2-ALKYL- AND 2-CYANO-SUBSTITUTED 1-ACYL-3,4-EPOXY-1,2,3,4-TETRAHYDROQUINOLINES — REACTIONS WITH *O*-NUCLEOPHILES

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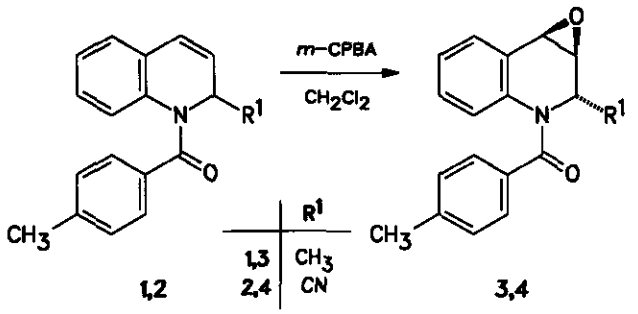
Abstract - The oxirane ring opening of 1,2,3,4-tetrahydroquinoline 3,4-epoxides with *O*-nucleophiles is described leading to 3,4-diol derivatives (**5** - **7**) with well defined stereochemistry. As by-products nitrate esters are formed. The reaction was applied to produce the epimeric epoxide (**10**) *via* a four step synthesis.

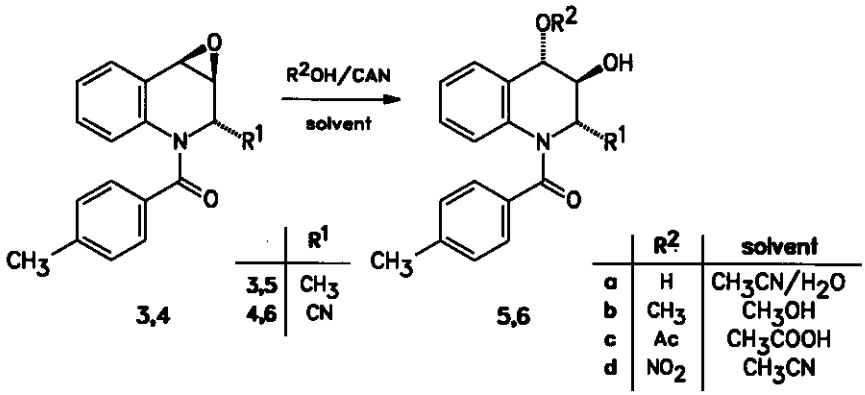
In previous papers we have reported on the synthesis of 1-acylated 2-alkyl and 2-cyano substituted 3,4-epoxides of 1,2,3,4-tetrahydroquinolines which are formed as pure *trans*-diastereomers (**3**, **4**) by epoxidation of 1,2-dihydroquinolines (**1**, **2**) (Scheme 1).[1,2] These versatile intermediates furnish tetrahydroquinolines with strictly predictable relative stereochemistry.[3]



Only relative stereochemistry shown throughout.

Scheme 1

The *trans*-diol derivatives (**5**) and (**6**) were obtained from the reaction of **3** and **4** with *O*-nucleophiles like water, alcohols, or carboxylic acids in the presence of Ce(IV) salts as effective catalysts according to Iranpoor and coworkers.[4] Applying their mild and neutral conditions, the diol derivatives were available by treatment with catalytic amounts of cerium ammonium nitrate (CAN) not only in the 2-alkyl but also in the 2-cyano series (Scheme 2). Contrary to these results, we had found that the reaction with *N*-nucleophiles leads to different products depending on the substituent at C-2: The 2-alkyl substituted epoxides yield the *N*-analogous ring opened compounds too, however, the 2-cyano epoxides undergo fragmentation to 4-hydroxyquinoline and benzoylamides.[3,5]



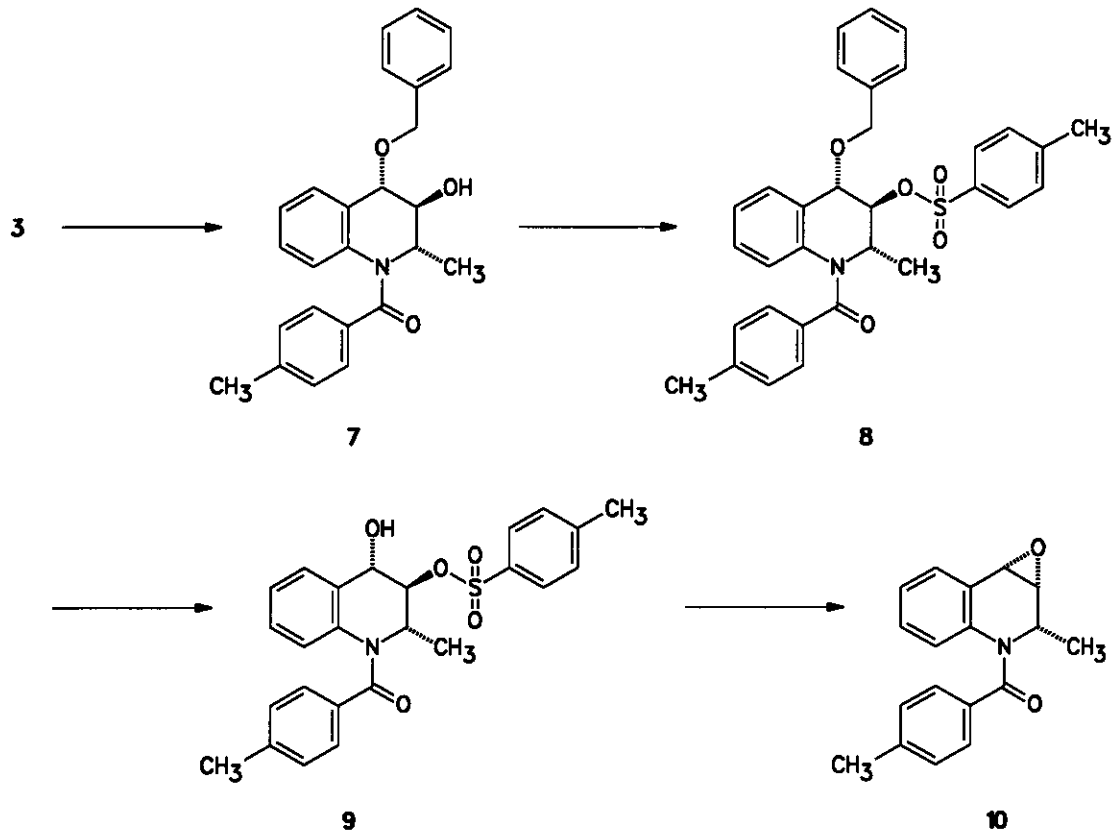
Scheme 2

Corresponding to the described results of epoxide ring opening with *N*-nucleophiles on compounds (**3**) the *O*-nucleophiles exclusively attack the 4-position. The relative stereochemistry of the resulting diols fully corresponds to the configuration of the epoxide ring opening products of **3** with *N*-nucleophiles.

All oxirane ring opening experiments afforded by-products in low amounts, which possess an identical general structure but are different concerning the substituent on C-2, of course. These products could be elucidated as nitrate esters (**5d**) and (**6d**) whose generation can be understood by the concurrent nucleophilic attack of nitrate. The appearance of such by-products was not observed by Iranpoor.[4] The formation of **5d** and **6d** could be forced by reaction of **3** and **4** with molar equivalents of CAN.

Referring to the observation that the nucleophile selectively reacts at the 4-position the synthesis of the diastereomeric epoxide (**10**) could be planned. The epoxide (**3**) was opened with benzyl

alcohol yielding the 4-benzyloxy substituted tetrahydroquinolin-3-ol (**7**) which was tosylated at the 3-OH group to produce **8**. Removement of the benzyl moiety by catalytic hydrogenation gave **9**, the recyclisation to the epimeric epoxide (**10**) was simply achieved by treatment of **9** with potassium hydroxide in methanol (Scheme 3).



Scheme 3

In comparison with **3**, the *2SR,3RS,4SR*-epoxide (**10**) shows nmr-spectroscopically well distinct 3-H and 4-H signals (see Table). The $J_{2,3}$ coupling is in good accordance with the demanded *cis* configuration, supporting an additional proof for the *trans* diastereoselectivity of the formerly reported epoxidation step.

	Relative configuration	Chemical shift (ppm)			Coupling (Hz)	
		2-H	3-H	4-H	$J_{2,3}$	$J_{3,4}$
3	*2SR,3SR,4RS*	5,32	3,79	3,95	2,1	4,4
10	*2SR,3RS,4SR*	5,25	3,84	3,90	6,3	4,2

EXPERIMENTAL SECTION

Melting points were taken on a Kofler hot stage apparatus and are uncorrected. Solvents and common reagents were obtained commercially and used as received, dry acetonitrile and methanol were obtained by storage over molecular sieve (3 Å). Elementary analyses were performed by Mag. J. Theiner, Institut für Physikalische Chemie der Universität Wien. Ir spectra were recorded as KBr pellets using a Perkin Elmer model 298 spectrophotometer. Nmr spectra were determined on a Bruker AC 80 or a Varian Unity-plus 300. All substances, unless otherwise noted, were measured in $CDCl_3$ as a solvent. ^1H Nmr spectra were recorded with $(CH_3)_4Si$ as the internal reference, the chemical shifts of the ^{13}C nmr spectra are given in ppm related to the resonance of $CDCl_3$ (77.0 ppm), an asterisk marks peaks of double intensity. Mass spectra were recorded on a MAT CH-7 by Dr. L. Jirovetz. Column chromatography was conducted on Merck silica gel 60.

(2*SR*, 3*SR*, 4*SR*)-3,4-Dihydroxy-2-methyl-1-toluoyl-1,2,3,4-tetrahydroquinoline (5a)

To a suspension of **3** (280 mg, 1 mmol) in 12 ml of water/acetonitrile (1+3) a catalytic amount of CAN was added. After stirring at room temperature for 2 h (tlc-control) the organic solvent was evaporated and the residue partitioned between water and ethyl acetate (3 x). The combined organic layers were dried over sodium sulfate and concentrated. The oily residue was purified by column chromatography (ether), yield 250 mg **5a** (84%) as a white solid, mp 72 - 74 °C; ^1H-nmr (80 MHz): δ (ppm) = 7.55 (1H, d, J = 7.8 Hz, arom. H), 7.30 - 6.76 (6H, m, arom. H), 6.48 (1H, d, J = 7.8 Hz, arom. H), 4.78 - 4.38 (2H, m, 4-H, 2-H), 4.35 - 3.75 (2H, br, OH, exchangeable), 3.32 (1H, dd, J = 8.3 Hz, J = 5.0 Hz, 3-H), 2.25 (3H, s, p-CH_3), 1.30 (3H, d, J = 6.8 Hz, 2-CH_3); ^{13}C-nmr (75 MHz): δ (ppm) = 169.7 (C=O), 140.7, 136.0, 132.9, 132.2, 128.8*, 128.6*, 126.8, 126.0, 125.8, 124.1 (arom. C), 81.5, 71.2 (4-C, 3-C), 55.7 (2-C), 21.3 (p-CH_3), 19.3 (2-CH_3); ir: 1620 cm^{-1} (ν_{amide}); ms (m/z) 297 (M^+). Anal. Calcd for $C_{18}H_{19}NO_3$: C, 72.71; H, 6.44; N, 4.71. Found: C, 72.86; H, 6.33; N, 4.57.

(2*SR*, 3*SR*, 4*SR*)-3-Hydroxy-4-methoxy-2-methyl-1-toluoyl-1,2,3,4-tetrahydroquinoline (5b)

To a suspension of **3** (280 mg, 1 mmol) in 5 ml of dry methanol a catalytic amount of CAN was added. After stirring at room temperature for 2 h (tlc-control) the solvent was evaporated and the

residue purified by column chromatography (petroleum ether/ether: 1:2), yield 250 mg **5b** (81%), colorless crystals from ether, mp 165 - 166 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.55-6.80 (7H, m, arom. H), 6.54 (1H, dd, J = 8.3 Hz, J = 1.5 Hz, arom. H), 4.61 (1H, dq, J = 6.8 Hz, J = 4.9 Hz, 2-H), 4.20 (1H, d, J = 7.3 Hz, 4-H), 3.78 (3H, s, OCH_3), 3.64 - 3.38 (1H, m, 3-H, after D_2O-exchange: 3.51, dd, J = 7.3 Hz, J = 4.9 Hz), 3.16 (1H, d, OH, exchangeable), 2.30 (3H, s, p-CH_3), 1.27 (3H, d, J = 6.8 Hz, 2-CH_3); ^{13}C-nmr (20.12 MHz): δ (ppm) = 169.7 (C=O), 140.4, 136.2, 132.5, 130.5, 128.7*, 128.4*, 126.8, 126.1, 125.3, 125.1 (arom. C), 80.5, 78.0 (4-C, 3-C), 59.5 (OCH_3), 54.9 (2-C), 21.2 (p-CH_3), 17.9 (2-CH_3); ir: 1620 (ν_{amide}), 1090 cm^{-1} ($\nu_{C\text{-}O\text{-}C}$); ms (m/z) 311 ($M^+$). Anal. Calcd for $C_{19}H_{21}NO_3$: C, 73.28; H, 6.79; N, 4.49. Found: C, 73.02; H, 6.81; N, 4.56.

(2*SR*, 3*SR*, 4*SR*)-4-Acetoxy-3-hydroxy-2-methyl-1-toluoyl-1,2,3,4-tetrahydroquinoline (5c)

To a solution of **3** (280 mg, 1 mmol) in 2 ml of acetic acid a catalytic amount of CAN was added. After stirring for 30 min the solution was diluted with water and extracted with dichloromethane (3 x). The combined organic fractions were washed with saturated sodium bicarbonate solution, dried over sodium sulfate and evaporated in vacuo. The residue was purified by column chromatography (ether), yield 200 mg **5c** (59%) as yellowish solid, colorless crystals from ether, mp 153 - 157 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.35 - 6.83 (7H, m, arom. H), 6.70 - 6.53 (1H, m, arom. H), 5.88 (1H, d, J = 6.2 Hz, 4-H), 4.72 (1H, dq, J = 6.8 Hz, J = 4.1 Hz, 2-H), 3.87 - 3.61 (1H, m, 3-H; after D_2O-exchange: 3.74, dd, J = 6.2 Hz, J = 4.1 Hz), 2.93 (1H, d, OH, exchangeable), 2.30, 2.25 (3H, 3H, s, s, acetyl-CH_3, p-CH_3), 1.27 (3H, d, J = 6.8 Hz, 2-CH_3); ^{13}C-nmr (20.12 MHz): δ (ppm) = 170.7, 170.5 (C=O), 140.5, 136.3, 132.4, 128.8*, 128.5*, 127.4, 127.3, 126.2, 126.1, 125.0 (arom. C), 76.5, 71.6 (4-C, 3-C), 54.4 (2-C), 21.3, 21.0 (p-CH_3, acetyl-CH_3), 17.1 (2-CH_3); ir: 1735 (ν_{ester}), 1620 cm^{-1} (ν_{amide}); ms (m/z) 339 (M^+). Anal. Calcd for $C_{20}H_{21}NO_4$: C, 70.77; H, 6.23; N, 4.12. Found: C, 70.52; H, 6.28; N, 4.07.

(2*SR*, 3*SR*, 4*SR*)-3-Hydroxy-2-methyl-1-toluoyl-1,2,3,4-tetrahydroquinoline-4-nitrate (5d)

To a suspension of **3** (280 mg, 1 mmol) in 5 ml of dry acetonitrile CAN (660 mg, 1.2 mmol) was added. After stirring at room temperature for 90 min the solution was diluted with water and

extracted with ethyl acetate (3 x). The combined organic fractions were washed with water, dried over sodium sulfate and evaporated in vacuo. Purification of the residue by column chromatography (ether), yield 100 mg (29%), colorless crystals from ether, mp 142 - 144 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.45 - 6.80 (7H, m, arom. H), 6.75 - 6.50 (1H, m, arom. H), 5.96 (1H, d, J = 3.5 Hz, 4-H), 4.78 (1H, dq, J = 6.8 Hz, J = 3.5 Hz, 2-H), 4.10 - 3.75 (2H, br, 3-H; after D_2O-exchange: 3.87, t, J = 3.5 Hz), 2.31 (3H, s, p-CH_3), 1.16 (3H, d, J = 6.8 Hz, 2-CH_3); ^{13}C-nmr (75 MHz): δ (ppm) = 171.2 (C=O), 141.1, 136.6, 132.3, 128.9*, 128.8*, 128.6, 128.0, 126.5, 125.2, 122.8 (arom. C), 79.4, 73.7 (4-C, 3-C), 53.6 (2-C), 21.4 (p-CH_3), 15.7 (2-CH_3); ir: 1640, 1625 (ν_{amide}, $\nu_{R\text{-}ONO_2}$), 1275 cm^{-1} ($\nu_{R\text{-}ONO_2}$); ms (m/z) 342 (M^+); Anal. Calcd for $C_{18}H_{18}N_2O_5$: C, 63.15; H, 5.29; N, 8.18. Found: C, 62.94; H, 5.23; N, 7.92.

(*2SR*, 3*SR*, 4*SR*)-2-Cyano-3,4-dihydroxy-1-toluoyl-1,2,3,4-tetrahydroquinoline (6a)

To a solution of **4** (290 mg, 1 mmol) in 9 ml of acetonitrile and 3 ml of H_2O and a catalytic amount of CAN was added under stirring. After reaction overnight the organic solvent was evaporated and the residue was partitioned between water and ethyl acetate (3 x). The organic layers were washed with brine, dried over sodium sulfate and evaporated in vacuo. The residue was purified by column chromatography (ether), yield 250 mg **6a** (81 %) as colorless solid, mp 191 - 193 °C; ^{1}H-nmr ($CDCl_3$ + methanol-d_4, 80 MHz): δ (ppm) = 7.64 (1H, d, J = 7.5 Hz, arom. H), 7.43 - 6.86 (6H, m, arom. H), 6.58 (1H, dd, J = 7.5 Hz, J = 1.0 Hz, arom. H), 5.16 (1H, d, J = 5.8 Hz, 2-H), 4.65 (1H, d, J = 8.3 Hz, 4-H), 4.0 - 4.2 (2H, br, exchangeable), 3.94 (1H, dd, J = 8.3 Hz, J = 5.8 Hz, 3-H), 2.33 (3H, s, p-CH_3); ^{13}C-nmr (DMSO-d_6, 20.12 MHz): δ (ppm) = 169.1 (C=O), 141.2, 135.1, 132.6, 131.1, 129.0*, 128.7*, 127.1, 126.1, 125.8, 124.8 (arom. C), 118.4 (CN), 76.4, 68.9 (4-C, 3-C), , 49.5 (2-C), 21.0 (p-CH_3); ir: 1630 cm^{-1} (ν_{amide}); ms (m/z) 308 (M^+). Anal. Calcd for $C_{18}H_{16}N_2O_3$: C, 70.11; H, 5.23; N, 9.08. Found: C, 69.91; H, 5.24; N, 9.09.

(2*SR*, 3*SR*, 4*SR*)-2-Cyano-3-hydroxy-4-methoxy-1-toluoyl-1,2,3,4-tetrahydroquinoline (6b)

To a suspension of **4** (290 mg, 1 mmol) in 5 ml of dry methanol a catalytic amount of CAN was added. After stirring for 5 h (tlc-control) the mixture was filtered through cotton-wool and

evaporated in vacuo. Purification by column chromatography (petroleum ether/ether: 1:2), yield 260 mg **6b** (81 %), colorless crystals from ether, mp 164-165 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.58 - 7.40 (1H, m, arom. H), 7.33 - 6.88 (6H, m, arom. H), 6.60 (1H, dd, J = 7.7 Hz, J = 1.2 Hz, arom. H), 5.27 (1H, d, J = 4.6 Hz, 2-H), 4.36 - 4.03 (3H, m, 3-H, 4-H, OH), 3.79 (3H, s, OCH_3), 2.33 (3H, s, p-CH_3); ^{13}C-nmr ($CDCl_3$ + methanol-d_4, 20.12 MHz): δ (ppm) = 169.9 (C=O), 141.8, 134.9, 130.0, 129.1, 128.7*, 128.6*, 127.4, 126.0, 125.9, 124.9 (arom. C), 116.8 (CN), 79.1, 74.4 (4-C, 3-C), 59.7 (OCH_3), 49.0 (2-C), 21.3 (p-CH_3); ir: 1630 cm^{-1} (ν_{amide}); ms (m/z) 322 (M^+). Anal. Calcd for $C_{19}H_{18}N_2O_3$: C, 70.79; H, 5.62; N, 8.69. Found: C, 70.57; H, 5.64; N, 8.58.

(2*SR*, 3*SR*, 4*SR*)-4-Acetoxy-2-cyano-3-hydroxy-1-toluoyl-1,2,3,4-tetrahydroquinoline (6c)

To a suspension of **4** (290 mg, 1 mmol) in 10 ml of acetic acid a catalytic amount of CAN was added. After stirring overnight at room temperature the solvent was evaporated in vacuo and reevaporated with chloroform (3 x). Purification of the residue by column chromatography (petroleum ether/ether: 1:3), yield 200 mg **6c** (57%), colorless crystals from chloroform/ether, mp 186 - 188 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.43 - 6.92 (7H, m, arom. H), 6.78 - 6.58 (1H, m, arom. H), 5.91 (1H, d, J = 5.3 Hz, 4-H), 5.57 (1H, d, J = 3.7 Hz, 2-H), 4.44 - 4.22 (1H, m, 3-H), 4.03 (1H, d, OH, exchangeable), 2.35, 2.27 (3H, 3H, s, s, p-CH_3, acetyl-CH_3); ^{13}C-nmr (DMSO-d_6, 20.12 MHz): δ (ppm) = 169.7* (C=O), 141.3, 135.5, 131.2, 128.8**, 128.2*, 125.6, 125.5, 125.0 (arom. C), 116.9 (CN), 70.6, 69.3 (4-C, 3-C), 48.0 (2-C), 20.9, 20.8 (p-CH_3, acetyl-CH_3); ir: 1745 (ν_{ester}), 1660 cm^{-1} (ν_{amide}); ms (m/z) 350 (M^+). Anal. Calcd for $C_{20}H_{18}N_2O_4$: C, 68.56; H, 5.17; N, 7.99. Found: C, 68.44; H, 4.89; N, 7.79.

(2*SR*, 3*SR*, 4*SR*)-2-Cyano-3-hydroxy-1-toluoyl-1,2,3,4-tetrahydroquinoline-4-nitrate (6d)

To a suspension of **4** (290 mg, 1 mmol) in 10 ml of dry acetonitrile CAN (660 mg, 1.2 mmol) was added. After stirring at room temperature for 30 min the solution was diluted with water and extracted with ethyl acetate (3 x). The combined organic fractions were washed with brine, dried over sodium sulfate and evaporated in vacuo. Purification of the residue by column chromatography (petroleum ether/ether: 1:2), yield 160 mg **6d** (45%) as yellowish solid,

colorless crystals from ether, mp 164 - 166 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.55 - 6.90 (7H, m, arom. H), 6.80 - 6.60 (1H, m, arom. H), 5.99 (1H, d, *J* = 4.4 Hz, 4-H), 5.58 (1H, d, *J* = 3.9 Hz, 2-H), 4.53 - 4.30 (1H, m, 3-H, after D_2O-exchange: t, *J* = 3.9 Hz), 3.95 (1H, d, *J* = 4.9 Hz, OH, exchangeable), 2.35 (3H, s, *p*-CH_3); ^{13}C-nmr (DMSO-d_6, 20.12 MHz): δ (ppm) = 170.0 (C=O), 141.4, 136.1, 131.2, 130.5, 129.2, 128.9*, 128.8*, 125.5, 125.1, 120.3 (arom. C), 116.1 (CN), 77.8, 67.8 (4-C, 3-C), 47.2 (2-C), 21.0 (*p*-CH_3); ir: 1665, 1630 (ν_{amide}, ν_{asNO_2}), 1270 cm^{-1} (ν_{syNO_2}); ms (m/z) 353 (M^+). Anal. Calcd for $C_{18}H_{15}N_3O_5$: C, 61.18; H, 4.27; N, 11.89. Found: C, 61.41; H, 4.46; N, 11.71.

(2*SR*, 3*SR*, 4*SR*)-4-Benzyloxy-3-hydroxy-2-methyl-1-toluoyl-1,2,3,4-tetrahydroquinoline (7)

To a stirred solution of **3** (560 mg, 2 mmol) in 5 ml of dry acetonitrile and 0.5 ml of benzyl alcohol a catalytic amount of CAN was added. After stirring for 3 h further 0.5 ml of benzyl alcohol and a catalytic amount of CAN were added. The mixture was stirred overnight, diluted with water and extracted with dichloromethane (3 x). The collected organic fractions were washed with water, dried over sodium sulfate and evaporated in vacuo. Purification of the residue by column chromatography (petroleum ether/ether: 1:1), yield 490 mg **7** (63%) as yellowish solid, colorless crystals from ether, mp 143 - 145 °C; ^{1}H-nmr (80 MHz): δ ppm) = 7.58 - 6.79 (12H, m, arom. H), 6.63 - 6.45 (1H, m, arom. H), 4.96 (2H, d, *J* = 2.6 Hz, benzyl. H), 4.80 - 4.38 (2H, m, 2-H, 4-H), 3.69 - 3. 41 (1H, m, 3-H, after D_2O-exchange: dd, *J* = 7.8 Hz, *J* = 4.9 Hz), 2.74 (1H, d, *J* = 3.9 Hz, OH, exchangeable), 2.29 (3H, s, *p*-CH_3), 1.29 (3H, d, *J* = 6.7 Hz, 2-CH_3); ^{13}C-nmr (75 MHz): δ (ppm) = 169.6 (C=O), 140.5, 137.9, 136.6, 132.6, 130.8, 128.9*, 128.6*, 128.5*, 128.0, 127.9*, 127.1, 126.3, 125.3, 125.1 (arom. C), 79.1, 78.9, 73.9 (3-C, 4-C, benzyl. C), 55.1 (2-C), 21.4 (*p*-CH_3), 18.5 (2-CH_3); ir: 1620 (ν_{amide}), 1070 cm^{-1} (ν_{C-O-C}); ms (m/z) 387 (M^+). Anal. Calcd for $C_{25}H_{25}NO_3$: C, 77.49; H, 6.50; N, 3.61. Found: C, 77.28; H, 6.52; N, 3.55.

(2*SR*, 3*SR*, 4*SR*)-4-Benzyloxy-2-methyl-1-toluoyl-3-tosyloxy-1,2,3,4-tetrahydroquinoline (8)

To an ice-cooled mixture of **7** (770 mg, 2 mmol) and *p*-toluenesulphonyl chloride (1.53 g, 8 mmol) in 5 ml of dichloromethane 3 ml of pyridine were added with stirring. After reaction at

room temperature overnight the mixture was diluted with water, stirred for 10 min and then acidified with 6N HCl. The aqueous phase was extracted with dichloromethane (3 x), the combined organic layers were washed with 2N HCl (2 x) and 2N sodium carbonate (2 x), dried over sodium sulfate and evaporated. Spontaneously crystallizing oil, colorless crystals from ether, mp 125-127 °C; additional purification of the mother liquor by column chromatography (petroleum ether/ether: 1:2), total yield 990 mg **8** (92 %); ^{1}H-nmr (80 MHz): δ (ppm) = 7.80 (2H, d, J = 8.0 Hz, arom. H), 7.50 - 6.90 (14H, m, arom. H), 6.68 - 6.52 (1H, m, arom. H), 5.10 - 4.60 (3H, m, 2-H, 3-H, 4-H), 4.82 (2H, s, benzyl. H), 2.40, 2.30 (3H, 3H, s, s, p-CH_3), 1.15 (3H, d, J = 6.9 Hz, 2-CH_3); ^{13}C-nmr (75 MHz): δ (ppm) = 169.8 (C=O), 144.8, 140.7, 137.5, 136.2, 133.8, 132.5, 129.8*, 128.8*, 128.7*, 128.4*, 128.1*, 127.9, 127.8*, 127.7, 127.6, 127.5, 125.8, 125.1 (arom. C), 84.1, 75.1, 73.1 (4-C, 3-C, benzyl. C), 52.3 (2-C), 21.4, 21.3 (p-CH_3), 16.5 (2-CH_3); ir: 1645 (ν_{amide}), 1370, 1340, 1190, 1180 cm^{-1} ($\nu_{SO_2\text{-}O}$); ms (m/z) = 541 (M^+). Anal. Calcd for $C_{32}H_{31}NO_5S$: C, 70.96; H, 5.77; N, 2.59; S, 5.92. Found: C, 71.20; H, 5.84; N, 2.59; S, 5.74.

(2*SR*, 3*SR*, 4*SR*)-4-Hydroxy-2-methyl-1-toluoyl-3-tosyloxy-1,2,3,4-tetrahydroquinoline (9)

A solution of **8** (1.08 g, 2 mmol) in 12 ml of acetic acid and 100 mg of Pd/C (10 %) were hydrogenated at 80 °C over night. The catalyst was filtered off over Celite and the solvent was evaporated. The residue was partitioned between water and dichloromethane (3 x), the combined organic layers were dried over sodium sulfate and evaporated. Purification by column chromatography (petroleum ether/ether: 1:2), yield 240 mg **9** (27 %), colorless crystals from ether/petrolether, mp 140 - 142 °C; ^{1}H-nmr (80 MHz): δ (ppm) = 7.98 - 6.82 (11H, m, arom. H), 6.50 (1H, d, J = 7.7 Hz, arom. H), 5.10 - 4.60 (2H, m, 4-H, 2-H), 4.40 (1H, dd, J = 7.9 Hz, J = 3.4 Hz, 3-H), 3.35 (1H, d, J = 3.5 Hz, OH, exchangeable), 2.45, 2.30 (3H, 3H, s, s, p-CH_3), 1.08 (3H, d, J = 6.9 Hz, 2-CH_3); ^{13}C-nmr (75 MHz): δ (ppm) = 169.1 (C=O), 145.5, 141.0, 136.4, 133.1, 131.9, 130.0*, 129.6, 128.9*, 128.7*, 128.0*, 127.6, 125.8*, 125.3 (arom. C), 89.3, 69.1 (4-C, 3-C), 53.1 (2-C), 21.7, 21.4 (p-CH_3), 18.3 (2-CH_3); ir: 1625 (ν_{amide}), 1390, 1360, 1190, 1180 cm^{-1} ($\nu_{SO_2\text{-}O}$); ms (m/z) = 451 (M^+). Anal. Calcd for $C_{25}H_{25}NO_5S$: C, 66.50; H, 5.58; N, 3.10; Found: C, 66.34; H, 5.54; N, 2.92.

(2*SR*, 3*RS*, 4*SR*)-3,4-Epoxy-2-methyl-1-toluoyl-1,2,3,4-tetrahydroquinoline (10)

To a stirred solution of **9** (450 mg, 1 mmol) in 4 ml of dry methanol a pellet of potassium hydroxide was added. After 5 min (tlc-control) the solvent was evaporated at low temperature. The residue was partitioned between water and dichloromethane (3 x), the organic layers were dried over sodium sulfate and evaporated. Purification by column chromatography (petroleum ether/ether: 1:2), yield 220 mg **10** (78 %) as yellowish solid, colorless crystals from ether, mp 146 - 148 °C; ^{1}H-nmr (300 MHz): δ (ppm) = 7.47 (1H, dd, *J* = 7.5 Hz, *J* = 1.5 Hz, arom. H), 7.22 - 6.82 (6H, m, arom. H), 6.44 (1H, d, *J* = 8.1 Hz, arom. H), 5.25 (1H, quint, *J* = 6.7 Hz, 2-H), 3.90 (1H, d, *J* = 4.2 Hz, 4-H), 3.84 (1H, dd, *J* = 6.3 Hz, *J* = 4.2 Hz, 3-H), 2.26 (3H, s, *p*-CH_3), 1.19 (3H, d, *J* = 7.1 Hz, 2-CH_3); ^{13}C-nmr (75 MHz): δ (ppm) = 169.6 (C=O), 140.8, 137.1, 132.5, 130.6, 129.2*, 128.7*, 128.5, 126.7, 125.5, 125.0 (arom. C), 52.7, 49.8, 48.5 (4-C, 3-C, 2-C), 21.4 (*p*-CH_3), 15.0 (2-CH_3); ir: 1645 cm^{-1} (ν_{amide}); ms (m/z) = 279 (M^+): Anal. Calcd for $C_{18}H_{17}NO_2$: C: 77.40; H, 6.13; N, 5.01. Found: C, 77.21; H, 5.97, N, 4.84.

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