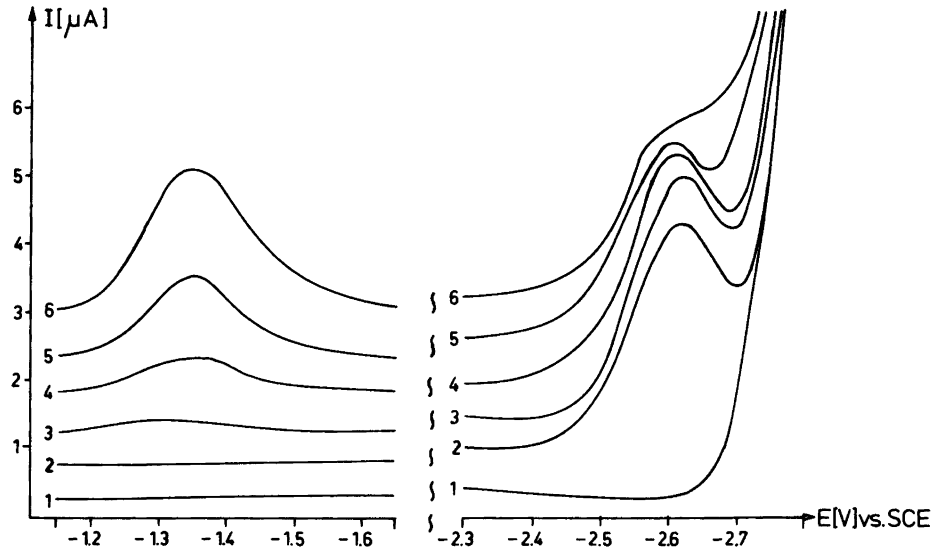


Fig. 1. Polarography of *1b* in 0.1 M Bu_4NClO_4-acetonitrile. (1) electrolyte; (2) (1)+10^{-3} M *1b*; (3) (2)+0.5×10^{-3} M HBF_4; (4) (2)+1.0×10^{-3} M HBF_4; (5) (2)+2.0×10^{-3} M HBF_4; (6) (2)+3.0×10^{-3} M HBF_4.

nol the butanol yield rose for *1a* to 92 % and for *2a* to 45 %. *1b* afforded under the same conditions 77 % decanol, however, *2b* being more difficult to reduce yielded only 13 %, possibly due to a simultaneous decomposition of the electrolyte. Protecting groups with very negative cleavage potentials are inconvenient as they are restricted to substrates with unreducible functional groups. Therefore we tried to shift the reduction potential of the picolyl group to more anodic values.

The potential for the electron transfer to a substrate can be decreased by the use of a mediator [16] (*outer activation*).[17] As an example, butyl benzyl ether ($E_{1/2}$: −3.1 V) can be cleaved at −2.67 V with biphenyl as electrocatalyst.[18] *1a*, however, was not reducible with anthracene (−1.96 V) as mediator; in cyclic voltammetry the

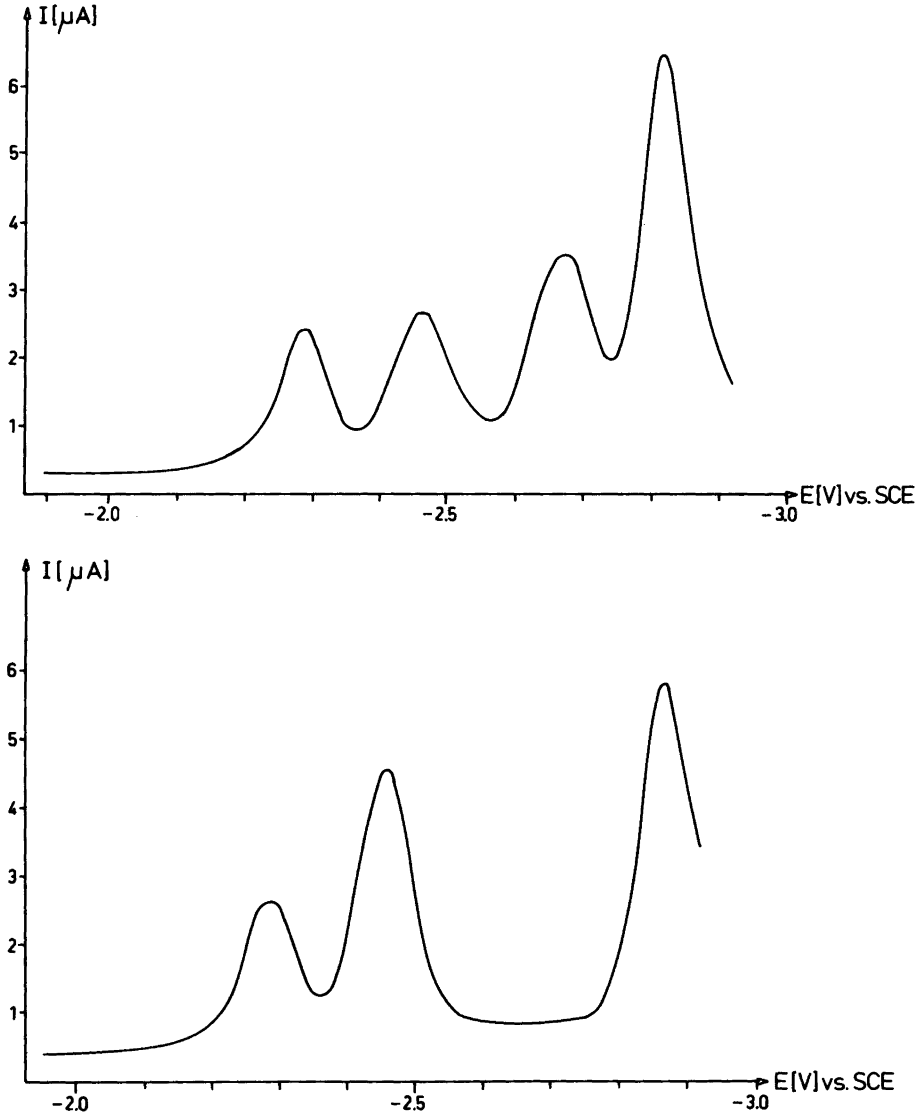


Fig. 2. Differential pulse polarograms of *1b*, *2b* and *6* (10^{-3} M) in 0.1 M Bu_4NBF_4−DMF; (a) *2b* and *6*; (b) *1b* and *6*.

$i_{p,a}$ and $i_{p,c}$ of antracene did not change on addition of *1a*.[16] Other mediators such as phenanthrene (−2.45 V), naphthalene (−2.49 V) and biphenyl (−2.67 V) were excluded because of their high reduction potentials. The reduction potential of a substrate can also be lowered by *inner activation*,[17] *e.g.* by extension of its conjugated system [$E_{1/2}$ (cinnamyl ether): −2.5 V, $E_{1/2}$ (benzyl ether): −3.1 V], or by electron attracting groups [$E_{1/2}$ (*p*-nitrobenzyl ether): −1.3 V]. In *1* and *2* the electron attracting ability of the nitrogen can be increased by quaternization. While pyridine is reduced at −2.61 V [19] the pyridinium salts have reduction potentials of −1.31 V [20] or −1.08 V.[21] The methiodide *3* ($E_{1/2}$: −1.22 V), prepared in 62 % yield from *2b*, is indeed reduced 1.45 V more anodically than *2b*. The preparative electrolysis in 0.1 M Bu_4NClO_4–methanol at −1.35 V, however, failed due to the formation of precipitates, the yield in decanol was only 5 %. The hydrochlorides *4* and *5*, prepared from *1b* and *2b* with dry HCl in ether, are reduced at $E_{1/2}$: −1.29 V (*4*) and −1.35 V (*5*); however, the preparative electrolysis of *5* in 0.1 M Bu_4NBF_4–acetonitrile at −1.35 V afforded no decanol.

With an acidic electrolyte it should be possible to protonate *1* and *2* and to reduce them at the potential of their hydrochlorides. In the polarography of *1b* as with pyridine [20,22] an increasing acidity of the electrolyte indeed decreased the current at −2.6 V and caused a new reduction peak to appear at −1.35 V (Fig. 1). The preparative electrolysis of *1b* or *2b* at −1.4 or −1.35 V in 0.5 M HBF_4–methanol afforded 72 or 70 % decanol. A control experiment secured that *1b* and *2b* are stable in the acidic electrolyte.

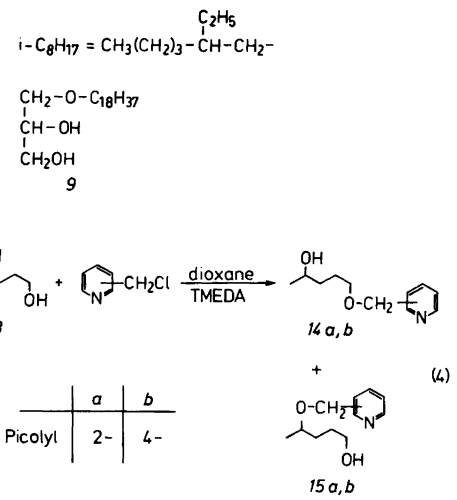
After the conditions had been worked out to prepare and to cleave the picolyl ethers in good yields, we studied how selectively the picolyl group can be cleaved in the presence of a second electroactive group and how chemoselectively picolyl ethers can be formed from diols. In a competition experiment the picolyl ethers (*1b*, *2b*) and the *p*-cyanobenzyl ether (*6*) were coelectrolyzed. In a neutral electrolyte at −2.2 V only *6* should be cleaved, while reduction at −1.35 V in an acidic medium should cleave *1b* and *2b* but not *6*. *6* was prepared from sodium 2-ethyl-1-hexoxide and *p*-cyanobenzyl bromide in 86 % yield and is reduced at $E_{1/2}$: −2.3, −2.47 V in 0.1 M Bu_4NBF_4–DMF. As polarography revealed, the reduction of *6* did not influence that of *2b* (Fig. 2a) but that of *1b*, here the first peak of *1b* is shifted anodically and merges with the second one of *6* (Fig. 2b). Possibly *6* acts partly as a mediator for the reduction of *1b*. The results of the preparative coelectrolysis of *1b* and *6*, and *2b* and *6* (eqn. (3)) are summarized in Table 2.

Table 2. Potential selective cleavage of the picolyl- or the *p*-cyanobenzyl group.

Ether	Yield of alcohol
−1.4 V, 0.5 M HBF_4–MeOH;	
1b+*6* (1:1)	70 % *7*
	0 % *8*
2b+*6* (1:1)	83 % *7*
	0 % *8*
−2.2 V, 0.1 M Bu_4NBF_4–DMF;	
1b+*6* (1:1)	10 % *7*
	74 % *8*
2b+*6* (1:1)	0 % *7*
	57 % *8*

Table 2 demonstrates that in acidic medium the selective cleavage of the picolyl group besides the *p*-cyanobenzyl group is indeed possible. In a neutral electrolyte the *p*-cyanobenzyl ether can be deprotected selectively in the presence of a 2-picolyl ether, while with the 4-picolyl ether the selectivity is not quite so good. The latter is in accordance with the smaller difference in the reduction potentials for *6* and *1b*: ΔE=0.18 compared to that of *6* and *2b*: ΔE=0.39 V.

The chemoselectivity in the reaction with a primary or secondary hydroxyl group was tested with *9* [23] as substrate. After reaction of *9* with NaH or Na and subsequent treatment with 2-picolyl chloride in dioxane/HMPA 55 % of the 1-*O*-octadecyl-2,3-*O*-di(2-picolyl)-glycerol (*10*) and only 25 % of the wanted monoprotected product as a mixture of 10 % 1-*O*-octadecyl-2-*O*-(2-picolyl)-glycerol (*11*) and 15 % 1-*O*-octadecyl-3-*O*-(2-picolyl)-glycerol (*12*) were obtained. As the selectivity for the benzylation of 1,3-butanediol is described as good,[24] we also increased the distance between the two hydroxy groups. Indeed 1,4-pentanediol (*13*) prepared from ethyl levulinate by reduction with $LiAlH_4$ according to Ref. 25 yielded 67 % 1-(2-picolyloxy)-pentan-4-ol (*14a*) and 16 % 4-(2-picolyl-



oxy)-pentan-1-ol (*15a*) after reaction with sodium in dioxane/TMEDA and treatment with 2-picolyl chloride (eqn. (4)). In the same way, treatment with 4-picolyl chloride yielded 54 % 1-(4-picolyloxy)-pentan-4-ol (*14b*) and 12 % 4-(4-picolyloxy)-pentan-1-ol (*15b*). The chemoselectivity for the primary to the secondary hydroxyl group is under these conditions 4.3–4.6:1.

The picolyl group thus turned out to be a quite useful electroactive protecting group. Picolyl ethers can be prepared in good yields, whereby a primary hydroxyl group can chemoselectively be protected. The ethers are stable towards acids and bases and can be cleaved potential selectively either at −1.4 V in an acidic electrolyte or at −2.6 V in neutral medium.

EXPERIMENTAL

IR spectra were recorded on the Perkin-Elmer instruments 298 and 421. ^{1}H NMR spectra were obtained with a Varian HA 100 and a Bruker WM 300 spectrometer, using TMS as an internal standard. Mass spectra were produced by the Varian MAT 111, SM 1 and CH 7 spectrometers.

Gas and liquid chromatography. For gas chromatography a Varian 1440 instrument coupled to the Spectra Physics integrator Minigrator Autolab was used together with the following glass columns: Column A: Ø 2 mm, 1.7 m, 10 % FFAP on chromosorb WAW DMCS; column B: same as A but 4 % FFAP; column C: same as A but 4 % SE 30; column D: same as A but 4 % OV 225. Nitrogen was used as carrier gas. Gas chromatographic yields were determined according to Ref. 26 with hydrocarbons from Merck as standard. For liquid chromatography silica gel (0.063–0.2 mm) Merck was used. Medium pressure liquid chromatography was performed in a Pharmacia chromatography tube, combined with a pump Type SC 1 with pulsation damper Duramat from C+G, Heidelberg, and an Isco fraction collector Modell 238. HPLC was carried out with a Lewa-pump, type HU 1 and a steel-column, length 50 cm, internal diameter 1.6 cm from Knaur with silica gel 7 μm (Merck). Analytical TLC was done on TLC-aluminium foils 60 F_{254} from Merck and polyethylene foils Polygram SiL G/UV_{254} from Macherey-Nagel.

Electrochemistry. Cyclic voltammogramms were recorded by a Wenking 68 Fr 0.5 potentiostat, combined with a Wavetek function generator 133 and a Hewlett-Packard XY-recorder Typ 7045 A (voltage scan: 40 mV/s) in a Methrom EA 876 vessel with a glassy carbon (Ø 5 mm) cathode and a platinum-foil (Ø 5 mm) anode. Polarogramms were obtained with a Bruker polarograph 310 with a Methrom drop controller E 354 S and a vessel EA 876. Reference electrodes were the cadmium/amalgam (Marple) [27] and the saturated calomel electrode. Preparative electrolyses were done with a Wenking potentiostat (3 A, 60 V) and a dc-integrator (construction: Dr. H. Luftmann, Univ. Münster). The temperature was regulated with a Lauda TK 30 D thermostat to 20 °C. An undivided cylindrical cell A (150 ml, water jacket) with three electrodes: mercury pool (Ø 5 cm), platinum foil (Ø 2 cm), Marple or Ag/Ag^+-reference electrode, and a divided cell B (as A, but with a G4 glass frit) were used. All electrolyses were done under nitrogen.

Solvents were distilled and if necessary dried.[28] DMF was stirred for two days over P_2O_5, distilled at 55 °C/20 Torr under nitrogen, and stored over molecular sieves (4 A) in the refrigerator. Methanol was used in *p.a.* quality (Merck). Diisopropyl ether was purified by column filtration on basic aluminium oxide activity I (Woelm). Tetrabutylammonium perchlorate (Bu_4NClO_4) was prepared from Bu_4NHSO_4 and sodium perchlorate, doubly crystallized from water and vacuum dried at 100 °C. Similarly Bu_4NBF_4 was obtained from $NaBF_4$.

4- and 2-picolyl butyl ether (1a *and* 2a). 0.46 g (20 mmol) sodium are dissolved at 80 °C under nitrogen in 10 ml butanol, after 1 h the excess butanol is distilled off at 15 Torr and 30 ml dioxane–HMPA (1:1) are added to the white solid. 3.28 g (20 mmol) 4-picolyl chloride hydrochloride are dissolved in 40 ml water, 8 N potassium hydroxide is added to the solution

until the colour changed to rose. The ether extract (3×30 ml, dried on $MgSO_4$) is added at 40 °C within 15 min to the alkoxide, then stirring is continued at room temperature overnight. For work-up most of the solvent is distilled off, 40 ml water are added, extracted with ether (5×20 ml), dried ($MgSO_4$) and distilled at 50 °C/0.01 Torr to yield 2.74 g (83 %) *1a*.

1a: IR (film): 3080–2860, 1600–1580, 1110, 800 cm^{-1}. ^1H NMR (CCl_4): δ 1.0 (3H, t), 1.6 (4H, m), 3.5 (2H, t), 4.5 (2H, s), 7.2 (2H, d), 8.6 (2H, d). MS [*m/e* (% rel. int.)]: 165 (1, M), 122 (5), 108 (10), 93 (100), 92 (99). Anal. $C_{10}H_{15}NO$: C, H, N.

2a: B.p. 49 °C, 0.1 Torr. IR (film): 3080–2860, 1600–1500, 770 cm^{-1}. ^1H NMR (CCl_4): δ 1.0 (3H, s), 1.6 (4H, m), 3.6 (2H, t), 4.6 (2H, s), 7.1–8.5 (4H, m). MS [*m/e* (% rel. int.)]: 122 (2), 108 (10), 93 (100), 92 (35). Anal. $C_{10}H_{15}NO$: C, H, N.

*4- and 2-picolyl decyl ether (*1b *and* 2b*)*. To 1.8 g (75 mmol) sodium hydride in 100 ml dioxane 8.14 g (50 mmol) decanol in dioxane are added at 80 °C under nitrogen and with stirring, stirring is continued for 3 h and then at room temperature overnight. 7.5 g (59 mmol) 4-picolyl chloride, prepared before use as above, in dioxane are added dropwise to the alkoxide. Thereafter 15 ml HMPA are added and stirred overnight at room temperature. For work-up 100 ml water are added, extracted with ether (4×50 ml), dried ($MgSO_4$), distilled at 0.01 Torr and filtered through silica gel (ethyl acetate) to yield 8.9 g (70 %) *1b*. Analogous 8.35 g (67 %) *2b* are obtained.

1b: B.p. 139–141 °C/0.01 Torr. IR (film): 3050–2840, 1600–1500, 1100, 780 cm^{-1}. ^1H NMR (CCl_4): δ 0.9 (3H, t), 1.3 (14H, m), 1.6 (2H, q), 3.3 (2H, t), 4.3 (2H, s), 7.0 (2H, d), 8.5 (2H, d). MS [*m/e* (% rel. int.)] 249 (3, M), 234, 220, 206, 102, 178, 164 (all 1), 150 (95), 108 (100), 93 (50). Anal. $C_{16}H_{27}NO$: C, H, N.

2b: IR (film): 3050–2800, 1560–1580, 1120, 750 cm^{-1}. ^1H NMR (CCl_4): δ 0.9 (3H, t), 1.3 (14H, m), 1.6 (2H, q), 3.4 (2H, t), 4.5 (2H, s), 7.0–8.4 (4H, m). MS [*m/e* (% rel. int.)]: 108 (18), 93 (100). Anal. $C_{16}H_{27}NO$: C, H, N.

Cathodic cleavage of *1* and *2* in a neutral electrolyte

General conditions. 2.5 to 5 mmol *1, 2* are dissolved in the electrolyte and electrolyzed at the polarographically determined reduction potentials with initial currents of 100 to 150 mA in cell A until 3 to 4 F/mol had been consumed. Work-up (I) for butanol: The electrolyte is distilled at a maximum temperature of 40 °C under reduced pressure and cooling with liquid nitrogen to separate DMF and butanol from the supporting electrolyte. Work-up (II) for decanol: Water is added to the electrolyte, then extracted with ether (1×100 ml, 3×50 ml), the ether extracts are washed with 2 N H_2SO_4, water and thereafter dried ($MgSO_4$).

Electrolysis of 1a. 0.83 g (5 mmol) *1a* in 50 ml 0.1 M Bu_4NClO_4–DMF are electrolyzed until 1127 As are consumed. After work-up (I) the amount of butanol was quantitatively determined by GLC on column A (100 °C/iso.).

Electrolysis of 1b. 1.25 g (5 mmol) *1b* in 80 ml 0.1 M Bu_4NClO_4–DMF–5 % methanol are electrolyzed until 1200 As were consumed. After work-up (II) decanol is quantitatively determined by GLC on column C (140 °C, iso.).

Cathodic behaviour of *3*, *4* and *5*

Preparation of *3*. 0.63 g (2.5 mmol) *2b* are stirred for 3 days with 0.71 g (5 mmol) methyl iodide in 5 ml diisopropyl ether. Crystals, precipitating during the reaction, were collected and new methyl iodide added. 0.61 g (62 %) *N*-methyl-2-decyloxymethylpyridinium iodide (*3*) were thus obtained.

3: Yellow plates. M.p. (ethyl acetate) 92 °C. IR (KBr) 2920–2850, 1625–1455, 1120, 770 cm^{-1}. ^1H NMR (acetone-d_6): δ 0.9 (3H, t), 1.3 (14H, m), 1.7 (2H, q), 3.7 (2H, t), 4.6 (3H, s), 5.2 (2H, s), 8.1–9.5 (4H, m). MS [*m/e* (% rel. int.)]: 264 (1), 249 (1), 142 (54), 127 (43), 122 (54), 108 (49), 93 (100). Anal. $C_{17}H_{30}NOI$: C, H, N.

Preparative electrolysis of 3. 0.587 g (1.5 mmol) *3* in 50 ml 0.1 M Bu_4NClO_4-methanol are electrolyzed in cell B at 0 °C and −1.22 V. After short electrolysis a yellow-grey precipitate deposited and the initial current of 100 mA dropped to 0 mA, which terminated the electrolysis.

Preparation of 4 *and* 5. When dry HCl gas is bubbled into a solution of 0.63 g (2.5 mmol) *1b* or *2b* in 20 ml ether, *4* and *5* precipitate as yellow crystals.

4: Yield: 93 %. M.p. 85 °C (subl.). IR (KBr): 3070, 2850–2920, 1630–1500, 1110, 785 cm^{-1}. ^1H NMR ($CDCl_3$): δ 0.9 (3H, t), 1.1–1.5 (14H, m), 1.7 (2H, q), 3.7 (2H, t), 4.8 (2H, s), 8.0 (2H, d), 8.8 (2H, d). MS [*m/e* (% rel. int.)]: 250 (69), 249 (100), 108 (94). Anal. $C_{16}H_{28}NOCl$: C, H, N.

5: Yield: 97 %. M.p. 65 °C (subl.). IR (KBr): 3020, 2920–2850, 2500, 1600, 1160, 770 cm^{-1}. ^1H NMR ($CDCl_3$): δ 0.9 (3H, t), 1.1–1.5 (14H, m), 1.7 (2H, q), 3.7 (2H, t), 5.1 (2H, s), 7.8–8.8 (4H, m). MS [*m/e* (% rel. int.)]: 250 (39), 108 (100).

Anal. $C_{16}H_{28}NOCl$: C, H, N.

Preparative electrolysis of 5. 0.571 g (2 mmol) *5* in 60 ml 0.1 M Bu_4NBF_4-acetonitrile are electrolyzed in cell A at −1.8 V (Ag/Ag^+) with 10 mA for 30 h until 470 As had been consumed. In the electrolyte neither decanol, nor *5* or *2b* could be detected by GLC.

Cathodic cleavage of *1*, *2* in an acidic electrolyte

Preparative electrolysis of 2b. 1.25 g (5 mmol) *2b* dissolved in 100 ml 0.5 M HBF_4-methanol are electrolyzed in cell A at −1.4 V until *2b* could be detected no longer by TLC (CH_2Cl_2: CH_3CO_2Et, 20:1) or GLC (column C, 50 °C, 8 °C/min). The electrolyte is then diluted with water, extracted with ether (3×75 ml), the ether extracts are neutralized ($NaHCO_3$) and dried ($MgSO_4$). Decanol is quantitatively determined (yield: 70 %) by GLC (column C, 120 °C, iso) and isolated (64 %) by bulb-to-bulb distillation. Similarly from *1b* 72 % decanol were found by GLC and 65 % isolated by bulb-to-bulb distillation.

Chemical stability of 2b *in the acidic electrolyte.* 0.25 g (1 mmol) *2b* are stirred for 2 days in 0.5 M HBF_4-methanol at room temperature. After the usual work-up only *2b* could be detected by GLC and TLC.

Selective cathodic cleavage of *1b*, *2b* and *6*

Preparation of 6. To 0.8 g (33 mmol) NaH in 20 ml dioxane are added dropwise at 80 °C under stirring 3.2 g (25 mmol) 2-ethyl-1-hexanol in 10 ml dioxane. After a further 3 h at 80 °C, 4.75 g (25 mmol) *p*-cyanobenzyl bromide in 20 ml dioxane are added, stirring is continued for 1 h at 80 °C and then for 12 h at room temperature. For work-up 50 ml water are added, the organic layer is separated and the aqueous layer extracted with ether (3×30 ml). The combined organic layers are dried ($MgSO_4$), the ether evaporated and the residue purified by column chromatography (silica gel, CH_2Cl_2) to 5.24 g (86 %) *p*-cyanobenzyl 2-ethylhexyl ether (*6*).

6: IR (film): 3010, 2220, 1600–1500, 1100, 820 cm^{-1}. ^1H NMR ($CDCl_3$): δ 0.9 (6H, t), 1.5–1.1 (9H, m), 3.1 (2H, d), 4.1 (2H, s), 6.9 (2H, d), 7.1 (2H, d). MS [*m/e* (% rel. int.)]: 245 (1, M), 117 (100). Anal. $C_{16}H_{23}NO$: C, H, N.

Preparative electrolysis

6 and 2b *in a neutral electrolyte.* 3 mmol *6* and 3 mmol *2b* dissolved in 60 ml 0.1 M Bu_4NBF_4–DMF are electrolyzed in cell B at −1.38 V (Marple) with an initial current of 100 mA. After 615 As had been consumed, 50 ml water were added then extracted with ether (1×50 ml, 5×30 ml) and the ether extracts dried ($MgSO_4$). 2-Ethyl-1-hexanol, *p*-tolunitrile and *2b* are quantitatively determined by GLC (column B, 70 °C, 8 °C/min). Decanol could not be detected. Similarly *6* and *1b* were coelectrolyzed.

6 and 2b *in an acidic electrolyte.* 3 mmol *2b* and 3 mmol *6* dissolved in 60 ml 0.5 M HBF_4-methanol are electrolyzed in cell B at −1.35 V (Ag/Ag^+) until by GLC and TLC *2b* was no longer detectable. For work-up water was added, then extracted with ether, the ether extracts washed with $NaHCO_3$, water and dried ($MgSO_4$). Decanol and *6* were quantitatively determined by GLC (column B, 8 °C/min). 2-Ethyl-1-hexanol and *p*-tolunitrile could not be detected. Similarly *6* and *1b* were coelectrolyzed.

Protection of 9.[23] To 0.13 g (5.41 mmol) sodium hydride in 30 ml dioxane, 1.86 g (5.41 mmol) *9* are added at 80 °C under nitrogen and with stirring, which is continued for 2 h. Then 0.69 g (4.75 mmol) 2-picolyl chloride in dioxane are added dropwise to the alkoxide.

With 10 ml HMPA stirring is continued overnight at room temperature. For work-up 50 ml water are added, extracted with ether (5×30 ml), washed with saturated NaCl-solution (2×30 ml), dried ($MgSO_4$) and evaporated. Separation with HPLC (Si 60, p=45 bar, CH_2Cl_2–ethyl acetate–acetone 3:3:1) yielded 1.33 g (55 %) 1-*O*-octadecyl-2,3-*O*-di-(2-picolyl)-glycerol (*10*); 0.3 g (15 %) 1-*O*-octadecyl-3-*O*-(2-picolyl)-glycerol (*11*) and 0.2 g (10 %) 1-*O*-octadecyl-2-*O*-(2-picolyl)-glycerol (*12*).

10: IR (film): 3100, 3000–2800, 1580, 1520, 1100, 730 cm^{-1}. ^1H NMR ($CDCl_3$): δ 0.8 (3H, t), 1.3 (30H, m), 1.6 (2H, m), 3.5 (2H, t), 3.6–3.9 (5H, m), 4.6 (2H, s), 4.9 (2H, s), 7.1–8.5 (8H, m). MS [*m/e* (% rel. int.)]: 526 (2, M), 434 (43), 418 (6), 404 (16), 243 (15), 93 (100). Anal. $C_{33}H_{54}N_2O_3$: C, H, N.

11: IR (film): 3400, 3100, 2820–2900, 1580, 1460, 1100, 760 cm^{-1}. ^1H NMR ($CDCl_3$): δ 0.9 (3H, t), 1.1–1.3 (30H, m), 1.6 (2H, m), 3.4 (2H, t), 3.5–3.8 (6H, m), 4.8 (2H, s), 7.2–8.5 (4H, m). MS [*m/e* (% rel. int.)]: 436 (0.5, M), 184 (0.8), 152 (35), 93 (100). Anal. $C_{27}H_{49}NO_3$: C, H, N.

12: IR (film): 3500–3100, 2850–3000, 1600, 1100, 750 cm^{-1}. ^1H NMR ($CDCl_3$): δ 0.7 (3H, t), 1.1–1.3 (30H, m), 1.6 (2H, m), 3.4 (2H, t), 3.5–3.8 (6H, m), 4.7–5.0 (2H, m), 7.2–8.6 (4H, m). MS [*m/e* (% rel. int.)]: 436 (1, M), 184 (0.7), 152 (18), 93 (100). Anal. $C_{27}H_{49}NO_3$: C, H, N.

Selective protection of 13 *with 2-picolyl chlo-*

ride: 1.0 g (9.6 mmol) *13* [25] and 0.221 g (9.6 mmol) sodium are heated under reflux in 15 ml dioxane under nitrogen and with stirring until the reaction was complete. After cooling, 1.22 g (9.6 mmol) 2-picolyl chloride and 1 ml TMEDA are added and stirring is continued overnight. For work-up 30 ml water are added, the aqueous layer is extracted with ether (3×30 ml), the ether layers are washed with saturated NaCl-solution (2×15 ml) and dried ($MgSO_4$). The yields and product-ratios were determined by GLC (column D): 1.27 g (67 %) 1-(2-picolyloxy)-pentan-4-ol (*14a*), 0.28 g (16 %) 4-(2-picolyloxy)-pentan-1-ol (*15a*). The reaction mixture was separated by HPLC (Si 60, 7 μm, p=45 bar, CH_2Cl_2/MeOH 9:1).

14a: IR (film): 3380, 2800–2960, 1740, 1360–1425, 1100, 750 cm^{-1}. ^1H NMR ($CDCl_3$): δ 1.1 (3H, d), 1.5–1.8 (4H, m), 3.2 (1H, s), 3.6 (2H, t), 3.8 (1H, sext.), 4.6 (2H, s), 7.1–8.6 (4H, m). MS [*m/e* (% rel. int.)]: 196 (<1, M), 122 (3), 108 (30), 93 (100). Anal. $C_{11}H_{17}NO_2$: C, H, N.

15a: IR (film): 3380, 2800–2960, 1740, 1560–1425, 1100, 750 cm^{-1}. ^1H NMR ($CDCl_3$): δ 1.2 (3H, d), 1.5–1.8 (4H, m), 3.2 (1H, s), 3.6 (2H, t), 3.8 (1H, sext.), 4.6 (2H, m), 7.1–8.6 (4H, m). MS [*m/e* (% rel. int.)]: 196 (<1, M), 165 (1), 131 (15), 108 (31) 92 (100). Anal. $C_{11}H_{17}NO_2$: C, H, N.

Selective protection of 13 *with 4-picolyl chloride.* The amounts and procedures are the same as above. The yields were 1.00 g (54 %) 1-(4-picolyloxy)-pentan-4-ol (*14b*) and 0.21 g (12 %) 4-(4-picolyloxy)-pentan-1-ol (*15b*).

14b: IR (film): 3400, 2850–2900, 1630, 1570–1430, 1120, 820 cm^{-1}. ^1H NMR ($CDCl_3$): δ 1.2 (3H, d), 1.5–1.9 (4H, m), 3.2 (1H, s), 3.4 (2H, t), 3.9 (1H, sext.), 4.5 (2H, s), 7.2 (2H, s), 8.6 (2H, s). MS [*m/e* (% rel. int.)]: 196 (<1, M), 110 (15), 108 (40), 92 (100). Anal. $C_{11}H_{17}NO_2$: C, H, N.

15b: IR (film): 3400, 2850–2900, 1630–1430, 1120, 820 cm^{-1}. ^1H NMR ($CDCl_3$): δ 1.2 (3H, d), 1.5–1.9 (4H, m), 3.2 (1H, s), 3.4 (2H, t), 3.9 (1H, sext.), 4.5 (2H, m), 7.2 (2H, s), 8.6 (2H, s). MS [*m/e* (% rel. int.)]: 196 (<1, M), 165 (<1), 110 (10), 108 (30), 92 (100). Anal. $C_{11}H_{17}NO_2$: C, H, N.

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