Enantioselective Synthesis of Optically Active Pyridine Derivatives and C_2-Symmetric 2,2′-Bipyridines

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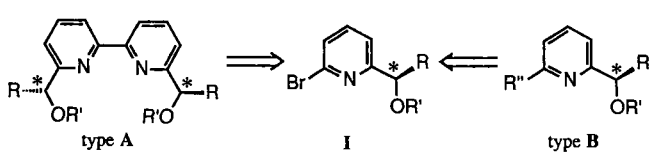
Optically active pyridine derivatives **2**, **15**, **18**, **19**, **21**, **26**, and **27** are obtained by enantioselective reduction of the corresponding ketones **5**, **7**, **11**–**13**, **24**, and **25** using the chiral borane reagent chlorodiisopinocampheylborane [$(Ipc)_2BCl$]. Nickel(0)-mediated coupling of bromopyridines **2**, **15**, and **31** gives C_2-symmetric 2,2′-bipyridines (*R,R*)-**32**, (*R,R*)-**33**, and (*S,S*)-**38**, respectively, which form metal complexes with Co^{II}, Pd^{II}, Cu^{I}, and Ag^{I}. Aryl-substituted pyridines **26**, and **39**–**41** are synthesized by palladium(0)-catalyzed cross couplings of **2** and **15** with boronic acids **42**–**44**.

The structure and electronic properties of chiral ligands govern reactions of metal complexes in asymmetric catalysis. An ideal asymmetric environment at the catalytically active metal center together with suitable kinetics is required to achieve an effective stereoselective catalysis with high turnover numbers[1]. Structural modifications of chiral mono- and bidentate phosphanes have led to the development of excellent transition-metal complexes for several highly enantioselective transformations. More recently, nitrogen-containing chelating ligands are gaining increasing importance[2] because many of them can be easily synthesized in enantiopure form by using starting materials from the "chiral pool"[3]. In contrast to the great number of structural investigations of 2,2′-bipyridine metal complexes[4], the syntheses and uses of complexes of chiral 2,2′-bipyridine derivatives have been neglected. This is even more surprising since metal complexes containing nitrogen-coordinating ligands such as 2,2′-bipyridines have been successfully employed for ketone hydrogenations and epoxidations[5]. Only a few optically active compounds of this class of substrates have been described and tested in asymmetric catalysis with moderate success[6].

Recently, we described the syntheses of enantiopure C_2-symmetric 2,2′-bipyridines bearing chelating sidechains[7] or annulated heterocyclic rings[8] with the intention of reducing conformational flexibility. The presence of a two-fold axis of symmetry was expected to reduce the number of possible diastereomeric conformations in the stereodetermining step[9]. Some of these compounds were successfully employed in enantioselective catalysis to give optically active products with high e.e.'s[10].

In this article we give a detailed account of the preparative results obtained in the syntheses of C_2-symmetric 2,2′-bipyridines (type **A**) and substituted pyridine derivatives (type **B**, including regioisomers of **B**). The following papers describe the use of these compounds in the catalyzed enantioselective addition of dialkylzinc compounds to aldehydes[11] and in the nickel-catalyzed asymmetric conjugate addition of organozinc compounds to enones[12].

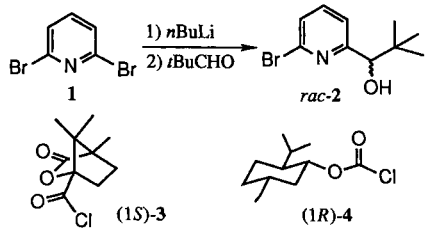


R = alkyl, R' = H, alkyl, ester, R'' = H, aryl, alkynyl

Since rational ligand design is still far from being attained, we envisaged a synthetic strategy that allowed various chemical modifications of ligand structures. Optically active bromopyridines of type **I** became the key intermediates from which C_2-symmetric 2,2′-bipyridines (type **A**) could be obtained by metal-mediated homocouplings. Pyridines of type **B** could be synthesized from **I** by metal-catalyzed cross-coupling reactions with various organometallic compounds.

Enantioselective Synthesis of I

We started our investigations with the synthesis of **2** which we intended to resolve by chromatographic separation of intermediate diastereomers or selective crystallization of a diastereomeric salt. Monolithiation of commercially available 2,6-dibromopyridine (**1**) with *n*-butyllithium in ether followed by trapping with pivalaldehyde gave *rac*-**2** in 85% yield. Separation of the diastereomeric esters and carbonates derived from (1*S*)-camphanoyl chloride [(1*S*)-**3**] and (−)-[(1*R*)-menthyl chloroformate] [(1*R*)-**4**], respectively, by preparative-scale column chromatography on silica gel proved to be impractical due to poor resolution. However, the camphanic acid esters served as valuable tools for the determination of the optical purities of **2** and analogous compounds by ^{1}H-NMR spectroscopy and HPLC (vide infra). No crystallization of the dibenzoyltartrate of **2** was observed.



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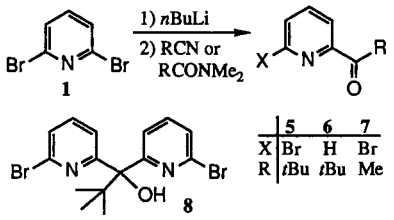
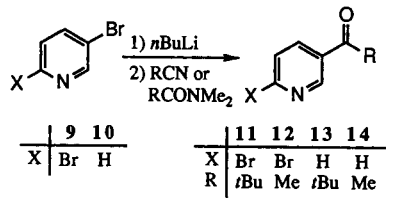
Next, we turned our attention to the *enantioselective* preparation of **2**. In 1986, Brown et al. described the use of chlorodiisopinocampheylborane [$(Ipc)_2BCl$] for asymmetric reductions of prochiral aromatic ketones[13]. α-Tertiary alkyl ketones were successfully reduced with very high enantioselectivities (e.e. >90%). Based on these reports, we intended to use this now commercially available reagent[14] for the enantioselective reduction of pyridyl ketones. 2,6-Disubstituted compounds **5** and **7** were synthesized in 88 and 70% yields, respectively, by metal-halogen exchange of **1** with *n*-butyllithium in ether[15,16] followed by treatment with pivalonitrile or *N*,*N*-dimethylacetamide[16a].

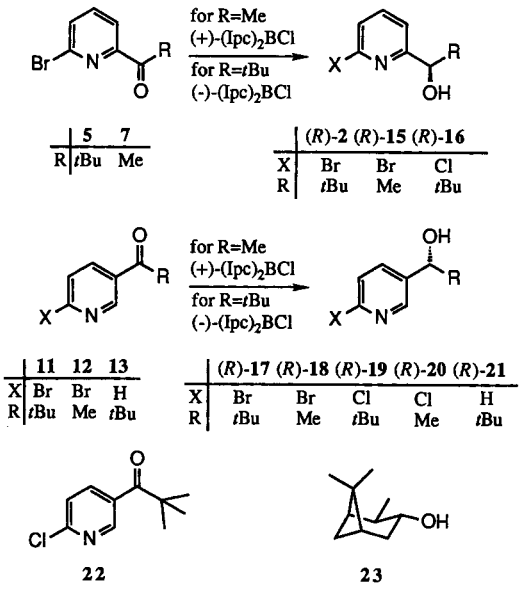


Trapping the intermediate 6-bromo-2-pyridyllithium with methyl pivalate reduced the yield of **5** to 58% and gave **8** as the major byproduct. In THF, lithiation was less selective, and **6**, together with **1** and **5**, was identified by ^{1}H-NMR spectroscopy and TLC. Alternatively, **5** was prepared by oxidation of **2** with pyridinium chlorochromate (PCC) in 73% yield.

2,5-Disubstituted bromopyridyl ketones were synthesized analogously by selective lithiation of **9**. In contrast to the described procedure[17], selective monolithiation was observed in diethyl ether, but not in THF. In ether, the desired products **11** and **12** were obtained in good yields (**11**: 71%; **12**: 83%) whereas THF solutions gave product mixtures. **13** was analogously synthesized from 3-bromopyridine (**10**).



Asymmetric reductions were performed with either (+)- or (−)-$(Ipc)_2BCl$. The optical purities of the products were analyzed by HPLC using a chiral stationary phase or ^{1}H-NMR spectroscopy of diastereomeric derivatives (vide infra). In all cases investigated, the enantiomeric excesses of the bromopyridyl alcohols were ≥90% (Table 1). The extent of asymmetric induction was independent of the substitution pattern (2,5- or 2,6-positions). Methyl and *tert*-butyl ketones were reduced with almost the same enantiomeric excess. Reduction of *tert*-butyl ketone **5** at room temperature by (−)-$(Ipc)_2BCl$ gave predominantly the (*R*)-configurated product (*R*)-**2** [(*R*)-**2**:(*S*)-**2** ≥ 95:5]. Neither the use of THF nor the amount of $(Ipc)_2BCl$ had a major influence on the asymmetric induction. At 40°C, the enantiomeric excess of **2** decreased to 86%. The same reducing reagent gave the (*S*) enantiomers from methyl ketones **7** and **12**. (*S*)-**15** and (*R*)-**18** were obtained with >90% e.e. by using (−)-$(Ipc)_2BCl$ and (+)-$(Ipc)_2BCl$, respectively. These results are in accordance with the general selectivity rules described by Brown et al. for the asymmetric reduction of aromatic ketones[13]. The optical purities of **2** and **15** were easily raised by a single recrystallization of the corresponding camphanic acid esters followed by hydrolysis under basic conditions to give both alcohols with e.e.'s >99%.



In order to obtain high enantioselectivities in the asymmetric reduction, THF solutions of methyl ketones **7** and **12** had to be cooled below −15°C before the addition of $(Ipc)_2BCl$. Slow warming to room temperature and stirring for a few hours gave the desired alcohols. The asymmetric reduction of the sterically more hindered *tert*-butyl ketones required much longer reactions times. Stirring at room temperature for 1 to 9 days without solvent or in concentrated THF solutions was essential for these reductions.

Table 1. Asymmetric reduction of pyridyl ketones by using $(Ipc)_2BCl$

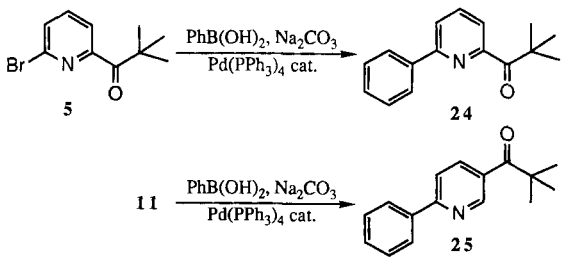
Ketone	Position of substitution	X	R	Alcohol	Enantiomer of borane	Yield (%)	Ratio of (*R*):(*S*)
5	2,6	Br	*t*Bu	**2**	(−)	ca. 61%[a]	95:5[b]
7	2,6	Br	Me	**15**	(−)	85%	4:96[c,d]
11	2,5	Br	*t*Bu	**19**	(−)	32%[e]	91:9[b,c,f]
12	2,5	Br	Me	**18**	(+)	ca. 88%[a]	96:4[c]
13	3	H	*t*Bu	**21**	(+)	34%	7:93[b,f]
14	3	H	Me	**30**	(−)	65%	4:96[g]
24	2,6	Ph	*t*Bu	**26**	(−)	62%	93:7[c]
25	2,5	Ph	*t*Bu	**27**	(−)	75%	93:7[c,f]

[a] Contained the corresponding chloropyridine (see Experimental). — [b] Determined by ^{1}H-NMR spectroscopy of the corresponding camphanic acid esters. — [c] Determined by HPLC (Chiralcel OD). — [d] Determined by ^{1}H-NMR spectroscopy of the corresponding MTPA esters. — [e] Obtained as chloropyridine **19**. — [f] Absolute configuration deduced from ^{1}H-NMR shift correlations (see text). — [g] Ref.[13].

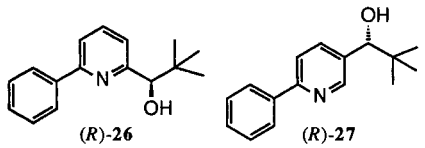
Depending on reaction time and temperature, the chromatographically homogeneous alcohols contained various amounts of inseparable chloropyridines which were identified by means of spectroscopy (MS, NMR). For example, reduction of **5** at room temperature for 23 h without solvent gave **2** and **16** in a ratio of approximately 94:6[18]. Stirring at room temperature for 4 days (THF solution) or at higher temperature for ca. 12 h (40°C, neat) led to a substantial increase in the formation of **16** (ratio **2**:**16** = 83:17 and 71:29, respectively; analyzed by ^{1}H-NMR spectroscopy of the crude samples and camphanic acid esters). Neither the addition of a sterically hindered base (2,6-di-*tert*-butylpyridine; trap for traces of HCl) nor the use of toluene (radical trap) had a major influence on the formation of **16**. Tetrabutylammonium bromide inhibited the reduction. Halogen exchange became the major sidereaction in the reduction of 2,5-disubstituted bromopyridyl ketones **11** and **12**. After stirring a mixture of **11** and $(Ipc)_2BCl$ in THF for 21 h at room temperature, ca. 50% of **11** was transformed into chloropyridyl ketone **22**. Only traces of the corresponding reduction products **17** and **19** were identified in the crude product mixture. After 9 days at room temperature, only chlorinated compounds **19** and **22** were isolated by chromatography in low yields[19,20]. The enantiomeric excess of **19** (82% e.e.) was slightly lower than the optical purities of comparable bromopyridines. Analysis by mass spectrometry and HPLC of a chromatograpically homogeneous sample of **19** revealed the presence of small amounts of the desired alcohol **17**. The reduction of methylpyridyl ketone **12** proceeded significantly faster than halogen exchange. Only 8–15% of chlorinated compound **20** was detected by MS and NMR spectroscopy in chromatographically homogeneous samples of the desired alcohol **18**.

Isopinocampheol (**23**) was identified as another major byproduct of the asymmetric reduction using $(Ipc)_2BCl$. **23** was separated from the product mixture by careful chromatography. Since **23** was not present in the reducing reagent (^{1}H-NMR analysis), it might have been formed by air oxidation during the workup which involved the addition of diethanolamine/ether for borane removal. In the crude product mixture, the amount of **23** appeared to increase upon standing in air. Additional **23** was formed during the chromatographical purification of the desired alcohols.

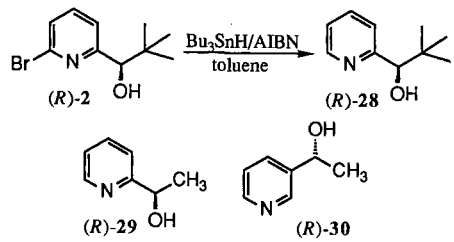
In the synthesis of 2,2′-bipyridines of type **A** by metal-mediated homocouplings, the presence of small amounts of chloropyridines is tolerated[21]. In contrast, in the palladium-catalyzed cross couplings chlorinated substrates are much less reactive[22]. For that reason, we decided to examine the asymmetric reduction of ketones **24** and **25**, which were obtained in good yields by tetrakis(triphenylphosphane)palladium(0)-catalyzed couplings of **5** and **11**, respectively, with phenylboronic acid (vide infra)[23].



Enantioselective reductions of **24** and **25** gave both of the desired alcohols **26** and **27** with 86% e.e. In comparison to the reductions of the analogous bromopyridines, these enantioselectivities are slightly lower (Table 1).



The absolute product configurations were determined by correlation with known alcohols. (*R*)-**28**, (*R*)-**29**, and (*R*)-**30** were obtained by radical debromination of the corresponding bromopyridines (*R*)-**2**, (*R*)-**15**, and (*R*)-**18**, respectively, using Bu_3SnH/AIBN in toluene.

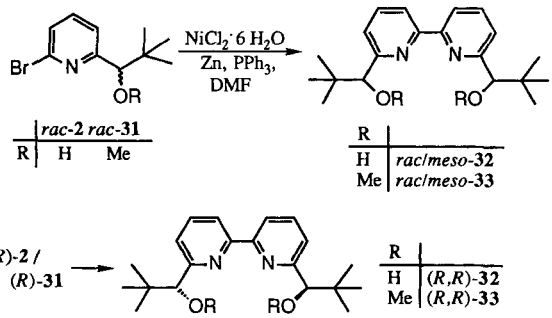


Alcohols **19** and **27** could not be unambigously correlated with known compounds and crystals obtained from the corresponding camphanic acid esters were unsuitable for X-ray diffraction analysis. According to a chemical shift correlation of ^{1}H-NMR signals of the camphanates (Table 2, vide infra), **19** and **27** are believed to have the (*R*) configuration when obtained by reduction with (−)-$(Ipc)_2BCl$. This assignment is in agreement with the selectivity rules for the asymmetric reduction of *tert*-butyl ketones described above.

Synthesis and Complexation of 2,2′-Bipyridines of Type A

Optically active C_2-symmetric 2,2′-bipyridines of type **A** were synthesized by nickel(0)-mediated homocoupling of **1**. Two diastereomers, *rac*-**32** and *meso*-**32**, were obtained from *rac*-**2** in a ratio of approximately 1:1[24]. No protection of the hydroxy groups was required.

rac-**32** and *meso*-**32** were separated by chromatography and have almost identical ^{1}H- (400 MHz) and ^{13}C-NMR (75



MHz) spectra. Debrominated compound **28** was the major byproduct of the coupling reaction. Its formation could be substantially reduced by using carefully degassed DMF solutions.

Enantiomerically pure (*R,R*)-**32** was obtained in 50–60% yield by coupling of (*R*)-**2**. It was shown by ^{1}H-NMR spectroscopy of the corresponding camphanic acid diesters (e.e. determination, vide infra) that the chromatographically purified sample of (*R,R*)-**32** was an enantiomerically pure compound. A diastereomer derived from (*S,S*)-**32** could not be detected. Thus, the coupling of two chiral molecules of high e.e. [(*R*)-**2**:(*S*)-**2** = 95:5] led to a large enantiomeric enrichment of the major product[25].

The analogous 2,2′-bipyridine **33** was prepared similarly by homocoupling of methyl ether **31**. Reaction of *rac*-**31** also gave two diastereomers (*meso*-**33** and *rac*-**33**) in a ratio of ca. 1:1 which were separated by chromatography. Optically active (*R,R*)-**33** was synthesized from (*R*)-**31** in 65% yield.

From the characteristic downfield shift of the NMR signals of the 3,3′-positions [δ = 8.31 for (*R,R*)-**32**; δ = 8.26 for (*R,R*)-**33**], a *transoid* arrangement of the nitrogen atoms must be assumed in solution[26]. Single-crystal X-ray analysis[27] of C_2-symmetric 2,2′-bipyridine (*R,R*)-**32** confirmed this conformation in the solid state (Figure 1). Rotation around the $C_{pyridine}-C_{substituent}$ bond allows the *tert*-butyl groups to be as distant as possible from the rest of the molecule. The angle between the two pyridine units of the bipyridine is 6.2°.

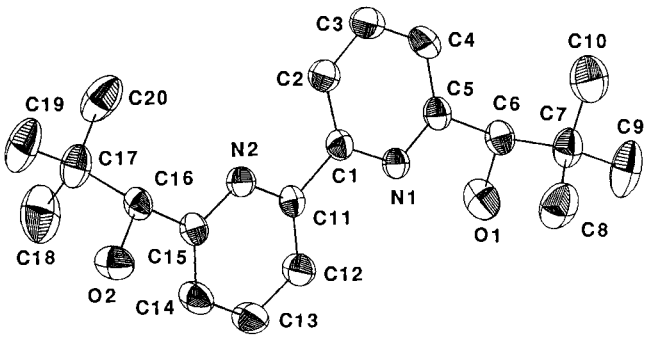
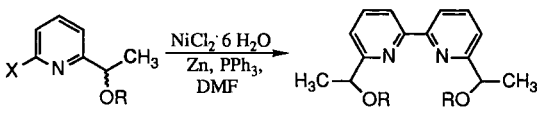


Figure 1. Molecular structure of (*R,R*)-**32** (ORTEP, 50% probability ellipsoids, with atomic numbering; H atoms omitted for clarity)

Next we focused on the synthesis of 2,2′-bipyridine **38**. Application of the same reaction conditions as described above, and attempts to homocouple **15**, trimethylsilyl ether **34**, or the corresponding camphanate, led to complete decomposition of the starting materials. Only large quantities of triphenylphosphane oxide were isolated by chromatography.

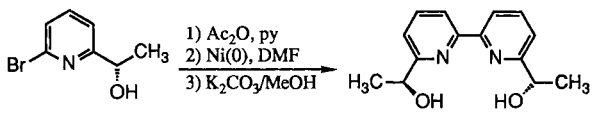


	15	34	35	36
X	Br	Br	Br	H
R	H	$SiMe_3$	Ac	Ac

R	
Ac	*rac/meso*-**37**
H	*rac/meso*-**38**

Protection of the hydroxy group of **15** by using acetic anhydride gave acetate **35** in 89% yield. Nickel-mediated homocoupling of **35** under standard reaction conditions ($NiCl_2 \cdot 6\ H_2O$, Zn, PPh_3, DMF) furnished diacetate **37** together with debrominated acetate **36**. Separation by flash chromatography afforded 2,2′-bipyridine **37** in 39% yield. Even by use of carefully degassed DMF solutions, the formation of **36** could not be suppressed. Deprotection of **37** under basic conditions (K_2CO_3, methanol) gave **38** in 91% yield. Alternatively, mixtures of **36** and **38** were deprotected under the same conditions, and pure 2,2′-bipyridine **38** was obtained by a single recrystallization of the resulting crude product from hexane.

According to this reaction sequence, *rac*-**15** was converted into two diastereomers of **38** [*rac*-**38** and *meso*-**38**] in a ratio of ca. 1:1 which exhibited identical ^{1}H- and ^{13}C-NMR spectra. *rac*-**38** and *meso*-**38** were not separable and had to be identified and distinguished by ^{1}H-NMR spectroscopy of their MTPA diesters (vide infra). By using (*S*)-**15** of 92% e.e. we obtained a mixture of (*S,S*)-**38** and *meso*-**38** in a ratio of 92:8. No (*R,R*)-**38** was detected by ^{1}H-NMR spectroscopy of the MTPA diesters. Recrystallization from hexane/ethyl acetate did not enrich the major diastereomer (Δ d.e. <2%). In order to avoid the formation of *meso*-**38**, the e.e. of bromopyridine (*S*)-**15** (92%) had to be increased. Recrystallization of the corresponding camphanic acid ester followed by saponification gave (*S*)-**15** with >99% e.e. Enantiomerically pure (*S,S*)-**38** was obtained by protection of (*S*)-**15** (>99% e.e.) with acetic anhydride followed by nickel(0)-mediated coupling of the acetate and diester hydrolysis. The absence of *meso*-**38** and (*R,R*)-**38** was proven by ^{1}H-NMR spectroscopy of the MTPA diesters. No other diastereomer was detected.



(*S*)-**15** (*S,S*)-**38** (e.e. >99%)

The chelating ability of 2,2′-bipyridine ligands as well as the stability of their coordination compounds is strongly influenced by substitution of the 6,6′-positions[28]. In order to investigate the structures and coordination behavior of these sterically hindered 2,2′-bipyridines, (*R,R*)-**33** was treated with one equivalent of cobalt dichloride hexahydrate in acetonitrile/methanol. A blue crystalline complex was isolated which could be recrystallized from toluene. Single-crystal X-ray diffraction analysis confirmed the ligand-to-cobalt ratio of 1:1 and the C_2 symmetry of the metal complex[7,27]. The cobalt atom exhibits a distorted tetrahedral coordination geometry and is surrounded by the two pyridine nitrogen atoms and the two chlorine atoms. The dihedral angle between the N–Co–N′ and the Cl–Co–Cl′ planes is –99.6° indicating the steric requirements of the *tert*-butyl groups. The enlargement of the angle between the pyridine units of the bipyridine to 13.0°[29] is presumably due to the

same reason. No coordinative binding of the ether oxygen atoms to the metal atom as found in $CoCl_2$ complexes with 2,2'-bipyridine crown ethers[30] is observed.

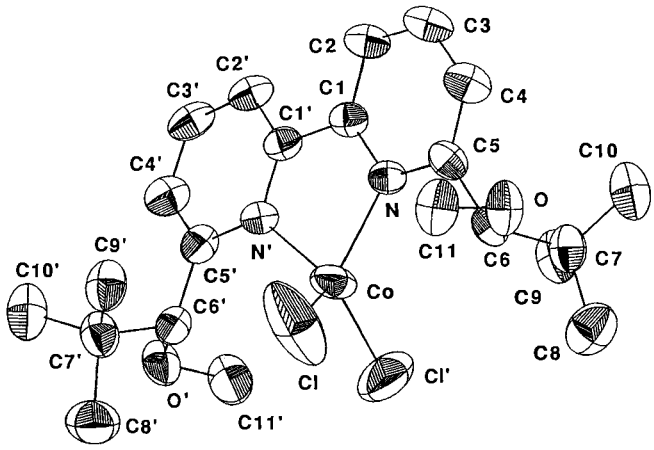


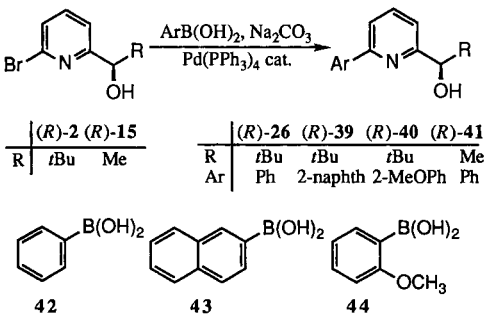
Figure 2. Molecular structure of (*R,R*)-**33** · $CoCl_2$ (ORTEP, 50% probability ellipsoids, with atomic numbering; H atoms omitted for clarity)

In 1980 Newkome et al. reported that certain palladium complexes had the ability to nick supercoiled DNA at low concentrations[31]. Triggered by these observations, we attempted to prepare a palladium complex of 2,2'-bipyridine **33**. When a hot solution of (*R,R*)-**33** in methanol was added to a solution of $PdCl_2$ in dilute HCl, brown crystals having the composition **33** · $PdCl_2$ · HCl were isolated. Surprisingly, the expected upfield shift of the signals for the 3,3'-protons in the ^{1}H-NMR spectrum of the complex (400 MHz, [D_3]acetonitrile) indicating the *syn* orientation of the pyridyl moiety[26] was not observed [for 3,3'-protons: (*R,R*)-**33**: δ = 8.29; after addition of $PdCl_2$: δ = 8.46]. Addition of silver or copper triflate to a solution of (*R,R*)-**33** in [D_3]acetonitrile caused a chemical shift change in the ^{1}H-NMR spectrum, but again, no upfield shift for the *anti*-to-*syn*-conformational change was observed. When a solution of (*S,S*)-**32** or (*S,S*)-**38** in [D_3]acetonitrile was treated with $CuBF_4$ · $(CH_3CN)_4$, the signals of the 3,3'-protons shifted slightly upfield [e.g.: (*S,S*)-**32**: δ = 8.36; after addition of $CuBF_4$ · $(CH_3CN)_4$: δ = 8.18][32]. After evaporation of the solvent, fragments of [**32** · Cu + 1^+] and [**32** · Cu^+] were detected by FAB-MS of the residue.

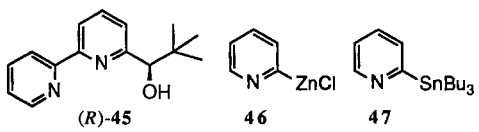
Optically pure (*S,S*)-**38** was used by Lehn et al. for the synthesis of chiral tris- and pentakisbipyridine strands which readily formed double helicate Cu^I and Ag^I complexes[33a]. This self-organizing process occurred with high helicity induction leading to the preferential generation of a right-handed double helicate.

Synthesis of Pyridines of Type B

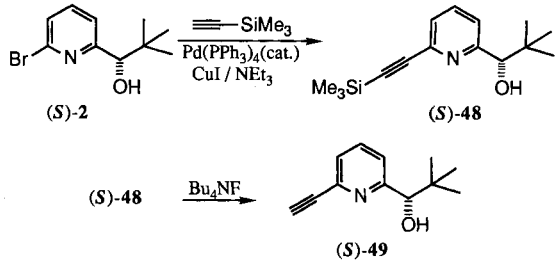
Palladium- and nickel-catalyzed cross-coupling reactions have been widely used for the synthesis of substituted aromatic compounds[22,23]. The mild reaction conditions allow chemical transformations without the necessity of protecting sensitive functional groups. 2,6-Disubstituted arylpyridines **26** and **39**–**41** were prepared by palladium(0)-catalyzed cross couplings of bromopyridines **2** and **15**, respectively with the corresponding arylboronic acids **42**–**44** (Suzuki conditions)[23]. No protection of the hydroxy group was required. Phenyl-substituted ketones **24** and **25** (vide supra) and arylated derivatives derived from 2,5-disubstituted bromopyridine **18**[35] were also synthesized in good yields. Small amounts of chloropyridines did not interfere with the coupling process, and they were easily removed by column chromatography. Whereas phenylboronic acid (**42**) was commercially available, 2-naphthylboronic acid (**43**) and 2-methoxyphenylboronic acid (**44**) were prepared by standard synthetic methods[34]. Metal-halogen exchange of the corresponding aryl bromide by using *n*-butyllithium followed by addition of trimethoxyborane and acidic workup gave **43** and **44** in ca. 60% yield.



The preparation of monosubstituted 2,2'-bipyridine **45** was accomplished by cross coupling of **2** with 2-pyridylzinc chloride (**46**) or tributyl-2-pyridylstannane (**47**) using catalytic amounts of tetrakis(triphenylphosphane)palladium(0). Both metalated pyridines **46** and **47** were obtained from 2-bromopyridine by lithium-halogen exchange followed by transmetalation with $ZnCl_2$ or tributyltin chloride[36,37], respectively.



Palladium catalysis was also applied to the transformation of **2** into acetylene **49**. The reaction of **2** with 4 equivalents of trimethylsilylacetylene was catalyzed by a mixture of $Pd(PPh_3)$/CuI in triethylamine. Desilylation of **48** by using Bu_4NF in THF gave **49** in an overall yield of 70%.



In the cross coupling of optically active bromopyridines, no racemization of the chiral center was observed for any of the compounds. The corresponding arylated pyridines were obtained without significant change in e.e. Subsequently, the optical purities of the products were easily raised by recrystallization of the corresponding camphanic acid esters followed by hydrolysis under basic conditions. By this reaction sequence, the enantiomeric excess of arylpyridine (*R*)-**26** was increased from 90 to >99% e.e. [alternatively, this compound was prepared by palladium-catalyzed coupling of enantiopure bromopyridine (*R*)-**2** with **42**]. **39** was enantiomerically enriched by chromatography of the corresponding camphanates followed by saponification, and (*S*)-**39** was obtained with 98% e.e.

No protection of the hydroxy group was required for all of the palladium-catalyzed couplings. Palladium insertion into the pyridyl–bromide bond gives a stable intermediate[38] which reacts with incoming nucleophiles. Oxidation of the hydroxy group was the major decomposition pathway of the pyridyl alcohols. Upon standing in air for a few days, the corresponding ketones were detected by TLC and ^{1}H-NMR spectroscopy. Attempts to utilize the potassium alkoxide of **26** led to complete oxidation of the hydroxy group. Thus, refluxing a toluene solution of **26** in the presence of KOH gave **24** in 80% yield as the only product.

Determination of the Enantiomeric Excesses

In order to evaluate the utility of the synthetic procedure, reliable methods for the determination of the enantiomeric excesses were required. For every reaction sequence, each step was followed by analysis of the optical purity of the product. Depending on the substrate, e.e.'s were either determined by HPLC using a chiral stationary phase[39] (Chiralcel OD) or by ^{1}H-NMR spectroscopy of the corresponding mono- or diesters derived from (1*S*)-camphanoyl chloride [(1*S*)-**3**] or (*R*)-α-methoxy-α-(trifluoromethyl)phenylacetyl chloride (MTPA chloride)[40]. In order to assure the correct and unambiguous assignment of the ^{1}H-NMR and HPLC signals, racemic samples of the alcohols were prepared for comparison. Since both enantiomers of the reducing reagent [(Ipc)$_2$BCl] were commercially available, the assignment of the signals was confirmed for most compounds by synthesizing the opposite enantiomer.

All racemic alcohols were obtained by lithium-halogen exchange of the corresponding mono- or dibromide followed by trapping of the anion with pivalaldehyde or acetaldehyde. Palladium-catalyzed couplings were performed as described above to give the racemic aryl- and alkynyl-substituted pyridines. The e.e.'s of all alcohols bearing a *tert*-butyl group were analyzed by ^{1}H-NMR spectroscopy of the camphanic acid esters. Their benzylic methine protons showed well-resolved base-line-separated singlets for all compounds. Without exception, the diastereomers derived from the (*R*) enantiomers of the alcohols and (1*S*)-**3** showed singlets *downfield* to those of the other diastereomer [derived from the (*S*) alcohol and (1*S*)-**3**] (Table 2). Usually, one of the camphanate methyl groups of the (*S*,1*S*) diastereomer gave a signal which was significantly shifted upfield with respect to all other methyl signals (Table 2).

Table 2. Selected ^{1}H-NMR data (δ values) for camphanic acid esters derived from (1*S*)-camphanoyl chloride [(1*S*)-**3**] and the indicated alcohols

Alcohol	Derived from (*R*) alcohol	Derived from (*S*) alcohol
2	5.56	5.49
	1.02	0.95
15	6.00	5.99
	0.99	0.97
17	5.61[a]	5.56[a]
19	5.64[a]	5.59[a]
21	5.67[a]	5.62[a]
26	5.75	5.67
	0.97	0.83
27	5.71[a]	5.66[a]
28	5.72	5.64
32	5.73[b]	5.66[b]
	0.96[b]	0.84[b]
39	5.79	5.71
45	5.76	5.71
49	5.67	5.59

[a] Absolute configuration deduced from ^{1}H-NMR shift correlation (see text); not yet determined with certainty. – [b] (*R*,*R*)-**32** and (*S*,*S*)-**32**, respectively.

These observations were used to deduce the absolute configurations of **19**, **21**, and **27** which could not be determined by correlation with known alcohols. According to this analysis, the major enantiomers must have the (*R*) configuration when (–)-(Ipc)$_2$BCl is used for the reduction of **11**, **13**, and **25**, respectively.

The optical purity of pyridine **15** was analyzed by ^{1}H-NMR spectroscopy of the corresponding esters derived from (*R*)-MTPA chloride. In addition, the diastereomeric camphanates of **15** and its acetate **35** gave well-resolved signals by HPLC using a chiral stationary phase. All three methods furnished identical results within the limits of experimental error. The optical purities of pyridines **18**[35], **19**, **26**, **27**, and **40** (Table 3) were also analyzed by HPLC. No derivatizations were required for these analyses. Assignment of the absolute product configuration by using the elution order was not possible. Whereas the (*R*) enantiomer of **26** is faster eluted than (*S*)-**26**, the opposite elution order was observed for **40** [(*S*)-**40** faster than (*R*)-**40**].

For the d.e. and e.e. analyses of 2,2′-bipyridines **32** and **38**, mixtures of diastereomers (*meso*-**32**/*rac*-**32** and *meso*-**38**/*rac*-**38**) were synthesized from *rac*-**2** and *rac*-**15**, respectively. The diastereomeric dicamphanates of **32** gave base-line-separated ^{1}H-NMR signals for the benzylic methine protons of all diastereomers (Table 3). Again, the diastereomer obtained from (*R*,*R*)-**32** exhibited the most downfield shifted signal for these protons. Bipyridine **38** was analyzed as the corresponding MTPA diesters. The protons in the 3,3′-positions showed well-resolved doublets which were used for d.e. and e.e. determination. These results were in good agreement with those obtained by analysis based on integration of the doublets for the methyl protons of the bipyridine substituent.

Table 3. Retention times [min] of enantiomeric alcohols by HPLC using a chiral stationary phase[a]

Alcohol	(*R*) Enantiomer	(*S*) Enantiomer
15[b]	8.2	9.8
17	8.0[c]	16.1[c]
18	8.7	11.3
19	7.2[c]	12.3[c]
26	16.1	19.8
27	35.4[c]	16.5[c]
40	22.9	7.1

[a] Chiralcel OD; flow: 1 ml/min; 1.5–10% 2-propanol in hexane (for analytical details see Experimental). – [b] Analyzed as acetate **35**. – [c] Absolute configuration deduced from ^{1}H-NMR shift correlation (see text); not yet determined with certainty.

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Experimental

^{1}H and ^{13}C NMR: Varian Gemini 300, Varian VXR 400; multiplicities determined with the APT pulse sequence; solvent $CDCl_3$, unless noted otherwise; chemical shifts in values relative to TMS ($\delta = 0$) for protons or $CDCl_3$ ($\delta = 77$) for carbon atoms. – Melting points: Kofler melting point apparatus (corrected values) and Büchi 530 (uncorrected values). – IR: Perkin-Elmer 781. – MS: VG 70–250. – Optical rotations: Perkin-Elmer 141 (RT: room temp.). – Elemental analyses: Leco CHN-900. – HPLC: Kontron Instruments (pump: Kontron 420, detector: Kontron 432); column: Chiralcel OD (Daicel), 25 cm × 0.46 cm i.d. – X-ray: Enraf-Nonius CAD4. – All reactions were carried out in flame-dried glassware under argon by using anhydrous solvents; products were isolated by CC or flash chromatography on SiO_2 (Chemische Fabrik Uetikon, size: C 560, 35–70 micron) or Al_2O_3 (Fluka, type 507C neutral, activity I, 100–125 mesh) and detected by UV or revealed by coloration with phosphomolybdic acid (PMA). – Enantiomers of chlorodiisopinocampheylborane [$(Ipc)_2BCl$]: Aldrich.

Procedure A (Synthesis of Camphanates or MTPA Esters for e.e. Determination): A solution of ca. 20 mg of the alcohol in 0.5 ml of CH_2Cl_2 and 0.25 ml of pyridine was treated with 80–100 mg (ca. twofold excess) of (1*S*)-camphanoyl chloride [(1*S*)-**3**] [or 60–80 mg of (–)-(*R*)-α-methoxy-α-(trifluoromethyl)phenylacetyl chloride, MTPA chloride] followed by a catalytic amount (ca. 5 mg) of 4-(dimethylamino)pyridine (DMAP). For diols 4 to 5 equivalents of acid chloride were used. The mixture was stirred at room temp. until complete conversion of the starting alcohol was indicated by TLC. After the addition of 20 ml of CH_2Cl_2, the solution was extracted with 5 ml of 1 N HCl. The layers were separated, and the organic layer was washed with 20 ml of brine. After drying with Na_2SO_4 and removal of the solvent under reduced pressure, the crude product was analyzed by ^{1}H-NMR spectroscopy of HPLC. Traces of remaining pyridine were removed by addition of 1 ml of toluene followed by evaporation of the solvent under reduced pressure. To ensure the correct assignment of the ^{1}H-NMR or HPLC signals, diastereomeric mixtures derived from racemic alcohols were synthesized and analyzed by the same method. Characteristic data obtained from HPLC and ^{1}H-NMR analyses of both diastereomers are compiled. A complete list of ^{1}H-, ^{13}C-NMR, and mass spectra is presented if these spectra have been recorded. In no case the latter were used for e.e. determination.

Procedure B (Representative of the Synthesis of Racemic Pyridyl Alcohols by Lithium-Halogen Exchange). – *rac-1-(6-Bromopyridin-2-yl)-2,2-dimethylpropanol* (*rac*-**2**): A solution of 4.74 g (20 mmol) of 2,6-dibromopyridine (**1**) in 100 ml of diethyl ether was cooled to –78 °C, and the resulting suspension was treated with 12.5 ml (20 mmol) of a 1.6 M solution of *n*-butyllithium in *n*-hexane over a period of 10 min. The precipitate dissolved, and a clear yellow solution resulted. After stirring at this temp. for 75 min, 1.5 ml (1.90 g, 22 mmol) of pivalaldehyde was added dropwise. The solution was stirred for 2 h at –78 °C, allowed to warm to room temp. over a period of 15 min, and then added to 10 ml of dilute HCl. The layers were separated, and the aqueous layer was extracted three times with 10 ml each of diethyl ether. The combined organic layers were washed with 20 ml of brine and dried with Na_2SO_4. The solvent was removed under reduced pressure to give 5.22 g of crude product that crystallized after ca. 2 h. Kugelrohr distillation (110 °C/0.02 mbar) gave 4.16 g (85%) of *rac*-**2** as white needles, m.p. 57–58 °C. – IR (film): $\tilde{\nu}$ = 3400 cm^{-1}, 2960, 1572, 1548, 1430, 1127, 1045, 762, 697. – ^{1}H NMR: δ = 0.92 [s, 9H, $C(CH_3)_3$], 3.62 (d, D_2O exchange, J = 7.6 Hz, 1H, OH), 4.34 (d, J = 7.6 Hz, 1H, C*H*OH), 7.18 (d, J = 7.7 Hz, 1H, aromatic H), 7.39 (dd, J = 7.9, 0.7 Hz, 1H, aromatic H), 7.50 (dd, J = 7.7, 7.7 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 25.9 (CH_3), 36.3 (C), 80.4 (CH), 121.6 (CH), 126.7 (CH), 138.0 (CH), 140.7 (C), 162.0 (C). – MS (EI, 70 eV): *m/z* (%) = 189 (97), 188 (71), 187 (100), 186 (68), 78 (31), 57 (67), 41 (33); (CI, NH_3): *m/z* (%) = 246 (97) [M^+ + 1], 244 (100) [M^+ + 1], 166 (30), 150 (24).

$C_{10}H_{14}BrNO$ (244.2) Calcd. C 49.19 H 5.79 N 5.74
Found C 49.12 H 5.77 N 5.66

*Camphanates Derived from rac-***2** *and* (1*S*)-**3**: A solution of 244 mg (1 mmol) of *rac*-**2** in 2.5 ml of CH_2Cl_2 and 0.5 ml of pyridine was cooled to 0 °C and treated with 260 mg (1.2 mmol) of (1*S*)-**3** followed by a catalytic amount (ca. 10 mg) of DMAP. After stirring at room temp. for 3 h, 10 ml of water was added. The layers were separated, and the aqueous layer was extracted three times with 20 ml each of CH_2Cl_2. The combined organic layers were washed with 2 N HCl, satd. aqueous $NaHCO_3$ solution, and brine. After drying of the organic phase with Na_2SO_4, the solvent was removed under reduced pressure to give 440 mg of a white solid. Recrystallization from cyclohexane (13 ml) gave 290 mg (68%) of a mixture of diastereomers. – M.p. 157–158 °C (cyclohexane). – IR (KBr): $\tilde{\nu}$ = 2980 cm^{-1}, 1785, 1743, 1552, 1434, 1270, 1261, 1170, 1118, 1100, 1060. – MS (EI, 70 eV): *m/z* (%) = 426 (2) [M^+ + 1], 424 (2) [M^+ + 1], 369 (42), 367 (42), 188 (77), 186 (88), 182 (89), 173 (49), 171 (52), 164 (79), 136 (89), 83 (77), 55 (83), 41 (100).

$C_{20}H_{26}BrNO_4$ (424.4) Calcd. C 56.60 H 6.19 N 3.30
Found C 56.67 H 6.21 N 3.39

Diastereomer A [from (*R*)-**2**]: ^{1}H NMR: δ = 1.00 [s, 9H, $C(CH_3)_3$], 1.02 (s, 3H, CH_3), 1.06 (s, 3H, CH_3), 1.13 (s, 3H, CH_3), 1.63–1.74 (m, 1H, CH_2), 1.88–1.98 (m, 1H, CH_2), 2.01–2.17 (m, 1H, CH_2), 2.43–2.52 (m, 1H, CH_2), 5.56 [s, 1H, C*H*$C(CH_3)_3$], 7.25 (d, J = 7.7 Hz, 1H, aromatic H), 7.39 (d, J = 7.8 Hz, 1H, aromatic H), 7.51 (dd, J = 7.7, 7.7 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 9.7 (CH_3), 16.7 (CH_3), 16.8 (CH_3), 26.1 (CH_3), 28.9 (CH_2), 30.9 (CH_2), 35.2 (C), 54.2 (C), 55.0 (C), 84.0 (CH), 91.2 (C), 121.1 (CH), 127.1 (CH), 138.1 (CH), 140.9 (C), 158.8 (C), 166.8 (C), 178.4 (C).

Diastereomer B [from (*S*)-**2**]: Data obtained from a mixture with diastereomer A. – ^{1}H NMR: δ = 0.95 (s, 3H, CH_3), 1.00 [s, 9H, $C(CH_3)_3$], 1.12 (s, 3H, CH_3), 1.22 (s, 3H, CH_3), 1.63–1.74 (m, 1H,

CH_2), 1.88–1.98 (m, 1H, CH_2), 2.01–2.17 (m, 1H, CH_2), 2.43–2.52 (m, 1H, CH_2), 5.49 [s, 1H, $CHC(CH_3)_3$], 7.24–7.28 (m, 1H, aromatic H), 7.39 (d, J = 7.8 Hz, 1H, aromatic H), 7.51 (dd, J = 7.7, 7.7 Hz, 1H, aromatic H). – ^{13}C NMR (values for diastereomers A and B): δ = 9.61 (CH_3), 16.50/16.55 (CH_3), 16.65/16.70 (CH_3), 25.99/26.05 (CH_3), 28.78/29.01 (CH_2), 30.69/30.78 (CH_2), 34.95/35.13 (C), *54.15/54.39* (C), 54.86 (C), 83.63/83.69 (CH), 91.11 (C), 121.06/121.42 (CH), 126.99/127.08 (CH), 138.05/138.10 (CH), 140.9/140.95 (C), 158.41/158.66 (C), 166.59/166.71 (C), 178.12/178.30 (C).

Solvent systems for the attempted separation of diastereomers A and B (all on SiO_2): R_f = 0.15/0.19 [hexane/ethanol (10:1)]; R_f = 0.10/0.14 [hexane/methanol (10:1)]; R_f = 0.45 [toluene/2-propanol (20:1)]; R_f = 0.31/0.38 [hexane/2-propanol (8:1)]; 0.23/0.28 [hexane/2-propanol (10:1)]; R_f = 0.26/0.21 [hexane/2-propanol (12:1)].

*Carbonates Derived from rac-***2** *and* (1*R*)-**4**: A solution of 244 mg (1 mmol) of *rac*-**2** in 3 ml of CH_2Cl_2 and 0.2 ml of pyridine was cooled to 0°C and treated dropwise with 263 mg (0.26 ml, 1.2 mmol) of (–)-[(1*R*,2*S*,5*R*)-menthyl chloroformate] [(1*R*)-**4**]. After stirring for 2 h at room temp., 10 ml of water was added. The layers were separated, and the aqueous layer was extracted three times with 20 ml each of diethyl ether. After drying the combined organic layers with Na_2SO_4, the solvent was removed under reduced pressure to give 510 mg of a brown oil which was purified by chromatography [CC: 20 g of SiO_2, hexane/ethyl acetate (10:1 then 3:1)]. Yield 280 mg (66%) of a mixture of diastereomers A and B as a white solid. – TLC: R_f = 0.4 [SiO_2, hexane/ethyl acetate (5:1)]. – IR (KBr): $\tilde{\nu}$ = 2985 cm^{-1}, 1735, 1580, 1551, 1432, 1363, 1260, 1118, 956. – ^{1}H NMR: δ = 0.67/0.74 (d, J = 7.0 Hz, 3H), 0.78–0.95 (m, 6H), 0.99 (s, 9H), 0.99–1.10 (m, 2H), 1.37–1.47 (m, 2H), 1.64–1.68 (m, 2H), 1.76–2.06 (m, 3H), 4.41–4.53 (m, 1H), 5.36/5.39 (s, 1H), 7.26–7.32 (m, 1H), 7.37–7.40 (m, 1H), 7.49–7.56 (m, 1H). – ^{13}C NMR: δ = 16.2/16.3 (CH_3/CH), 20.6 (CH_3/CH), 21.9/22.0 (CH_3/CH), 23.3/23.4 (CH_2), 25.9/26.0 (CH_3/CH), 26.2 (CH_3/CH), 31.4 (CH_3/CH), 34.1 (CH_3/CH), 35.2/35.3 (C), 40.6/40.7 (CH_2), 46.7 (CH_3/CH), 78.6/78.7 (CH), 86.0/86.1 (CH), 120.2/120.3 (CH), 126.8/127.0 (CH), 138.1/138.2 (CH), 140.7 (C), 154.3/154.4 (C), 159.8/159.9 (C). – MS (EI, 70 eV): *m/z* (%) = 427 (22) [M^+], 425 (22) [M^+], 370 (96), 368 (100), 326 (53), 324 (60).

$C_{21}H_{32}BrNO_3$ (426.5) Calcd. C 59.14 H 7.58 N 3.29
Found C 59.38 H 7.85 N 3.20

Solvent systems for the attempted separation of diastereomers A and B (all on SiO_2): R_f = 0.48 [hexane/diethyl ether (2:1)]; R_f = 0.40 [hexane/ethyl acetate (7:1)]; R_f = 0.41 (toluene); R_f = 0.61 (CH_2Cl_2); R_f = 0.48 [hexane/2-propanol (20:1)]; R_f = 0.52 [hexane/THF (5:1)]. No separation of the diastereomers was observed.

(S)-1-(6-Bromopyridin-2-yl)-2,2-dimethylpropanol [(*S*)-**2**]: Solid (+)-$(Ipc)_2BCl$ (6.03 g, 18.8 mmol) was rapidly stirred, and 3.90 g (16.1 mmol) of **5** was added to give a yellow suspension. After stirring at room temp. for a few hours, the solid dissolved, and the mixture became very viscous. Stirring was continued for 2 d. Removal of the volatile compounds under reduced pressure (ca. 0.2 mbar, 4 h) gave an oil which was dissolved in 100 ml of diethyl ether and treated with 5.40 g (51.4 mmol) of diethanolamine to give a white precipitate. After stirring for 3.5 h, the solid was removed by filtration, and the filter cake was washed with diethyl ether. Drying with Na_2SO_4 and removal of the solvent under vacuum gave a yellow oil. Volatile products were separated by kugelrohr distillation (ca. 0.2 mbar, 80°C). Chromatography [CC: 130 g of SiO_2, petroleum ether/ethyl acetate (7:1), column diameter 5.5 cm] of the residue (4.4 g) gave 3 fractions (A–C). Fraction A: 1.30 g of (*S*)-**2** (containing <5% of **16**, revealed by MS and ^{1}H-NMR); fraction B: 1.12 g of (*S*)-**2** (containing ca. 5% of **16**); fraction C: 0.29 g of a mixture of **2**, **16**, and **23**. Fractions A and B [2.42 g, ca. 62% of (*S*)-**2**, chemical purity ca. 95%, rest: **16**] were combined, and the e.e. was determined by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A (characteristic signals).

Diastereomer A [from (*R*)-**2**]: ^{1}H NMR: δ = 5.56 [s, 1H, $CHC(CH_3)_3$].

Diastereomer B [from (*S*)-**2**]: ^{1}H NMR: δ = 5.49 [s, 1H, $CHC(CH_3)_3$].

Enantiomeric ratio: (*S*)-**2**:(*R*)-**2** = 96:4. The spectral data of (*S*)-**2** were identical to those of *rac*-**2**. Isopinocampheol (**23**)[41] was isolated by chromatography [CC: SiO_2, petroleum ether/ethyl acetate (7:1)].

1-(6-Chloropyridin-2-yl)-2,2-dimethylpropanol (**16**): Identified in a 1:1 mixture with **2**; signals other than for **2**, only. – ^{1}H NMR: δ = 3.61 (d, J = 8.0 Hz, 1H, OH), 4.35 [d, J = 7.5 Hz, 1H, $CHC(CH_3)_3$], 7.15 (d, J = 8.2 Hz, 1H, aromatic H), 7.26 (d, J = 8.4 Hz, 1H, aromatic H), 7.60 (dd, J = 7.7, 7.7 Hz, 1H, aromatic H). – MS (CI, NH_3): *m/z* (%) = 202 (32) [M^+ + 1], 200 (100) [M^+ + 1].

Isopinocampheol (**23**)[41]: ^{1}H NMR: δ = 0.92 (s, 3H), 1.14 (d, J = 7.4 Hz, 3H), 1.22 (s, 3H), 1.67–1.69 (m, 1H), 1.72–1.75 (m, 1H), 1.78–1.83 (m, 1H), 1.90–1.97 (m, 2H), 2.33–2.39 (m, 1H), 2.47–2.56 (m, 1H), 4.04–4.09 (m, 1H). – ^{13}C NMR: δ = 20.7, 23.6, 27.6, 34.2, 38.1, 38.9, 41.7, 47.5, 47.8, 71.4. – MS (EI, 70 eV): *m/z* (%) = 121 (7), 110 (7), 95 (19), 84 (50), 70 (100), 55 (46), 43 (98), 41 (51), 39 (19). – MS (CI, NH_3): *m/z* (%) = 172 (6) [M^+ + NH_4] 154 (3) 137 (100), 81 (24).

Variations of Reaction Conditions: a) Small-scale reaction, neat, room temp., 1 d: 237 mg (0.797 mmol) of **5** and 401 mg (1.250 mmol) of (+)-$(Ipc)_2BCl$ after 22.5 h at room temp. gave 535 mg of a crude mixture (**2**:**5** = 2.5:1, ^{1}H-NMR analysis). CC [twice, 35 g/15 g of SiO_2, petroleum ether/ethyl acetate (7:1)] gave two fractions A and B. Fraction A: 92 mg of (*S*)-**2** (containing 6% of **16**); fraction B: 24 mg of (*S*)-**2** (containing ca. 12% of **16**). Enantiomeric ratio (fraction A, via camphanates): (*S*)-**2**:(*R*)-**2** = 96:4; two more signals [δ = 5.57 (minor), 5.50 (major)] in the ^{1}H-NMR spectrum of the camphanates (presumably due to esters of **16**) were found in a ratio of ca. 90:10 (the assignment was confirmed by the synthesis of the opposite enantiomer). Ratio according to the camphanates: **2**:**16** = 93:7.

b) Small-scale reaction, THF, 10°C, 1 d: 257 mg (1.062 mmol) of **5** and 328 mg (1.054 mmol) of (–)-$(Ipc)_2BCl$ in 0.1 ml of THF after 21 h at 10°C gave 540 mg of a crude mixture (ca. 37% conversion of **5**, ^{1}H-NMR analysis). CC [35 g of SiO_2, petroleum ether/ethyl acetate (7:1), column diameter 5 cm, packing height 7 cm] gave two fractions A and B. Fraction A: 134 mg of **5** [containing 7% of 1-(6-chloropyridin-2-yl)-2,2-dimethylpropanone, revealed by CI MS and ^{1}H NMR]; fraction B: 57 mg of (*R*)-**2** (containing ca. 8% of **16**). Enantiomeric ratio (via camphanates): (*R*)-**2**:(*S*)-**2** = 96:4; two more signals [δ = 5.57 (major), 5.50 (minor)] in the ^{1}H-NMR spectrum of the camphanates (presumably due to esters of **16**) were found in a ratio of ca. 93:7 (the assignment was confirmed by the synthesis of the opposite enantiomer). Ratio according to the camphanates: **2**:**16** = 93:7.

1-(6-Chloropyridin-2-yl)-2,2-dimethylpropanone: ^{1}H NMR (signals other than those for **2**): δ = 7.43 (dd, J = 7.8, 1 Hz, 1H, aromatic H), 7.76 (dd, J = 7.8, 7.8 Hz, 1H, aromatic H), 7.84 (dd, J = 7.7, 1 Hz, 1H, aromatic H). – MS (CI, NH_3): *m/z* (%) = 200 (5) [M^+ + 1], 198 (16) [M^+ + 1].

c) Large-scale reaction, THF, room temp., 4 d: 5.00 g (21.1 mmol) of **5** and 8.11 g (25.3 mmol) of (−)-$(Ipc)_2BCl$ in 1.5 ml of THF after 4 d at room temp. gave 9.55 g of a crude mixture. Chromatography [CC: 480 g of SiO_2, petroleum ether/ethyl acetate (15:1)] gave two fractions A and B. Fraction A: 0.89 g of **2** (containing an unidentified impurity, UV-inactive, coloration with PMA); fraction B: 2.31 g of **2** (containing ca. 16% of **16**). Fractions A and B were dissolved in hexane (4 ml/mg), and fast cooling (dry ice/acetone) followed by isolation of the solid by filtration gave 2.82 g of **2** (chemical purity ca. 84%; rest: **16**, chromatographically homogeneous). Enantiomeric ratio (by HPLC of derivative **40**): (*R*)-**2**:(*S*)-**2** = 98:2.

d) Small-scale reaction, neat, 40°C, 14 h: 478 mg (1.98 mmol) of **5** and 823 mg (2.57 mmol) of (−)-$(Ipc)_2BCl$ after 14 h at 40°C gave 900 mg of a crude mixture. CC [50 g of SiO_2, petroleum ether/ethyl acetate (7:1)] gave two fractions A and B. Fraction A: 150 mg of (*R*)-**2** (chemical purity 81%; rest **16**); fraction B: 86 mg of (*R*)-**2** (chemical purity 70%; rest **16**). Enantiomeric ratio (fraction B, via camphanates): (*R*)-**2**:(*S*)-**2** = 93:7; two more signals [δ = 5.57 (major), 5.50 (minor)] in the ^{1}H-NMR spectrum of the camphanates (presumably due to esters of **16**) were found in a ratio of ca. 83:17 (the assignment was confirmed by the synthesis of the opposite enantiomer). Ratio according to the camphanates: **2**:**16** = 71:29.

Procedure C (Representative of the Synthesis of tert-Butyl Ketones by Using Pivalonitrile). — 1-(6-Bromopyridin-2-yl)-2,2-dimethylpropanone (**5**)

a) *From 2,6-Dibromopyridine* (**1**) *and Pivalonitrile:* A suspension of 5.92 g (25 mmol) of 2,6-dibromopyridine (**1**) in 100 ml of diethyl ether was cooled to −78°C and treated slowly with 17.2 ml (27.5 mmol, 1.1 eq.) of a 1.6 N solution of *n*-butyllithium in *n*-hexane over a period of 5 min. The precipitate dissolved, and a clear yellow solution resulted. After stirring for 30 min at this temp., 3.3 ml (2.49 g, 30 mmol) of pivalonitrile was added. The solution became red-orange. After stirring at −78°C for 1 h, the solution was allowed to reach room temp. (red mixture, formation of a precipitate), and 90 ml of 2 N H_2SO_4 was added, giving a clear yellow solution. The mixture was refluxed for 2 h (oil bath temp. 60°C), cooled to room temp., and diluted with 25 ml of diethyl ether. The layers were separated, and the organic layer was extracted three times with 25 ml each of diethyl ether. The combined organic layers were washed with 25 ml of satd. aqueous Na_2CO_3, and dried with Na_2SO_4. The solvent was removed under reduced pressure to give a yellow oil that was purified by kugelrohr distillation (95−100°C/0.04 mbar). Yield 5.30 g (88%) of **5** as a colorless oil. — IR (film): $\tilde{\nu}$ = 2468 cm^{-1}, 1452, 1425, 1120, 969, 750, 600. — ^{1}H NMR: δ = 1.44 [s, 9H, $C(CH_3)_3$], 7.58 (dd, *J* = 7.9, 1.0 Hz, 1H, aromatic H), 7.66 (dd, *J* = 7.8, 7.8 Hz, 1H, aromatic H), 7.87 (dd, *J* = 7.6, 1.0 Hz, 1H, aromatic H). — ^{13}C NMR: δ = 27.4 (CH_3), 44.2 (C), 122.5 (CH), 130.6 (CH), 139.0 (CH), 139.7 (C), 154.7 (C), 204.9 (C). — MS (EI, 70 eV): *m/z* (%) = 243 (13) [M^+], 241 (12) [M^+], 159 (99), 157 (100).

$C_{10}H_{12}BrNO$ (242.1) Calcd. C 49.60 H 5.00 N 5.79
Found C 49.31 H 4.99 N 5.75

b) *From 2,6-Dibromopyridine* (**1**) *and Methyl Pivalate. — Successive Method:* A suspension of 11.85 g (50 mmol) of 2,6-dibromopyridine (**1**) in 200 ml of diethyl ether was cooled to −78°C and treated slowly with 31 ml (50 mmol) of a 1.6 M solution of *n*-butyllithium in *n*-hexane over a period of 20 min. The precipitate dissolved, and a clear yellow solution resulted. After stirring for 90 min at this temp., 7.32 ml (6.39 g, 55 mmol) of methyl pivalate was added. TLC analysis after 15 min indicated complete conversion of **1** and formation of 2 major products {R_f = 0.55 and 0.47 [SiO_2, petroleum ether/ethyl acetate (5:1)]}. The solution was kept at −78°C for 30 min, allowed to warm to room temp. (30 min), and 50 ml of dilute HCl was carefully added. The aqueous layer was separated and extracted three times with 50 ml each of diethyl ether. The combined organic layers were washed with 50 ml of brine, and dried with Na_2SO_4. Removal of the solvent under reduced pressure gave 11.72 g of the crude product. ^{1}H-NMR analysis indicated the presence of 2 products (**5** and **8**). **5** was obtained by kugelrohr distillation (120°C/0.02 mbar) as a colorless oil; yield 7.06 g (58%) of **5**; TLC: R_f = 0.47 [SiO_2, petroleum ether/ethyl acetate (5:1)]. **8** was identified as 1,1-bis(6-bromopyridin-2-yl)-2,2-dimethylpropanol, and isolated from the residue by chromatography {CC: SiO_2, petroleum ether/ethyl acetate (15:1); TLC: R_f = 0.55 [SiO_2, petroleum ether/ethyl acetate (5:1)]}.

1,1-Bis(6-bromopyridin-2-yl)-2,2-dimethylpropanol (**8**): IR (KBr): $\tilde{\nu}$ = 3390 cm^{-1}, 2963, 1572, 1554, 1428, 1401, 1130, 799, 707. — ^{1}H NMR: δ = 0.96 [s, 9H, $C(CH_3)_3$], 6.18 (s, 1H, OH), 7.38 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.55 (dd, *J* = 8.1, 8.1 Hz, 2H, aromatic H), 8.20 (d, *J* = 7.7 Hz, 2H, aromatic H). — ^{13}C NMR: δ = 25.9 (CH_3), 40.9 (C), 80.2 (C), 122.8 (CH), 126.5 (CH), 138.6 (CH), 139.0 (C), 162.9 (C). — MS (EI, 70 eV): *m/z* (%) = 346 (19), 345 (52), 344 (39), 343 (100), 342 (29), 341 (50), 158 (45), 156 (29). — MS (CI, NH_3): *m/z* (%) = 404 (8), 403 (49) [M^+ + 1], 402 (17) [M^+], 401 (100) [M^+], 400 (10) [M^+], 399 (51) [M^+], 343 (21), 323 (13).

$C_{15}H_{16}Br_2N_2O$ (400.2) Calcd. C 45.02 H 4.04 N 7.00
Found C 45.14 H 3.95 N 7.00

c) *From 2,6-Dibromopyridine* (**1**) *and Methyl Pivalate. — Inverse Method:* The anion of **1** was prepared as described under b) and added to a precooled solution (−78°C) of the ester in 50 ml of diethyl ether through a teflon cannula. The product ratio of **5**:**8** remained unchanged; yield 55% of **5**.

d) *From 1-(6-Bromopyridin-2-yl)-2,2-dimethylpropanol* (**2**): A solution of 480 mg (1.97 mmol) of **2** in 5 ml of CH_2Cl_2 was added to a stirred suspension of 647 mg (3.00 mmol) of pyridinium chlorochromate (PCC) in 7 ml of CH_2Cl_2. The orange mixture turned dark immediately. After stirring for 16.5 h at room temp., the solution was filtered through Celite. The dark material was washed with 70 ml of diethyl ether, and the combined organic layers were dried with Na_2SO_4. The solvent was removed under reduced pressure to give 450 mg of the crude product (brown oil and solid) which was purified by chromatography [CC: 15 g of SiO_2, petroleum ether/ethyl acetate (10:1)]. Yield 350 mg (73%) of **5**.

Procedure D (Representative of the Synthesis of Methyl Ketones by Using N,N-dimethylacetamide). — 1-(6-Bromopyridin-2-yl)-ethanone (**7**)[16a]: A solution of 4.7 g (20 mmol) of 2,6-dibromopyridine (**1**) in 100 ml of diethyl ether was cooled to −78°C, and 12.5 ml (20 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane was added slowly. After 30 min at this temp., 2.0 ml (1.9 g, 22 mmol) of *N,N*-dimethylacetamide was added. The solution was stirred at −78°C for 1.25 h and allowed to warm to room temp. (30 min). After the addition of 25 ml of 1 N HCl, the layers were separated, and the aqueous layer was extracted three times with 20 ml each of diethyl ether. The combined organic layers were washed with brine and dried with Na_2SO_4. The solution was concentrated to ca. 10 ml in volume and cooled to 0°C. After a few hours, 2.78 g (70%) of crystalline **7** was isolated by filtration. — M.p. 44°C. — IR (film): $\tilde{\nu}$ = 1695 cm^{-1}, 1550, 1438, 1358, 1303, 1236, 1125. — ^{1}H NMR: δ = 2.71 (s, 3H, CH_3), 7.65−7.72 (m, 2H, aromatic H), 7.99 (dd, *J* = 7.1, 1.5 Hz, 1H, aromatic H). — ^{13}C NMR: δ = 25.7, 120.4, 131.7, 139.1, 141.3, 154.3, 198.5. — MS (EI, 70 eV): *m/z* (%) = 201

(43) [M^+], 199 (44) [M^+], 159 (46), 158 (34), 157 (47), 156 (31), 78 (37), 76 (32), 43 (100).

C_7H_6BrNO (200.1) Calcd. C 42.03 H 3.03 N 7.00
Found C 41.98 H 2.86 N 6.79

1-(6-Bromopyridin-3-yl)-2,2-dimethylpropanone (**11**): According to procedure C; from 2.37 g (10 mmol) of 2,5-dibromopyridine (**9**) in 35 ml of diethyl ether, 6.3 ml (10 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 1.00 g (1.3 ml, 12 mmol) of pivalonitrile. Chromatography [CC: 50 g of SiO_2, petroleum ether/ethyl acetate (7:1)]. Yield 1.71 g (71%) of **11** as a white solid. – M.p. 60.5–61°C. – IR ($CHCl_3$): $\tilde{\nu}$ = 3690 cm^{-1}, 3020, 2965, 1680, 1575, 1450, 1190, 1090, 960, 710, 700, 660. – ^1H NMR: δ = 1.35 [s, 9H, $C(CH_3)_3$], 7.56 (d, *J* = 8.3 Hz, 1H, aromatic H), 7.87 (dd, *J* = 8.3, 2.5 Hz, 1H, aromatic H), 8.74 (d, *J* = 2.5 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 27.5 (CH_3), 44.4 (C), 127.8 (CH), 132.7 (C), 138.0 (CH), 144.6 (C), 149.4 (CH), 205.9 (C). – MS (EI, 70 eV): *m/z* (%) = 237 (11), 187 (7), 186 (16), 184 (14), 159 (14), 158 (16), 157 (15), 156 (16), 76 (14), 57 (100), 41 (30); (CI, NH_3): *m/z* (%) = 245 (11), 244 (98) [M^+ + 1], 243 (11), 242 (100) [M^+ + 1], 164 (56).

$C_{10}H_{12}BrNO$ (242.1) Calcd. C 49.60 H 5.00 N 5.79
Found C 49.72 H 4.99 N 5.93

1-(6-Bromopyridin-3-yl)ethanone (**12**): According to procedure D; from 474 mg (2 mmol) of 2,5-dibromopyridine (**9**) in 20 ml of diethyl ether, 1.25 ml (2 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 209 mg (0.22 ml, 2.4 mmol) of *N,N*-dimethylacetamide. Crude 387 mg of a yellowish solid, purification by chromatography [CC: 20 g of SiO_2, petroleum ether/ethyl acetate (3:1)]. Yield 331 mg (83%) of **12** as a white solid; TLC: R_f = 0.44 [SiO_2, petroleum ether/ethyl acetate (1:1)] [for comparison: **9**: R_f = 0.51; 3-bromopyridine (**10**): R_f = 0.74]; R_f = 0.28 [SiO_2, petroleum ether/ethyl acetate (3:1)] (for comparison: **9**: R_f = 0.41; **10**: R_f = 0.53). – M.p. 119–121°C (hexane). – IR (KBr): $\tilde{\nu}$ = 3098 cm^{-1}, 3060, 1680, 1578, 1552, 1363, 1307, 1102. – ^1H NMR: δ = 2.63 (s, 3H, CH_3), 7.62 (d, *J* = 8.3 Hz, 1H, aromatic H), 8.09 (dd, *J* = 7.6, 1.7 Hz, 1H, aromatic H), 8.90 (d, *J* = 1.7 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 26.7 (CH_3), 128.4 (CH), 131.4 (C), 137.6 (CH), 146.9 (C), 150.4 (CH), 195.5 (C). – MS (EI, 70 eV): *m/z* (%) = 201 (32) [M^+], 199 (32) [M^+], 186 (98), 184 (100), 158 (39), 156 (40), 43 (100).

C_7H_6BrNO (200.1) Calcd. C 42.03 H 3.03 N 7.00
Found C 42.21 H 3.15 N 6.88

1-(Pyridin-3-yl)-2,2-dimethylpropanone (**13**)[42]: According to procedure C; from 1.58 g (1.0 ml, 10 mmol) of 3-bromopyridine (**10**) in 40 ml of diethyl ether, 6.9 ml (11 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 1.00 g (1.3 ml, 12 mmol) of pivalonitrile in 10 ml of diethyl ether; neutralized with aqueous Na_2CO_3; 1.63 g of a crude orange oil; purification by kugelrohr distillation (0.2 mbar, 50°C) gave 1.30 g (80%) of **13** as a colorless oil (according to ^1H NMR slightly impure); second kugelrohr distillation: 1.00 g (61%) of **13**; TLC: R_f = 0.39 [SiO_2, petroleum ether/ethyl acetate (1:1)]. – ^1H NMR: δ = 1.37 [s, 9H, $C(CH_3)_3$], 7.31–7.40 (m, 1H, aromatic H), 8.01 (ddd, *J* = 7.8, 2.0, 2.0 Hz, 1H, aromatic H), 8.71 (dd, *J* = 5.8, 1.6 Hz, 1H, aromatic H), 8.99 (d, *J* = 1.9 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 27.4 (CH_3), 44.2 (C), 123.5 (CH), 134.1 (C), 135.7 (CH), 149.0 (CH), 151.8 (CH), 207.7 (C). – MS (EI, 70 eV): *m/z* (%) = 163 (8) [M^+], 135 (6), 107 (37), 106 (67), 79 (100), 57 (95); (CI, NH_3): *m/z* (%) = 164 (100) [M^+ + 1].

$C_{10}H_{13}NO$ (163.2) Calcd. C 73.59 H 8.03 N 8.58
Found C 73.65 H 8.22 N 8.74

rac-(6-Bromopyridin-2-yl)ethanol (*rac*-**15**): According to procedure B; from 2.37 g (10 mmol) of 2,6-dibromopyridine (**1**) in 45 ml of diethyl ether, 6.25 ml (10 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 0.61 ml (0.49 g, 11 mol) of acetaldehyde; 1.74 g of a crude yellow oil. Purification by kugelrohr distillation (0.2 mbar/65–100°C). Yield 1.48 g (73%) of **15** as a colorless oil; TLC: R_f = 0.35 [SiO_2, petroleum ether/ethyl acetate (2:1)]; R_f = 0.17 [Al_2O_3, petroleum ether/ethyl acetate (5:1)]. – IR (film): $\tilde{\nu}$ = 3380 cm^{-1}, 2975, 1582, 1552, 1430, 1405, 1158, 1130, 790, 605. – ^1H NMR: δ = 1.51 (d, *J* = 6.5 Hz, 3H, CH_3), 3.47 (br. s, 1H, OH), 4.88 (q, *J* = 6.5 Hz, 1H, C*H*OH), 7.30 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.40 (d, *J* = 7.8 Hz, 1H, aromatic H), 7.56 (dd, *J* = 7.7, 7.8 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 23.7, 69.1, 118.6, 126.6, 139.4, 141.2, 165.6. – MS (EI, 70 eV): *m/z* (%) = 202 (4) [M^+ + 1], 200 (3), 188 (89), 186 (100), 158 (28), 106 (20), 78 (69), 51 (23); (CI, NH_3): *m/z* (%) = 204 (96) [M^+ + 1], 202 (100) [M^+ + 1], 124 (57), 108 (28). – HPLC: e.e. determination with the corresponding acetate **35**.

C_7H_8BrNO (202.1) Calcd. C 41.61 H 3.99 N 6.93
Found C 41.46 H 4.13 N 6.75

*Camphanates Derived from rac-***15** *and* (1*S*)-**3**: According to procedure A; TLC: R_f = 0.41 [SiO_2, petroleum ether/ethyl acetate (2:1)]. – HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 1.5% 2-propanol in hexane; retention times: diastereomer derived from (*R*)-**15**: 21.0 min (*k'* = 6.0); diastereomer derived from (*S*)-**15**: 22.7 min (*k'* = 6.6); diastereomers derived from *rac*-**15** gave two well-separated signals with equal peak areas.

Diastereomer A [from (*S*)-**15**]: M.p. 105–105.5°C. – IR (KBr): $\tilde{\nu}$ = 3520 cm^{-1}, 2935, 1765, 1715, 1560. – ^1H NMR: δ = 0.97 (s, 3H, CH_3), 1.11 (s, 3H, CH_3), 1.13 (s, 3H, CH_3), 1.64 (d, *J* = 6.6 Hz, 3H, $CHCH_3$), 1.65–1.74 (m, 1H, CH_2), 1.89–2.10 (m, 2H, CH_2), 2.43–2.52 (m, 1H, CH_2), 5.99 (q, *J* = 6.4 Hz, 1H, $CHCH_3$), 7.38 (d, *J* = 7.5 Hz, 1H, aromatic H), 7.41 (d, *J* = 7.9, 1H, aromatic H), 7.55 (dd, *J* = 8.0, 7.4 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 9.5, 16.4, 16.4, 20.6, 28.8, 30.4, 54.2, 54.7, 73.3, 90.5, 119.1, 127.1, 139.1, 141.4, 160.7, 166.4, 178.0. – MS (EI, 70 eV): *m/z* (%) = 383 (4) [M^+], 381 (4) [M^+], 202 (25), 200 (23), 187 (44), 186 (60), 185 (47), 184 (58), 136 (65), 121 (25), 109 (89), 104 (49), 83 (100), 55 (50), 41 (60); (CI; NH_3): *m/z* (%) = 384 (99) [M^+ + 1], 382 (100) [M^+ + 1].

$C_{17}H_{20}BrNO_4$ (382.3) Calcd. C 53.41 H 5.28 N 3.67
Found C 53.52 H 5.06 N 3.53

Diastereomer B [from (*R*)-**15**]: Data obtained from a mixture with diastereomer A. – ^1H NMR: δ = 0.99 (s, 3H, CH_3), 1.07 (s, 3H, CH_3), 1.13 (s, 3H, CH_3), 1.65 (d, *J* = 6.7 Hz, 3H, $CHCH_3$), 1.65–1.74 (m, 1H, CH_2), 1.89–2.10 (m, 2H, CH_2), 2.43–2.52 (m, 1H, CH_2), 6.00 (q, *J* = 6.6 Hz, 1H, $CHCH_3$), 7.34 (d, *J* = 7.6 Hz, 1H, aromatic H), 7.41 (d, *J* = 7.9, 1H, aromatic H), 7.57 (dd, *J* = 7.8, 7.8 Hz, 1H, aromatic H). – ^{13}C NMR (values for diastereomers A and B): δ = 9.66, 16.60, 16.71, 20.78, 28.88/28.92, 30.57/30.73, 54.33/54.39, 54.85, 73.47/73.56, 90.91/90.95, 118.87/119.13, 127.27, 139.15/139.19, 141.56, 160.92/161.02, 166.58/166.62, 178.15/178.21.

Preparative-Scale Synthesis of the Camphanate Derived from (*S*)-**15** *and* (1*S*)-**3**: A solution of 3.03 g (15 mmol) of (*S*)-**15** [(*S*)-**15**:(*R*)-**15** = 96:4] in 70 ml of CH_2Cl_2 and 35 ml of pyridine was treated with 4.23 g (19.5 mmol) of (1*S*)-**3** followed by a catalytic amount of DMAP. After stirring for 16 h at room temp., 30 ml of 1 N HCl was added. The organic layer was separated, washed with brine, and dried with Na_2SO_4. The solvent was removed under reduced pressure to give 6.45 g of a crude product [90% d.e. (analysis by ^1H-NMR spectroscopy)] which was purified by chromatography [CC: 110 g of SiO_2, petroleum ether/ethyl acetate (3:1)]. Yield 4.45 g (79%) of the camphanate as white crystals. Ratio of diastereomers: 95:5 (analysis by ^1H-NMR spectroscopy). Recrystallization: 4.45 g from 270 ml of hexane gave 3.37 g of the camphanate

[>99% d.e. (determined by ^{1}H NMR and HPLC)]. Second recrystallization of the residue from 70 ml of hexane gave 0.68 g of the camphanate [70% d.e. (determined by ^{1}H-NMR)]; residue: 36% d.e. (determined by ^{1}H NMR).

(S)-(6-Bromopyridin-2-yl)ethanol [(*S*)-**15**]

a) *By Asymmetric Reduction of* **7** *with (−)-(Ipc)$_2$BCl:* A solution of 3.75 g (18.6 mmol) of **7** in 25 ml of THF was cooled to −18°C (ice/NaCl) and treated with 7.22 g (22.5 mmol) of (−)-(Ipc)$_2$BCl. The mixture was allowed to warm to room temp. over a period of 2.25 h and stirred at this temp. for 3 h. After addition of 50 ml of diethyl ether followed by 5.9 g (56.3 mmol) of diethanolamine, the mixture was stirred for an additional 3 h. The white precipitate was separated by filtration and washed with diethyl ether. The combined organic layers were dried with Na_2SO_4, and the solvent was removed under reduced pressure to give 7.61 g of a yellow oil that was purified by chromatography [CC: 185 g of SiO_2, petroleum ether/ethyl acetate (3:1)]. Yield 3.23 g (85%; purity >95%) of (*S*)-**15** as a colorless oil. The spectroscopical data of (*S*)-**15** were identical to those of *rac*-**15**. Enantiomeric ratio: (*R*)-**15**:(*S*)-**15** = 4:96 (e.e. analysis by HPLC of the corresponding acetate **35** and ^{1}H-NMR spectroscopy of the MTPA esters). − $[\alpha]_D^{RT}$ = +10.8 (*c* = 2.75, $CHCl_3$) for (*R*)-**15**:(*S*)-**15** = 84:16 (e.e. analysis by ^{1}H-NMR spectroscopy of the MTPA esters). e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A (characteristic signals).

Diastereomer A [from (*R*)-**15**]: ^{1}H NMR: δ = 0.99 (s, 3H, CH_3), 1.07 (s, 3H, CH_3).

Diastereomer B [from (*S*)-**15**]: ^{1}H NMR: δ = 0.97 (s, 3H, CH_3), 1.11 (s, 3H, CH_3).

e.e. analysis by ^{1}H-NMR spectroscopy of the MTPA esters derived from (−)-(*R*)-MTPA chloride according to general procedure A (characteristic signals).

Diastereomer A [from (*R*)-**15**]: ^{1}H NMR: δ = 1.68 (d, *J* = 6.8 Hz, 3H, CH_3).

Diastereomer B [from (*S*)-**15**]: ^{1}H NMR: δ = 1.61 (d, *J* = 6.8 Hz, 3H, CH_3).

b) *By Saponification of the Camphanate:* A solution of 3.35 g (8.8 mmol) of the camphanate derived from (*S*)-**15** and (1*S*)-**3** (>99% d.e.) in 200 ml of methanol was treated with 4.26 g (30.8 mmol) of K_2CO_3. After stirring for 2 h at room temp., the solvent was removed under reduced pressure, and 20 ml of water was added to the residue. Three extractions with 60 ml each of diethyl ether followed by drying of the combined organic layers with Na_2SO_4 and removal of the solvent under reduced pressure gave 1.68 g (corresponding to 94% of **15**) of the product which was used for the synthesis of **38** without further purification.

rac-1-(6-Bromopyridin-3-yl)-2,2-dimethylpropanol (*rac*-**17**): According to procedure B; from 1.19 g (5 mmol) of 2,5-dibromopyridine (**9**) in 20 ml of diethyl ether, 3.13 ml (5.0 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 0.61 ml (5.5 mmol) of pivalaldehyde; crude yellow solid. Purification by chromatography [CC: 50 g of SiO_2, petroleum ether/ethyl acetate (5:1)]. Yield 0.95 g (78%) of *rac*-**17** as a white solid; TLC: R_f = 0.16 [SiO_2, petroleum ether/ethyl acetate (5:1)]. − M.p. 122−123°C. − IR ($CHCl_3$): $\tilde{\nu}$ = 3690 cm^{-1}, 3020, 2960, 2870, 1580, 1522, 1458, 1365, 1090, 1010, 705. − ^{1}H NMR: δ = 0.92 [s, 9H, C(CH_3)$_3$], 2.12 (br. s, 1H, OH), 4.41 (br. s, 1H, C*H*OH), 7.44 (d, *J* = 8.2 Hz, 1H, aromatic H), 7.55 (dd, *J* = 8.2, 2.5 Hz, 1H, aromatic H), 8.26 (s, 1H, aromatic H). − ^{13}C NMR: δ = 25.6 (CH_3), 35.7 (C), 79.3 (CH), 127.1 (CH), 137.0 (C), 137.8 (CH), 140.7 (C), 149.3 (CH). − MS (EI, 70 eV): *m/z* (%) = 189 (70), 188 (32), 187 (73), 186 (30), 78 (66), 57 (100), 51 (32), 41 (69), 39 (34); (CI, NH_3): *m/z* (%) = 247 (10), 246 (96) [M^+ + 1], 245 (11), 244 (100) [M^+ + 1], 167 (9), 166 (79), 150 (14), 109 (6), 108 (7). − HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 10% 2-propanol in hexane; retention times: (presumably) (*R*)-**17**: 8.0 min (*k'* = 1.7); (presumably) (*S*)-**17**: 16.1 min (*k'* = 4.4). Both enantiomers gave two base-line-separated signals with equal peak areas; the absolute configuration was not determined for certainty.

$C_{10}H_{14}BrNO$ (244.2) Calcd. C 49.19 H 5.79 N 5.74
Found C 49.44 H 5.92 N 5.64

*Camphanates Derived from rac-***17** *and* (1*S*)-**3**: According to procedure A (data obtained from a mixture of diastereomers): ^{1}H NMR: δ = 0.89 (s, 3H, CH_3), 0.97 [s, 18H, C(CH_3)$_3$], 0.98 (s, 3H, CH_3), 1.04 (s, 3H, CH_3), 1.08 (s, 3H, CH_3), 1.12 (s, 3H, CH_3), 1.23 (s, 3H, CH_3), 1.70−1.74 (m, 2H, CH_2), 1.90−2.04 (m, 4H, CH_2), 2.37−2.41 (m, 2H, CH_2), 5.56 [s, 1H, C*H*C(CH_3)$_3$], 5.61 [s, 1H, C*H*C(CH_3)$_3$], 7.47−7.50 (m, 4H, aromatic H), 8.30−8.31 (m, 2H, aromatic H). e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A (characteristic signals).

Diastereomer A [from presumably (*R*)-**17**]: ^{1}H NMR: δ = 5.61 [s, 1H, C*H*(CH_3)$_3$].

Diastereomer B (from presumably (*S*)-**17**): ^{1}H NMR: δ = 5.56 [s, 1H, C*H*(CH_3)$_3$].

rac-(6-Bromopyridin-3-yl)ethanol (*rac*-**18**): According to procedure **B**; from 474 mg (2 mmol) of 2,5-dibromopyridine (**9**) in 24 ml of diethyl ether, 1.4 ml (2.2 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 106 mg (0.14 ml, 2.4 mmol) of acetaldehyde. Crude 249 mg of a yellowish oil. Purification by chromatography [CC: 10 g of SiO_2, petroleum ether/ethyl acetate (2:1)]. Yield 214 mg (53%) of *rac*-**18** as a colorless oil that crystallized after short-path distillation (40−50°C, 10^{-2} mbar). M.p. 47−48°C; TLC: R_f = 0.29 [SiO_2, petroleum ether/ethyl acetate (1:1)]. − IR (film): $\tilde{\nu}$ = 3360 cm^{-1}, 2488, 1582, 1565, 1453, 1370, 1095, 1025, 1010, 900, 835, 790, 737 cm^{-1}. − ^{1}H NMR: δ = 1.48 (d, *J* = 6.5 Hz, 3H, CH_3), 4.01 (br. d, *J* = 3.5 Hz, 1H, OH), 4.91 (dq, *J* = 6.5, 3.5 Hz, 1H, C*H*OH), 7.43 (d, *J* = 8.2 Hz, 1H, aromatic H), 7.60 (dd, *J* = 8.2, 2.5 Hz, 1H, aromatic H), 8.24 (d, *J* = 2.4 Hz, 1H, aromatic H). − ^{13}C NMR: δ = 25.0 (CH_3), 66.9 (CH), 127.8 (CH), 136.2 (CH), 140.2 (C), 140.8 (C), 147.5 (CH). − MS (EI, 70 eV): *m/z* (%) = 203 (12) [M^+], 201 (13) [M^+], 188 (90), 186 (96), 160 (16), 158 (19), 78 (100). − HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 10% 2-propanol in hexane; retention times: (*R*)-**18**: 8.7 min (*k'* = 1.9); (*S*)-**18**: 11.3 min (*k'* = 2.8); *rac*-**18** gave base-line-separated signals for (*R*)-**18** and (*S*)-**18** with equal peak areas.

C_7H_8BrNO (202.1) Calcd. C 41.61 H 3.99 N 6.93
Found C 41.47 H 4.08 N 6.84

(R)-(6-Bromopyridin-3-yl)ethanol [(*R*)-**18**] *and (6-Chloropyridin-3-yl)ethanol* (**20**): A solution of 386 mg (1.2 mmol) of (+)-(Ipc)$_2$BCl in 0.5 ml of THF was cooled to −17°C (ice/NaCl), and 130 mg (0.65 mmol) of **12** was added to give a slightly yellow solution containing a white precipitate. The mixture was allowed to warm up slowly (analysis by TLC indicated ca. 50% conversion of **12** after 1.25 h; temp. −8°C), and stirring was continued for 3.25 h at room temp. (TLC analysis indicated complete conversion of **12**). After the addition of 5 ml of diethyl ether followed by 261 mg (2.5 mmol) of diethanolamine, a white precipitate formed. The mixture was stirred at room temp. for 1 h, and the resulting precipitate was separated by filtration and washed with 30 ml of diethyl ether. The

combined organic layers were dried with Na_2SO_4, and the solvent was removed under reduced pressure to give 387 mg of a viscous oil which was purified by chromatography [CC: 20 g of SiO_2, petroleum ether/ethyl acetate (2:1)]. Isolated 116 mg of a chromatographically homogeneous sample of (*R*)-**18** [contained ca. 8% of **20** (identified by MS and ^1H NMR) and ca. 5% of pinene derivatives] as a colorless oil; TLC: R_f = 0.29 [SiO_2, petroleum ether/ethyl acetat (1:1)]; byproducts {not UV-active, visible by coloration with PMA: R_f = 0.79, 0.71, 0.60, 0.48 [isopinocampheol (**23**)]}. The spectroscopical data of (*R*)-**18** were identical to those of *rac*-**18**. e.e. analysis by HPLC (for conditions see *rac*-**18**): (*R*)-**18**:(*S*)-**18** = 96:4. Two more signals (presumably due to **20**) were found in a ratio of 83:17 [retention times: 7.9 min (k' = 1.6), 10.5 min (k' = 2.5)]. Ratio assuming equal UV absorption **18**:**20** = 92:8.

(6-Chloropyridin-3-yl)ethanol (**20**): ^1H NMR (signals other than for **18**; data obtained from a inseparable mixture with **18**): δ = 7.32 (d, *J* = 8.2 Hz, 1H, aromatic H), 7.71 (dd, *J* = 8.2, 2.5 Hz, 1H, aromatic H). – ^{13}C NMR (signals other than for **18**; data obtained from an inseparable mixture with **18**): δ = 124.1, 136.3, 140.2, 147.0, 150.0. – MS (CI, NH_3): *m/z* (%) = 160 (25) [M^+ + 1], 158 (77) [M^+ + 1]. – HPLC: see **18**.

(R)-1-(6-Chloropyridin-3-yl)-2,2-dimethylpropanol [(*R*)-**19**] *and 1-(6-Chloropyridin-3-yl)-2,2-dimethylpropanone* (**22**): To a solution of 36 mg (0.149 mmol) of **11** in 0.1 ml of THF 93 mg (0.290 mmol) of (–)-$(Ipc)_2BCl$ was added. The resulting white suspension was intensively stirred for 21 h at room temp. Diethyl ether (1 ml) was added followed by 155 mg (1.471 mmol) of diethanolamine. After stirring for 2 h, the mixture was filtered, and the filter cake was washed with 25 ml of diethyl ether. Drying with Na_2SO_4 followed by removal of the solvent under reduced pressure gave 110 mg of a yellowish solid. Product ratio by ^1H-NMR spectroscopy **11**:**17**:**19**:**22** = 39:9:12:40. – Preparative-scale synthesis: From 0.49 g (2 mmol) of **11** and 1.30 g (4 mmol) of (–)-$(Ipc)_2BCl$ in 0.8 ml of THF; TLC analysis {**17**/**19**: R_f = 0.24 [petroleum ether/ethyl acetate (5:1)]; **11**/**22**: R_f = 0.52 (same solvent system); samples had to be added to diethanolamine/ether before analysis} indicated incomplete conversion of **11** after 8 d. Addition of 0.45 ml of $Et_2O \cdot BF_3$ (48%, 2 mmol), stirring for 24 h. Chromatography [CC: 60 g of SiO_2, petroleum ether/ethyl acetate (8:1) then (1:1)] gave 127 mg of **19** [ca. 32%, containing traces of **17** (HPLC analysis)] and 119 mg (30%) of **22**.

(R)-1-(6-Chloropyridin-3-yl)-2,2-dimethylpropanol [(*R*)-**19**]: M.p. 45–46.5°C. – IR ($CHCl_3$): $\tilde{\nu}$ = 3605 cm^{-1}, 2960, 2865, 1450, 1095, 700, 650. – ^1H NMR: δ = 0.92 [s, 9H, $C(CH_3)_3$], 2.15 (br. s, 1H, OH), 4.43 (br. s, 1H, C*H*OH), 7.27–7.30 (m, 1H, aromatic H), 7.65 (dd, *J* = 10.7, 2.5 Hz, 1H, aromatic H), 8.28 (d, *J* = 2.5 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 25.6, 35.8, 79.4, 123.3, 136.4, 137.9, 148.9, 150.3. – MS (EI, 70 eV): *m/z* (%) = 145 (31), 144 (18), 143 (100), 142 (40), 78 (20), 57 (59), 41 (27); (CI, NH_3): *m/z* (%) = 203 (3), 202 (32) [M^+ + 1], 201 (11), 200 (100) [M^+ + 1], 186 (9), 184 (29), 150 (16). Enantiomeric ratio: (*R*)-**19**:(*S*)-**19** = 91:9 (e.e. analysis by HPLC, absolute configuration not determined with certainty). – HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 10% 2-propanol in hexane; retention times: (*R*)-**19**: 7.2 min (k' = 1.4); (*S*)-**19**: 12.3 min (k' = 3.1). Both enantiomers gave two base-line-separated signals; the absolute configuration was not determined with certainty.

$C_{10}H_{14}ClNO$ (199.7) Calcd. C 60.15 H 7.07 N 7.02
Found C 60.46 H 7.21 N 7.15

e.e. analysis by ^1H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A (characteristic signals).

Diastereomer A [from (*R*)-**19**]: ^1H NMR: δ = 5.64 [s, 1H, $CHC(CH_3)_3$].

Diastereomer B [from (*S*)-**19**]: ^1H NMR: δ = 5.59 [s, 1H, $CHC(CH_3)_3$].

1-(6-Chloropyridin-3-yl)-2,2-dimethylpropanone (**22**): M.p. 46–47.5°C. – IR ($CHCl_3$): $\tilde{\nu}$ = 3610 cm^{-1}, 2975, 1675, 1515, 1475, 1430, 1420, 1110, 1040, 928, 625. – ^1H NMR: δ = 1.35 [s, 9H, $C(CH_3)_3$], 7.37–7.41 (m, 1H, aromatic H), 7.99 (dd, *J* = 10.7, 2.5 Hz, 1H, aromatic H), 8.78 (s, 1H, aromatic H). – ^{13}C NMR: δ = 27.6, 44.4, 124.0, 132.4, 138.5, 149.2, 153.6. – MS (EI, 70 eV): *m/z* (%) = 141 (15), 140 (26), 113 (29), 112 (15), 57 (100), 41 (42); (CI, NH_3): *m/z* (%) = 201 (3), 200 (32) [M^+ + 1], 199 (11), 198 (100) [M^+ + 1], 164 (20).

$C_{10}H_{12}ClNO$ (197.7) Calcd. C 60.76 H 6.12 N 7.09
Found C 60.58 H 6.26 N 6.99

rac-1-(Pyridin-3-yl)-2,2-dimethylpropanol (*rac*-**21**)[42]: According to procedure B, from 0.79 g (5 mmol) of 3-bromopyridine (**10**) in 15 ml of diethyl ether, 3.75 ml (6 mmol) of a 1.6 N solution of *n*-butyllithium in *n*-hexane, and 0.60 g (7 mmol) of pivalaldehyde; hydrolysis with aqueous NH_4Cl; 0.78 g of a crude yellow oil. Purification by chromatography [CC: 30 g of SiO_2, petroleum ether/ethyl acetate (1:1)]. Yield 0.54 g (66%) of *rac*-**21** as a brownish solid; TLC: R_f = 0.33 (SiO_2, ethyl acetate). – M.p. 79–82°C. – ^1H NMR: δ = 0.95 [s, 9H, $C(CH_3)_3$], 2.12 (br. s, 1H, OH), 4.45 (s, 1H, C*H*OH), 7.26–7.30 (m, 1H, aromatic H), 7.68–7.71 (m, 1H, aromatic H), 8.51–8.54 (m, 2H, aromatic H). – ^{13}C NMR: δ = 25.5 (CH_3), 35.5 (C), 79.6 (CH), 122.9 (CH), 135.6 (CH), 138.6 (C), 148.2 (CH), 149.0 (CH).

$C_{10}H_{15}NO$ (165.3) Calcd. C 72.67 H 9.17 N 8.48
Found C 73.02 H 9.25 N 8.11

Camphanates Derived from rac-**21** *and* (1*S*)-**3**: According to procedure A (data obtained from a mixture of diastereomers). – ^1H NMR: δ = 0.90 (s, 3H, CH_3), 0.98 [s, 21H, $C(CH_3)_3$], 1.05 (s, 3H, CH_3), 1.09 (s, 3H, CH_3), 1.12 (s, 3H, CH_3), 1.13 (s, 3H, CH_3), 1.66–1.76 (m, 2H, CH_2), 1.89–2.11 (m, 4H, CH_2), 2.34–2.49 (m, 2H, CH_2), 5.62 [s, 1H, $CHC(CH_3)_3$], 5.67 [s, 1H, $CHC(CH_3)_3$], 7.26–7.31 (m, 2H, aromatic H), 7.62–7.67 (m, 2H, aromatic H), 8.56–8.57 (m, 4H, aromatic H). – ^{13}C NMR: δ = 9.37 (CH_3), 16.50/16.58 (CH_3), 25.56/25.61 (CH_3), 28.66 (CH_2), 30.67/30.76 (CH_2), 34.95/35.07 (C), 54.05/54.14 (C), 54.74 (C), 82.11/82.37 (CH), 91.05/91.13 (C), 122.95/123.04 (CH), 133.48/133.54 (C), 135.29/135.36 (CH), 149.17/149.22 (CH), 149.53 (CH), 167.10 (C), 178.55 (C). – MS (EI, 70 eV): *m/z* (%) = 289 (31), 164 (19), 136 (29), 108 (100), 83 (25); (CI; NH_3): *m/z* (%) = 346 (66) [M^+ + 1], 216 (59), 150 (100).

(S)-1-(Pyridin-3-yl)-2,2-dimethylpropanol [(*S*)-**21**]: A solution of 700 mg (+)-$(Ipc)_2BCl$ (2.18 mmol) in 2 ml of THF was cooled to 0°C, and 163 mg (1.00 mmol) of **13** was added. After stirring for 21 h at room temp., 5 ml of diethyl ether was added followed by 580 mg (5.5 mmol) of diethanolamine. TLC analysis after 3 h indicated low conversion of **13** {**21**: R_f = 0.33 (SiO_2, ethyl acetate); **13**: R_f = 0.39 [SiO_2, petroleum ether/ethyl acetate (1:1)]}. The white solid was separated by filtration and washed with diethyl ether. The combined organic layers were dried with Na_2SO_4, and removal of the solvent under reduced presssure gave 510 mg of the crude product which was purified by chromatography (CC: 10 g of SiO_2, ethyl acetate). Yield 56 mg (34%) of (*S*)-**21** (absolute configuration not determined with certainty). Enantiomeric ratio: (*R*)-**21**:(*S*)-**21** = 7:93 (e.e. analysis by ^1H-NMR spectroscopy of the camphanates). e.e. analysis by ^1H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A (characteristic signals).

Diastereomer A [from (*R*)-**21**]: ^{1}H NMR: δ = 5.67 [s, 1H, C*H*C(CH$_3$)$_3$].

Diastereomer B [from (*S*)-**21**]: ^{1}H NMR: δ = 5.62 [s, 1H, C*H*C(CH$_3$)$_3$].

Procedure E [Representative of the Palladium(0)-Catalyzed Cross Couplings]. — 2,2-Dimethyl-1-(6-phenylpyridin-2-yl)propanone (**24**).

a) *By Palladium(0)-Catalyzed Cross Coupling of* **5** *and* **42**: A solution of 1.85 g (7.64 mmol) of **5** and 0.26 g (0.23 mmol) of tetrakis(triphenylphosphane)palladium(0) in 15.5 ml of toluene was treated with a solution of 1.62 g (15.3 mmol) of Na_2CO_3 in 7.8 ml of water followed by a solution of 1.12 g (9.12 mmol) of phenylboronic acid (**42**) in 3.9 ml of methanol. The mixture was stirred at 80–85°C for 14 h. After cooling to room temp., a solution of 3.8 ml of concd. aqueous NH_3 in 38 ml of satd. aqueous Na_2CO_3 was added, and the mixture was extracted three times with 60 ml each of CH_2Cl_2. The combined organic layers were washed with 50 ml of brine and dried with Na_2SO_4. Removal of the solvent under reduced pressure gave 2.50 g of the crude product which was purified by chromatography [CC: SiO_2, petroleum ether/ethyl acetate (30:1)]. Yield 1.18 g (64%) of **24** as white crystals. — M.p. 51.5–53°C; TLC: R_f = 0.36 [SiO_2, petroleum ether/ethyl acetate (30:1)]. — IR ($CHCl_3$): $\tilde{\nu}$ = 2970 cm^{-1}, 1685, 1578, 1445, 970, 690, 660. — ^{1}H NMR: δ = 1.56 [s, 9H, C(CH$_3$)$_3$], 7.46–7.55 (m, 3H, aromatic H), 7.87 (s, 3H, aromatic H), 8.08 (d, *J* = 8.1 Hz, 2H, aromatic H). — ^{13}C NMR: δ = 27.7 (CH$_3$), 44.2 (C), 122.0 (CH), 122.2 (CH), 126.9 (CH), 126.9 (CH), 128.9 (CH), 129.3 (CH), 137.6 (CH), 138.7 (C), 154.4 (C), 155.3 (C), 206.8 (C). — MS (EI, 70 eV): *m/z* (%) = 239 (9) [M$^+$], 224 (6), 211 (6), 155 (100), 154 (40); (CI, NH_3): *m/z* (%) = 240 (100) [M$^+$ + 1].

$C_{16}H_{17}NO$ (239.3) Calcd. C 80.29 H 7.17 N 5.85
Found C 80.48 H 6.94 N 5.92

b) *From* **26** *by Oxidation:* A solution of 49 mg (0.203 mmol) of **26** and 58 mg (1.04 mmol) of KOH in 10 ml of toluene was refluxed for 13 h. The solution was allowed to cool to room temp., and 20 ml of CH_2Cl_2 was added. Extraction with water (three times, 10 ml each) was followed by drying of the organic layer with Na_2SO_4 and removal of the solvent under reduced pressure. A clear oil was obtained which was purified by chromatography [CC: 5.5 g of SiO_2, petroleum ether/ethyl acetate (20:1)]. Yield 39 mg (80%) of **24**.

2,2-Dimethyl-1-(6-phenylpyridin-3-yl)propanone (**25**): According to procedure E; from 260 mg (1.07 mmol) of **11**, 37 mg (0.03 mmol) of tetrakis(triphenylphosphane)palladium(0), 230 mg (2.14 mmol) of Na_2CO_3, and 160 mg (1.28 mmol) of **42** after 14 h at 80–85°C (oil bath temp.); 300 mg of crude **25**. Purification by chromatography [CC: 18 g of SiO_2, petroleum ether/ethyl acetate (20:1)]. Yield 165 mg (63%) of **25** as white crystals. — M.p. 72.5–73.5°C; TLC: **25**: R_f = 0.16 [SiO_2, petroleum ether/ethyl acetate (20:1)]; **11**: R_f = 0.24 (same solvent system). — IR ($CHCl_3$): $\tilde{\nu}$ = 3620 cm^{-1}, 2980, 1675, 1042, 700, 690, 660. — ^{1}H NMR: δ = 1.40 [s, 9H, C(CH$_3$)$_3$], 7.45–7.53 (m, 3H, aromatic H), 7.79 (d, *J* = 8.3 Hz, 1H, aromatic H), 8.03–8.10 (m, 2H, aromatic H), 8.12 (dd, *J* = 8.3, 2.3 Hz, 1H, aromatic H), 9.12 (d, *J* = 2.3 Hz, 1H, aromatic H). — ^{13}C NMR: δ = 27.8 (CH$_3$), 44.4 (C), 119.7 (CH), 127.1 (CH), 128.9 (CH), 129.8 (CH), 131.7 (C), 136.9 (CH), 138.3 (C), 149.2 (CH), 159.1 (C), 206.5 (C). — MS (EI, 70 eV): *m/z* (%) = 239 (6) [M$^+$], 183 (15), 182 (100), 155 (9), 154 (15), 127 (21); (CI; NH_3): *m/z* (%) = 241 (18), 240 (100) [M$^+$ + 1], 226 (28).

$C_{16}H_{17}NO$ (239.3) Calcd. C 80.29 H 7.16 N 5.85
Found C 80.41 H 7.26 N 5.69

rac- and (R)-2,2-Dimethyl-1-(6-phenyl-pyridin-2-yl)propanol [*rac*-**26** *and* (*R*)-**26**]

a) *By Palladium(0)-Catalyzed Cross Coupling of* **2** *and* **42**: According to procedure E; from 1.41 g (5.76 mmol) of **2**, 0.20 g (0.17 mmol) of tetrakis(triphenylphosphane)palladium(0), 1.22 g (11.53 mmol) of Na_2CO_3, and 0.84 g (6.92 mmol) of **42** after 2.5 h at 85°C (oil bath temp.); 1.73 g of **26** as a crude yellow oil. Purification by chromatography [CC: 65 g of SiO_2, petroleum ether/ethyl acetate (18:1)]. Yield 0.94 g (68%) of **26** as a colorless oil (*rac*-**26**); TLC: R_f = 0.36 [SiO_2, petroleum ether/ethyl acetate (5:1)]. — IR (film): $\tilde{\nu}$ = 3430 cm^{-1}, 2955, 1591, 1570, 1448, 1055, 753, 690. — ^{1}H NMR: δ = 0.96 [s, 9H, C(CH$_3$)$_3$], 4.40 (d, *J* = 7.5 Hz, 1H, OH), 4.63 (d, *J* = 7.5 Hz, 1H, C*H*OH), 7.11 (dd, *J* = 7.4, 1.1 Hz, 1H, aromatic H), 7.41–7.49 (m, 3H, aromatic H), 7.61–7.70 (m, 2H, aromatic H), 7.98–8.01 (m, 2H, aromatic H). — ^{13}C NMR: δ = 26.0 (CH$_3$), 36.4 (C), 80.2 (CH), 119.0 (CH), 121.3 (CH), 126.9 (CH), 128.8 (CH), 129.2 (CH), 136.4 (CH), 138.9 (C), 155.4 (C), 159.6 (C). — MS (EI, 70 eV): *m/z* (%) = 185 (48), 184 (100), 154 (14); (CI, NH_3): *m/z* (%) = 243 (18), 242 (100) [M$^+$ + 1], 184 (27). Coupling of (*R*)-**2** gave (*R*)-**26** with the same e.e. — M.p. 41–42.5°C [for (*R*)-**26**:(*S*)-**26** > 99:1; analysis by HPLC]. — $[\alpha]_D^{RT}$ = −20.8 (*c* = 2.1, $CHCl_3$) [for (*R*)-**26**:(*S*)-**26** > 99:1; analysis by HPLC]. — HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 1.5% 2-propanol in hexane; retention times: (*R*)-**26**: 16.1 min (*k'* = 4.4); (*S*)-**26**: 19.8 min (*k'* = 5.6); *rac*-**26** gave two base-line-separated signals for (*R*)-**26** and (*S*)-**26** with equal peak areas.

$C_{16}H_{19}NO$ (241.4) Calcd. C 79.63 H 7.94 N 5.81
Found C 79.81 H 7.87 N 5.75

Calcd. 226.1232 [M$^+$ − CH$_3$; $C_{15}H_{16}NO$]
Found 226.1228 [MS (HR)]

Analysis of the corresponding *N*-phenylcarbamate: M.p. 124–125°C. — IR (KBr): $\tilde{\nu}$ = 3420 cm^{-1}, 3326, 2968, 1705, 1603, 1545, 1455, 1230, 1008, 750. — ^{1}H NMR: δ = 1.07 [s, 9H, C(CH$_3$)$_3$], 5.66 [s, 1H, C*H*C(CH$_3$)$_3$], 6.80 (br. s, 1H, NH), 7.04 (t, *J* = 7.4 Hz, 1H, aromatic H), 7.22–7.37 (m, 3H, aromatic H), 7.27–7.49 (m, 5H, aromatic H), 7.61–7.73 (m, 2H, aromatic H), 8.02–8.05 (m, 2H, aromatic H). — ^{13}C NMR: δ = 26.2, 35.0, 84.4, 119.1, 120.4, 123.5, 127.2, 128.8, 129.0, 129.2, 136.7, 138.1, 139.6, 153.3, 156.2, 158.5. — MS (EI, 70 eV): *m/z* (%) = 360 (7) [M$^+$], 224 (57), 208 (16), 185 (62), 184 (100), 154 (13); (CI, isobutane): *m/z* (%) = 361 (24) [M$^+$ + 1], 298 (9), 284 (7), 243 (45), 242 (100), 224 (12).

$C_{23}H_{24}N_2O_2$ (360.5) Calcd. C 76.63 H 6.72 N 7.77
Found C 76.65 H 6.69 N 7.49

Camphanates Derived from rac-**26** *and* (1*S*)-**3**: According to procedure A.

Diastereomer A [from (*R*)-**26**]: Data obtained from a mixture of diastereomers. — ^{1}H NMR: δ = 0.97 (s, 3H, CH$_3$), 1.02 (s, 3H, CH$_3$), 1.06 [s, 9H, C(CH$_3$)$_3$], 1.11 (s, 3H, CH$_3$), 1.64–1.73 (m, 1H, CH$_2$), 1.86–2.00 (m, 1H, CH$_2$), 2.01–2.09 (m, 1H, CH$_2$), 2.42–2.51 (m, 1H, CH$_2$), 5.75 [s, 1H, C*H*(CH$_3$)$_3$], 7.23 (dd, *J* = 7.4, 1.1 Hz, 1H, aromatic H), 7.37–7.48 (m, 3H, aromatic H), 7.63–7.76 (m, 2H, aromatic H), 8.01–8.04 (m, 2H, aromatic H).

Diastereomer B [from (*S*)-**26**]: ^{1}H NMR: δ = 0.83 (s, 3H, CH$_3$), 1.06 [s, 9H, C(CH$_3$)$_3$], 1.09 (s, 3H, CH$_3$), 1.14 (s, 3H, CH$_3$), 1.64–173 (m, 1H, CH$_2$), 1.88–2.00 (m, 1H, CH$_2$), 2.01–2.09 (m, 1H, CH$_2$), 2.42–2.51 (m, 1H, CH$_2$), 5.67 [s, 1H, C*H*(CH$_3$)$_3$], 7.24 (dd, *J* = 7.6, 1.0 Hz, 1H, aromatic H), 7.37–7.48 (m, 3H, aromatic H), 7.63–7.76 (m, 2H, aromatic H), 7.99–8.03 (m, 2H, aromatic H). — MS (EI, 70 eV): *m/z* (%) = 365 (9), 185 (13), 184 (100), 169 (21), 83 (11); (CI, NH_3): *m/z* (%) = 422 (100) [M$^+$ + 1], 226 (53), 225 (19), 224 (87), 216 (14).

e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A (characteristic signals).

Diastereomer A [from (*R*)-**26**]: ^{1}H NMR: δ = 5.75 [s, 1H, C*H*C(CH$_3$)$_3$].

Diastereomer B [from (*S*)-**26**]: ^{1}H NMR: δ = 5.67 [s, 1H, C*H*C(CH$_3$)$_3$].

(R)-2,2-Dimethyl-1-(6-phenylpyridin-2-yl)propanol [(*R*)-**26**]

b) *By Asymmetric Reduction of* **24**: A suspension of 1.90 g (5.9 mmol) of (−)-(Ipc)$_2$BCl in 0.8 ml of THF was cooled to 0°C, and 1.14 g (4.8 mmol) of **24** was added. The yellow mixture was allowed to warm to room temp., and stirring was continued for 5 d. TLC analysis {**26**: R_f = 0.46 [petroleum ether/ethyl acetate (5:1)]; samples had to be added to diethanolamine/ether before analysis} indicated incomplete conversion of **24**. The mixture was diluted with 20 ml of diethyl ether, and 1.00 g (9.5 mmol) of diethanolamine was added. Stirring was continued for ca. 12 h, and the white precipitate was separated by filtration. The filter cake was washed with 10 ml of cold diethyl ether, and the combined organic layers were dried with Na_2SO_4. The solvent was removed under reduced pressure to give 2.20 g of a yellow oil. Chromatography [CC: 70 g of SiO_2, petroleum ether/ethyl acetate (8:1)] gave 0.49 g (43%) of (*R*)-**26** and 0.49 g of **24**. Yield 75% (based on conversion of **24**). Enantiomeric ratio (*R*)-**26**:(*S*)-**26** = 93:7 (e.e. analysis by HPLC).

rac-2,2-Dimethyl-1-(6-phenylpyridin-3-yl)propanol (*rac*-**27**): According to procedure E; from 700 mg (2.87 mmol) of *rac*-**17**, 96 mg (0.09 mmol) of tetrakis(triphenylphosphane)palladium(0), 608 mg (11.53 mmol) of Na_2CO_3, and 420 mg (3.44 mmol) of **42** after 3 h at 80−85°C (oil bath temp.); 800 mg of a crude yellow oil. Purification by chromatography [CC: 50 g of SiO_2, petroleum ether/ethyl acetate (5:1)]. Yield 420 mg (61%) of *rac*-**27** as white crystals. − M.p. 121−123°C; TLC: R_f = 0.20 [SiO_2, petroleum ether/ethyl acetate (20:1)]. − IR ($CHCl_3$): $\tilde{\nu}$ = 3520 cm^{-1}, 3020, 2970, 1475, 1040, 705, 690, 660. − ^{1}H NMR: δ = 0.96 [s, 9H, C(CH$_3$)$_3$], 2.26 (br. s, 1H, OH), 4.47 (s, 1H, C*H*OH), 7.38−7.50 (m, 3H, aromatic H), 7.68−7.75 (m, 2H, aromatic H), 7.98−8.00 (m, 2H, aromatic H), 8.56 (s, 1H, aromatic H). − ^{13}C NMR: δ = 25.7 (CH$_3$), 35.8 (C), 79.9 (CH), 119.5 (CH), 126.8 (CH), 128.7 (CH), 128.9 (CH), 135.9 (CH), 136.0 (C), 139.1 (C), 148.9 (CH), 156.3 (C). − MS (EI, 70 eV): *m/z* (%) = 241 (3) [M$^+$], 185 (48), 184 (100); (CI, NH$_3$): *m/z* (%) = 243 (18), 242 (100) [M$^+$ + 1], 226 (34), 184 (9). − HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 10% 2-propanol in hexane; retention times: (*R*)-**27**: 35.4 min (k' = 10.8); (*S*)-**27**: 16.5 min (k' = 4.5). Both enantiomers gave two base-line-separated signals with equal peak areas; the absolute configuration was not determined with certainty.

C$_{16}$H$_{19}$NO (241.3) Calcd. C 79.62 H 7.94 N 5.81
Found C 79.48 H 8.03 N 5.74

Camphanates Derived from rac-**27** *and* (1*S*)-**3**: According to procedure A.

Diastereomer A [from (*R*)-**27**]: ^{1}H NMR: δ = 0.92 (s, 3H, CH$_3$), 1.02 (s, 3H, CH$_3$), 1.07 [s, 9H, C(CH$_3$)$_3$], 1.12 (s, 3H, CH$_3$), 1.66−1.75 (m, 1H, CH$_2$), 1.88−2.11 (m, 2H, CH$_2$), 2.35−2.50 (m, 1H, CH$_2$), 5.71 [s, 1H, C*H*(CH$_3$)$_3$], 7.39−7.50 (m, 3H, aromatic H), 7.66−7.71 (m, 2H, aromatic H), 7.97−8.01 (m, 2H, aromatic H), 8.62−8.64 (m, 1H, aromatic H). − ^{13}C NMR: δ = 9.6 (CH$_3$), 16.7 (CH$_3$), 16.8 (CH$_3$), 25.8 (CH$_3$), 28.9 (CH$_2$), 31.0 (CH$_2$), 35.4 (C), 54.3 (C), 54.9 (C), 81.6 (CH), 91.0 (C), 121.0 (CH), 127.4 (CH), 129.1 (CH), 130.1 (CH), 132.9 (CH), 136.0 (CH), 138.1 (C), 146.8 (CH), 156.0 (C), 166.8 (C), 178.2 (C).

Diastereomer B [from (*S*)-**27**]: Data obtained from a mixture of diastereomers. − ^{1}H NMR: δ = 0.99 (s, 3H, CH$_3$), 1.02 (s, 3H, CH$_3$), 1.10 [s, 9H, C(CH$_3$)$_3$], 1.13 (s, 3H, CH$_3$), 1.66−1.75 (m, 1H, CH$_2$), 1.88−2.11 (m, 2H, CH$_2$), 2.35−2.50 (m, 1H, CH$_2$), 5.66 [s, 1H, C*H*(CH$_3$)$_3$], 7.39−7.50 (m, 3H, aromatic H), 7.66−7.71 (m, 2H, aromatic H), 7.97−8.01 (m, 2H, aromatic H), 8.62−8.64 (m, 1H, aromatic H). − ^{13}C NMR (data given for diastereomers A and B): δ = 9.67 (CH$_3$), 16.79 (CH$_3$), 16.88 (CH$_3$), 25.86/25.91 (CH$_3$), 28.92 (CH$_2$), 30.92/31.01 (CH$_2$), 35.28/35.41 (C), 54.17/54.26 (C), 54.88 (C), 82.17/82.42 (CH), 91.09/91.16 (C), 119.52/119.62 (CH), 126.86 (CH), 128.77 (CH), 129.13 (CH), 131.69/131.74 (C), 136.00/136.00 (CH), 138.76 (C), 148.80 (CH), 157.00 (C), 166.84 (C), 178.17 (C).

e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to general procedure A.

Diastereomer A [from (*R*)-**27**]: ^{1}H NMR: δ = 5.71 [s, 1H, C*H*C(CH$_3$)$_3$].

Diastereomer B [from (*S*)-**26**]: ^{1}H NMR: δ = 5.66 [s, 1H, C*H*C(CH$_3$)$_3$].

(R)-2,2-Dimethyl-1-(6-phenylpyridin-3-yl)propanol [(*R*)-**27**]: A suspension of 480 mg (1.48 mmol) of (−)-(Ipc)$_2$BCl in 0.5 ml of THF was cooled to 0°C, and 177 mg (0.74 mmol) of **25** was added. The orange mixture was stirred at 0°C for 30 min, allowed to warm to room temp., and stirring was continued for 5 d. TLC analysis {**27**: R_f = 0.20 [petroleum ether/ethyl acetate (5:1)]; samples had to be added to diethanolamine/ether before analysis} indicated incomplete conversion of **25**. The mixture was diluted with 10 ml of diethyl ether, and 400 mg (3.7 mmol) of diethanolamine was added. Stirring was continued for ca. 12 h, and the white precipitate was separated by filtration. The filter cake was washed with 5 ml of cold diethyl ether, and the combined organic layers were dried with Na_2SO_4. The solvent was removed under reduced pressure to give 500 mg of a yellow oil. Chromatography [CC: 20 g of SiO_2, petroleum ether/ethyl acetate (5:1)] gave 111 mg (62%) of (*R*)-**27** (absolute configuration not determined with certainty). − $[\alpha]_D^{RT}$ = +40.8 (*c* = 2, CH_2Cl_2). Enantiomeric ratio (*R*)-**27**:(*S*)-**27** = 93:7 (e.e. analysis by HPLC).

Procedure F (Representative of the Radical Debromination). − *(R)-2,2-Dimethyl-1-(pyridin-2-yl)propanol* [(*R*)-**28**][43]: A solution of 248 mg (1.02 mmol) of (*R*)-**2** (chemical purity ca. 92%; rest: **16**), 582 mg (2.00 mmol) of Bu_3SnH, and 64 mg (0.39 mmol) of AIBN in 50 ml of toluene was stirred at 90−100°C (oil bath temp.) for 3.25 h. The solvent was removed under reduced pressure to give 1.01 g of a yellow oil which was purified by chromatography [CC: 40 g of SiO_2, petroleum ether/ethyl acetate (3:1)]. Yield 129 mg (78%) of (*R*)-**28** as a colorless oil (chemical purity ca. 95%; rest Bu_3SnR); TLC: R_f = 0.25 [petroleum ether/ethyl acetate (2:1)]. − ^{1}H NMR: δ = 0.92 [s, 9H, C(CH$_3$)$_3$], 4.32 (d, *J* = 7.2 Hz, 1H, OH), 4.36 (d, *J* = 7.2 Hz, 1H, C*H*OH), 7.18−7.21 (m, 2H, aromatic H), 7.63 (ddd, *J* = 7.7, 7.7, 1.7 Hz, 1H, C*H*OH), 7.18−7.21 (m, 2H, aromatic H), 7.63 (ddd, *J* = 7.7, 7.7, 1.7 Hz, 1H, aromatic H), 8.55 (d, *J* = 4.6 Hz, 1H, aromatic H). − ^{13}C NMR: δ = 25.9, 36.3, 80.3, 122.3, 122.8, 135.4, 147.8, 159.9. − $[\alpha]_D^{RT}$ = +32.5 (*c* = 1.2, EtOH) {ref.[43a] $[\alpha]_D^{20}$ = +27 (*c* = 0.215, EtOH) for (*R*)-**28**:(*S*)-**28** = 71.7:28.3}. Enantiomeric ratio (*R*)-**28**:(*S*)-**28** = 95:5 (e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates and MTPA ester[43a]). e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to procedure A (characteristic signals).

Diastereomer A [from (*R*)-**28**]: ^{1}H NMR: δ = 5.72 [s, 1H, C*H*C(CH$_3$)$_3$].

Diastereomer B [from (*S*)-**28**]: ^{1}H-NMR: δ = 5.64 [s, 1H, C*H*C(CH$_3$)$_3$].

e.e. analysis by ^{1}H-NMR spectroscopy of the esters derived from (−)-(*R*)-MTPA chloride according to procedure A (characteristic signals)[43a].

Diastereomer A [from (*R*)-**28**]: ^{1}H NMR: δ = 0.96 (s, 9H, CH_3), 5.76 [s, 1H, $CHC(CH_3)_3$].

Diastereomer B [from (*S*)-**28**]: ^{1}H NMR: δ = 0.92 (s, 9H, CH_3), 5.80 [s, 1H, $CHC(CH_3)_3$].

(R)-Pyridin-2-ylethanol [(*R*)-**29**][44]: According to procedure F; from 260 mg (1.29 mmol) of (*R*)-**15**, 751 mg (2.58 mmol) of Bu_3SnH, and 70 mg (0.43 mmol) of AIBN. Yield 107 mg of (*R*)-**29** (chemical purity ca. 95%; rest: Bu_3SnR); TLC: R_f = 0.22 (SiO_2, ethyl acetate). – ^{1}H NMR: δ = 1.15 (d, *J* = 6.3 Hz, 3H, CH_3), 4.32 (br. s, 1H, OH), 4.90 (q, *J* = 6.6 Hz, 1H, *CH*OH), 7.19–7.23 (m, 1H, aromatic H), 7.29 (d, *J* = 7.9, 1H, aromatic H), 7.70 (ddd, *J* = 7.7, 7.7, 1.7 Hz, 1H, aromatic H), 8.55 (d, *J* = 4.9 Hz, 1H, aromatic H). – $[\alpha]_D^{RT}$ = +35.3 (*c* = 2.3, EtOH) {ref.[44a] $[\alpha]_D^{25}$ = −49.8 (*c* = 3.1, EtOH) for (*S*)-**29**:(*R*)-**29** = 94:6}. Positive rotation after flash distillation.

(R)-Pyridin-3-ylethanol [(*R*)-**30**][45,13a]: According to procedure F; from 141 mg (0.70 mmol) of (*R*)-**18** (chemical purity ca. 85%; rest: **20**), 408 mg (1.40 mmol) of Bu_3SnH, and 23 mg (0.14 mmol) of AIBN. Yield 45 mg (37%) of (*R*)-**30**; TLC: R_f = 0.21 [SiO_2, ethyl acetate/triethylamine (10:1)]. – ^{1}H NMR: δ = 1.52 (d, *J* = 6.4 Hz, 3H, CH_3), 2.17 (br. s, 1H, OH), 4.97 (q, *J* = 6.4 Hz, 1H, *CH*OH), 7.29 (dd, *J* = 8.0, 5.0 Hz, 1H, aromatic H), 7.74 (ddd, *J* = 7.9, 1.7, 1.7 Hz, 1H, aromatic H), 8.52 (dd, *J* = 4.9, 1.3 Hz, 1H, aromatic H), 8.60 (s, 1H, aromatic H),). – $[\alpha]_D^{RT}$ = +40.3 (*c* ≈ 1.6, MeOH) {ref.[13a] $[\alpha]_D^{20}$ = −43.2 (*c* = 1.86, MeOH) for (*S*)-**30**:(*R*)-**30** = 96:4}.

rac- and (R)-[1-(6-Bromopyridin-2-yl)-2,2-dimethylpropyl] Methyl Ether [*rac*-**31** *and* (*R*)-**31**]: A solution of 1.00 g (4.1 mmol) of **2** in 12 ml of THF was cooled to 0°C, and 0.18 g (80%, 6 mmol) of NaH was added (gas evolution). After stirring at 0°C for 40 min, the resulting suspension was treated with 1.28 g (9 mmol) of methyl iodide. Stirring was continued for 1.5 h at this temp., 10 ml of water was added, and the layers were separated. The organic layer was extracted three times with 20 ml each of diethyl ether, and the combined organic layers were dried with Na_2SO_4. The solvent was removed under reduced pressure to give 1.05 g of the crude product which was purified by chromatography [CC: 30 g of SiO_2, hexane/ethyl acetate (30:1)]. Yield 0.89 g (84%) of **31** as white crystals. – M.p. 42–43°C (*rac*-**31**); TLC: R_f = 0.53 [SiO_2, hexane/ethyl acetate (5:1)]. – IR (KBr): $\tilde{\nu}$ = 2958 cm^{-1}, 1577, 1550, 1428, 1400, 1117, 1095. – ^{1}H NMR: δ = 0.91 [s, 9H, $C(CH_3)_3$], 3.23 (s, 3H, CH_3), 3.96 [s, 1H, $CHC(CH_3)_3$], 7.35 (dd, *J* = 7.6, 0.9 Hz, 1H, aromatic H), 7.38 (dd, *J* = 7.9, 0.9 Hz, 1H, aromatic H), 7.55 (dd, *J* = 7.8, 7.8 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 26.0 (CH_3), 35.7 (C), 57.9 (CH), 91.9 (CH_3), 120.7 (CH), 126.4 (CH), 138.1 (CH), 140.5 (C), 162.5 (C). – MS (EI, 70 eV): *m/z* (%) = 203 (72), 202 (29), 201 (73), 200 (25), 188 (98), 186 (100), 78 (28), 57 (40). – MS (CI, NH_3): *m/z* (%) = 260 (98) [M^+ + 1], 258 (100) [M^+ + 1], 214 (13), 180 (41). Reaction of (*R*)-**2** [(*R*)-**2**:(*S*)-**2** = 97:3, chemical purity ca. 92%; rest: **16**] gave (*R*)-**31** as white crystals. Spectral data identical to those of *rac*-**31**. – M.p. 65–66°C. – $[\alpha]_D^{RT}$ = +84.7 (*c* = 0.99, CH_2Cl_2).

$C_{11}H_{16}BrNO$ (258.2) Calcd. C 51.17 H 6.26 N 5.43
Found C 51.06 H 6.32 N 5.32

(S,S)-6,6'-Bis(1-hydroxy-2,2-dimethylpropyl)-2,2'-bipyridine [(*S,S*)-**32**]: A solution of 1.43 g (6.0 mmol) of $NiCl_2 \cdot 6\,H_2O$ in 35 ml of carefully degassed DMF was heated to 70°C (oil bath temp.), and 6.29 g (24.0 mmol) of triphenylphosphane was added to give a blue solution. Addition of 0.43 g (6.5 mmol) of zinc powder resulted in the formation of a dark red-brown mixture which was stirred at this temp. for 1 h. To this warm solution 1.22 g (5.0 mmol) of (*S*)-**2** [(*S*)-**2**:(*R*)-**2** = 96:4, chemical purity ca. 92%; rest: **16**] was added. After 2 h at 70°C, the mixture was allowed to cool to room temp., and 50 ml of 5% aqueous NH_3 was added to give a brown precipitate. The layers were separated, and the aqueous layer was extracted four times with 70 ml each of CH_2Cl_2/diethyl ether (2:1). The combined organic layers were concentrated under reduced pressure to a volume of ca. 30 ml. After dilution with 70 ml of CH_2Cl_2, the solution was extracted five times with 30 ml each of water and washed once with 50 ml of brine. Drying with Na_2SO_4 and removal of the solvent under reduced pressure gave 6.67 g of an oil which solidified upon standing to give a yellow-white solid. (*S,S*)-**32** was purified by chromatography [CC: 100 g of SiO_2; petroleum ether/ethyl acetate (10:1) (300 ml, for triphenylphosphane) then petroleum ether/ethyl acetate (1:1)] to give 2 fractions. Fraction A: 565 mg of a white solid [mainly **32**, small amount of 2,2-dimethyl-1-(pyridin-2-yl)propanol (**28**)]; fraction B: 28 mg of a white solid (small amount of **32**, mainly **28**). Recrystallization of fraction A from 50 ml of hexane gave 413 mg (50%) of **32** [(*R,R*)-**32** and (*R,S*)-**32** ⩽ 1.5%; analysis by ^{1}H-NMR spectroscopy of the dicamphanates]. – For small-scale reactions (1 mmol), a second chromatography (CC) of prepurified **32** (no recrystallization) was advantageous. – M.p. 158–159°C (hexane); TLC: R_f = 0.40 [SiO_2, petroleum ether/ethyl acetate (1:1)]; R_f = 0.27 [SiO_2, petroleum ether/ethyl acetate (2:1)] {for comparison: PPh_3: R_f = 0.55 [SiO_2, petroleum ether/ethyl acetate (2:1)]; **28**: R_f = 0.21 [SiO_2, petroleum ether/ethyl acetate (2:1)]}. – IR (KBr): $\tilde{\nu}$ = 3450 cm^{-1}, 2958, 2865, 1573, 1445, 1118, 1098, 1012, 805, 765. – ^{1}H NMR: δ = 0.98 [s, 18H, $C(CH_3)_3$], 4.38 (d, D_2O exchange, *J* = 7.5 Hz, 2H, OH), 4.44 (d, *J* = 7.5 Hz, 2H, *CH*OH), 7.23 (dd, *J* = 7.7, 0.7 Hz, 2H, aromatic H), 7.79 (dd, *J* = 7.9, 7.7 Hz, 2H, aromatic H), 8.31 (dd, *J* = 7.9, 0.9 Hz, 2H, aromatic H); (CD_3CN/TMS): δ = 0.94 [s, 18H, $C(CH_3)_3$], 4.04 (d, *J* = 7.0 Hz, 2H, OH), 4.41 (d, *J* = 7.0 Hz, 2H, *CH*OH), 7.36 (d, *J* = 7.8, 2H, aromatic H), 7.85 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.36 (d, *J* = 7.8 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 25.91 (CH_3), 36.27 (C), 80.24 (CH), 119.17 (CH), 123.03 (CH), 136.61 (CH), 153.86 (C), 159.32 (C). – MS (EI, 70 eV): *m/z* (%) = 313 (5), 272 (43), 271 (100), 254 (10), 253 (58), 239 (37), 214 (11), 213 (21), 57 (19); (CI, NH_3): *m/z* (%) = 330 (22), 329 (100) [M^+ + 1], 327 (17), 313 (14), 271 (27). – $[\alpha]_D^{RT}$ = −37.4 (*c* = 1.7, CH_2Cl_2) for (*R,R*)-**32** [(*S,S*)-**32** and (*R,S*)-**32** ⩽ 1%; analysis by ^{1}H-NMR spectroscopy of the dicamphanates]. The structure was confirmed by X-ray diffraction analysis.

$C_{20}H_{28}N_2O_2$ (328.5) Calcd. C 73.12 H 8.61 N 8.53
Found C 73.24 H 8.94 N 8.36

meso-6,6'-Bis(1-hydroxy-2,2-dimethylpropyl)-2,2'-bipyridine (*meso*-**32**): Homocoupling of *rac*-**2** gave 2 diastereomers (*rac*-**32** and *meso*-**32**) in a ratio of ca. 1:1. Their ^{1}H- and ^{13}C-NMR spectra were indistinguishable. They were identified via their dicamphanates.

meso-**32**: TLC: R_f = 0.48 [SiO_2, petroleum ether/ethyl acetate (1:1)]; R_f = 0.32 [SiO_2, petroleum cther/ethyl acetate (2:1)] {for comparison: *rac*-**32**: R_f = 0.27 [SiO_2, petroleum ether/ethyl acetate (2:1)]}. – M.p. 157–158°C (cyclohexane). – ^{1}H NMR: δ = 0.97 [s, 18H, $C(CH_3)_3$], 4.39 (d, D_2O exchange, *J* = 7.5 Hz, 2H, OH), 4.44 (d, *J* = 7.5 Hz, 2H, *CH*OH), 7.23 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.79 (dd, *J* = 7.8, 7.7 Hz, 2H, aromatic H), 8.30 (dd, *J* = 7.8, 1.0 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 25.91 (CH_3), 36.27 (C), 80.24 (CH), 119.17 (CH), 122.99 (CH), 136.61 (CH), 153.89 (C), 159.30 (C).

*Dicamphanates Derived from rac/meso-***32** *and* (1*S*)-**3**: According to procedure A.

Diastereomer A [from (*R,R*)-**32**]: ^{1}H NMR: δ = 0.96 (s, 6H, CH_3), 1.03 (s, 6H, CH_3), 1.05 [s, 18H, $C(CH_3)_3$], 1.12 (s, 6H, CH_3), 1.67–1.73 (m, 2H, CH_2), 1.89–1.96 (m, 2H, CH_2), 2.02–2.09 (m, 2H, CH_2), 2.44–2.51 (m, 2H, CH_2), 5.73 [s, 2H, $CHC(CH_3)_3$], 7.29 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.76 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.35 (d, *J* = 7.8 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 9.7 (CH_3), 16.7 (CH_3), 16.8 (CH_3), 26.2 (CH_3), 28.9 (CH_2), 30.9 (CH_2), 35.1 (C), 54.2 (C), 54.9 (C), 84.8 (CH), 91.2 (C), 119.9 (CH), 122.3 (CH), 136.7 (CH), 154.7 (C), 156.7 (C), 166.9 (C), 178.5 (C).

Diastereomer B [from *meso*-**32**]: ^{1}H NMR: δ = 0.92 (s, 3H, CH_3), 0.96 (s, 3H, CH_3), 1.05 [s, 21H, CH_3 and $C(CH_3)_3$], 1.12 (s, 3H, CH_3), 1.12 (s, 3H, CH_3), 1.14 (s, 3H, CH_3), 1.69–1.74 (m, 2H, CH_2), 1.91–1.97 (m, 2H, CH_2), 2.04–2.09 (m, 2H, CH_2), 2.42–2.49 (m, 2H, CH_2), 5.71 [s, 1H, $CHC(CH_3)_3$], 5.76 [s, 1H, $CHC(CH_3)_3$], 7.30 (dd, *J* = 7.3, 0.8 Hz, 1H, aromatic H), 7.32 (dd, *J* = 7.5, 0.7 Hz, 1H, aromatic H), 7.76 (dd, *J* = 7.9, 7.7 Hz, 1H, aromatic H), 7.77 (dd, *J* = 7.9, 7.7 Hz, 1H, aromatic H), 8.37 (d, *J* = 7.9 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 9.66 (CH_3), 16.69 (CH_3), 16.76 (CH_3), 16.78 (CH_3), 26.16 (CH_3), 26.22 (CH_3), 28.89 (CH_2), 29.02 (CH_2), 30.83 (CH_2), 30.90 (CH_2), 35.00 (C), 35.15 (C), 54.16 (C), 54.20 (C), 54.86 (C), 54.86 (C), 84.82 (CH), 84.95 (CH), 91.19 (C), 91.24 (C), 119.84 (CH), 119.92 (CH), 122.07 (CH), 122.26 (CH), 136.64 (CH), 136.77 (CH), 154.58 (C), 154.69 (C), 156.64 (C), 156.74 (C), 166.87 (C), 166.87 (C), 178.31 (C), 178.44 (C).

Diastereomer C [from (*S,S*)-**32**]: ^{1}H NMR: δ = 0.84 (s, 6H, CH_3), 1.05 [s, 18H, $C(CH_3)_3$], 1.10 (s, 6H, CH_3), 1.14 (s, 6H, CH_3), 1.67–1.73 (m, 2H, CH_2), 1.89–1.96 (m, 2H, CH_2), 2.02–2.09 (m, 2H, CH_2), 2.44–2.51 (m, 2H, CH_2), 5.66 [s, 2H, $CHC(CH_3)_3$], 7.32 (dd, *J* = 7.7, 0.9 Hz, 2H, aromatic H), 7.77 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.35 (dd, *J* = 7.9, 1.0 Hz, 2H, aromatic H).

e.e. analysis by ^{1}H-NMR spectroscopy of the dicamphanates derived from (1*S*)-**3** according to procedure A (characteristic signals).

Diastereomer A [from (*R,R*)-**32**]; ^{1}H NMR: δ = 5.73 [s, 2H, $CHC(CH_3)_3$].

Diastereomer B (from *meso*-**32**): ^{1}H NMR: δ = 5.71 [s, 1H, $CHC(CH_3)_3$], 5.76 [s, 1H, $CHC(CH_3)_3$].

Diastereomer C [from (*S,S*)-**32**]: ^{1}H NMR: δ = 5.66 [s, 2H, $CHC(CH_3)_3$].

Crystal-Structure Determination[27]: A summary of the data collection and structure refinement parameters is given in Table 4. Table 5 contains the fractional atomic coordinates for compound (*R,R*)-**32**.

(S,S)-6,6'-Bis(1-hydroxy-2,2-dimethylpropyl)-2,2'-bipyridine Copper Tetrafluoroborate Complex [(*S,S*)-**32** · $CuBF_4$]: A solution of 4.9 mg (0.015 mmol) of (*S,S*)-**32** in 0.8 ml of [D_3]acetonitrile was treated with 6.2 mg (0.020 mmol) of $CuBF_4 \cdot 4\,CH_3CN$. A clear yellow solution resulted which was examined by ^{1}H-NMR spectroscopy. The solvent was removed under reduced pressure to give a red solid that was analyzed by FAB MS. – ^{1}H NMR (CD_3CN/TMS): δ = 0.97 [s, 18H, $C(CH_3)_3$], 3.85 (d, *J* = 4.4 Hz, 2H, OH), 4.93 (d, *J* = 4.3 Hz, 2H, CHOH), 7.70 (d, *J* = 7.8, 2H, aromtic H), 8.03 (dd, *J* = 7.9, 7.9 Hz, 2H, aromatic H), 8.18 (d, *J* = 7.9 Hz, 2H, aromatic H). – MS (FAB, NMA): *m/z* (%) = 394 (11) [**32**$^+$ + Cu + 1], 393 (50) [**32**$^+$ + Cu + 1], 392 (29) [**32**$^+$ + Cu], 391 (100) [**32**$^+$ + Cu], 333 (15), 301 (16).

(R,R)-6,6'-Bis(1-methoxy-2,2-dimethylpropyl)-2,2'-bipyridine [(*R,R*)-**33**]: A solution of 1.11 g (4.65 mmol) of $NiCl_2 \cdot 6\,H_2O$ in 20 ml of carefully degassed DMF was heated to 72°C (oil bath temp.), and 4.89 g (18.62 mmol) of triphenylphosphane was added to give a blue solution. Addition of 0.33 g (5.04 mmol) of zinc powder resulted in the formation of a dark red-brown mixture which was stirred at this temp. for 1 h. To this solution 1.00 g (3.88 mmol) of (*R*)-**31** [(*R*)-**31**:(*S*)-**31** = 97:3, chemical purity ca. 92%; rest: methyl ether of **16**] was added. After 3 h at 70°C, the mixture was allowed to cool to room temp., and 20 ml of 5% aqueous NH_3 was added to give a brown precipitate. The layers were separated, and the aqueous layer was extracted three times with 80 ml each of CH_2Cl_2/diethyl ether (2:1). The combined organic layers were extracted three times with 20 ml each of water and washed once with 50 ml of brine. Drying with Na_2SO_4 and removal of the solvent under reduced pressure gave 6.8 g of an oil that solidified upon standing to give a yellow-white solid. **33** was purified by chromatography [CC: 250 g of SiO_2, hexane/ethyl acetate (50:1, for triphenylphosphane) then hexane/ethyl acetate (10:1)]. Yield 0.45 g (65%) of (*R,R*)-**33** as white crystals. – M.p. 154–155°C; TLC: R_f = 0.43 [SiO_2, hexane/ethyl acetate (8:1)]. – IR (KBr): $\tilde{\nu}$ = 2975 cm^{-1}, 1575, 1568, 1440, 972, 812, 776. – ^{1}H NMR: δ = 0.98 [s, 18H, $C(CH_3)_3$], 3.27 (s, 6H, OCH_3), 4.08 [s, 2H, $CHC(CH_3)_3$], 7.38 (dd, *J* = 7.8, 1 Hz, 2H, aromatic H), 7.80 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.26 (dd, *J* = 7.8, 1 Hz, 2H, aromatic H); (CD_3CN/TMS): δ = 0.95 [s, 18H, $C(CH_3)_3$], 3.23 (s, 6H, OCH_3), 4.04 (s, 2H, $CHOCH_3$), 7.39 (dd, *J* = 7.8, 1.1 Hz, 2H, aromatic H), 7.87 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.29 (dd, *J* = 7.8, 1.0 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 26.3 (CH_3), 35.5 (C), 57.6 (CH_3), 92.8 (CH), 119.6 (CH), 121.6 (CH), 136.6 (CH), 155.1 (C), 159.9 (C).

Table 4. Crystal-structure determination data for (*R,R*)-**32**

Formula $C_{20}H_{28}N_2O_2$; M_r = 328.50
a = 6.596(6), *b* = 12.957(2), *c* = 11.640(2) Å; β = 105.23(2)°; *V* = 959.96 Å^3; monoclinic system; space group $P2_1$ (No. 4)
μ(Mo K_α) = 4.1 cm^{-1}; graphite monochromator; *T* = 22°C;
$(\sin\Theta/\lambda)_{max}$ = 28, +/−*h*, +*k*, +*l* range
2193 independent reflexions; 1931 used reflections; 234 refined parameters; *R* = 0.052; R_w = 0.054; *w* = 1.6131/[$\sigma^2(F)$ + 0.000658 F^2]

Table 5. Fractional atomic coordinates for (*R,R*)-**32**

Atom	x/a	y/b	z/c	B_{eq}[a]
N1	0.3692 (4)	-0.1772 (4)	0.9151 (2)	2.50
O1	0.6946 (3)	-0.1926 (4)	1.1057 (2)	3.98
N2	0.1245 (4)	-0.1203 (3)	0.6076 (2)	2.57
O2	0.0281 (3)	-0.1299 (4)	0.2946 (2)	3.81
C1	0.2250 (5)	-0.1429 (4)	0.8187 (2)	2.64
C2	0.0370 (5)	-0.1022 (4)	0.8261 (3)	3.67
C3	-0.0038 (6)	-0.0948 (4)	0.9365 (3)	4.52
C4	0.1432 (5)	-0.1304 (4)	1.0347 (3)	4.11
C5	0.3262 (5)	-0.1717 (4)	1.0198 (2)	2.74
C6	0.4951 (5)	-0.2116 (4)	1.1254 (2)	2.85
C7	0.4722 (6)	-0.3255 (4)	1.1571 (3)	3.46
C8	0.4920 (8)	-0.3957 (4)	1.0561 (4)	5.13
C9	0.6498 (8)	-0.3498 (5)	1.2684 (4)	5.33
C10	0.2627 (7)	-0.3428 (4)	1.1861 (4)	5.71
C11	0.2787 (5)	-0.1450 (4)	0.7031 (2)	2.52
C12	0.4791 (5)	-0.1678 (4)	0.6950 (3)	3.40
C13	0.5221 (5)	-0.1616 (4)	0.5857 (3)	3.79
C14	0.3635 (5)	-0.1340 (4)	0.4874 (3)	3.62
C15	0.1652 (5)	-0.1145 (4)	0.5019 (2)	2.57
C16	-0.0167 (5)	-0.0874 (4)	0.3978 (2)	2.70
C17	-0.0636 (6)	0.0300 (0)	0.3824 (3)	3.70
C18	0.1247 (8)	0.0882 (5)	0.3658 (6)	6.95
C19	-0.2487 (8)	0.0439 (5)	0.2724 (4)	5.55
C20	-0.1309 (8)	0.0717 (5)	0.4904 (4)	5.15

[a] $B_{eq} = 8\pi^2(U_{11} + U_{22} + U_{33})/3$.

– MS (EI, 70 eV): *m/z* (%) = 356 (8) [M^+], 300 (38), 285 (55), 253 (100). – $[\alpha]_D^{RT}$ = +148.5 (*c* = 1.1, CH_2Cl_2).

$C_{22}H_{32}N_2O_2$ (356.6) Calcd. C 74.10 H 9.06 N 7.86
Found C 74.20 H 9.18 N 7.75

meso-6,6'-Bis(1-methoxy-2,2-dimethylpropyl)-2,2'-bipyridine (*meso*-**33**): Nickel(0)-mediated homocoupling of *rac*-**31** gave a ca. 1:1 mixture of *rac*-**33** and *meso*-**33**; TLC: R_f = 0.52 [SiO_2, hexane/ethyl acetate (8:1)]. – M.p. 162–163°C. The spectral data were identical with those of (*R,R*)-**33**.

(R,R)-6,6'-Bis(1-methoxy-2,2-dimethylpropyl)-2,2'-bipyridine Cobalt Dichloride Complex [(*R,R*)-**33** · $CoCl_2$]: A refluxing solution of 71 mg (0.199 mmol) of (*R,R*)-**33** in a mixture of 3 ml of methanol and 3 ml of acetonitrile was treated with 48 mg (0.202 mmol) of $CoCl_2 \cdot 6\ H_2O$. The blue solution which contained blue crystals was refluxed for 15 min. Cooling to room temp. gave 20 mg of blue crystals which were separated by filtration and recrystallized from 10 ml of hexane to give 11 mg of (*R,R*)-**33** · $CoCl_2$. The remaining solvent of the methanol/acetonitrile solution was removed under reduced pressure to give ca. 100 mg of a blue solid. Recrystallization from 50 ml of toluene gave additional 70 mg of (*R,R*)-**33** · $CoCl_2$ as fine blue needles. Yield 81 mg (84%) of (*R,R*)-**33** · $CoCl_2$ as blue needles. – M.p. >240°C. – IR (KBr): $\tilde{\nu}$ = 2970 cm^{-1}, 2955, 1597, 1570, 1478, 1455, 1430, 1163, 1085, 818. – MS (FAB, NBA): *m/z* (%) = 452 (2), 451 (1), 450 (6), 358 (26), 357 (100); (FD): *m/z* (%) = 490 (36) [M^+ + 1], 489 (43) [M^+ + 1], 488 (81) [M^+], 487 (51) [M^+], 486 (100) [M^+]. – $[\alpha]_D^{RT}$ = +352 (*c* = 0.15, acetone).

$C_{22}H_{32}Cl_2CoN_2O_2$ (486.4) Calcd. C 54.32 H 6.65 N 5.76
Found C 54.21 H 6.62 N 5.77

Preparation of the crystals for X-ray analysis[7]: After the addition of $CoCl_2 \cdot 6\ H_2O$ to (*R,R*)-**33**, the clear solution was slowly cooled to room temp. The blue crystals were isolated by filtration, washed with small amounts of water followed by CH_2Cl_2 and dried in air. Recrystallization from toluene gave needles which were not suitable for X-ray diffraction analysis.

(R,R)-6,6'-Bis(1-methoxy-2,2-dimethylpropyl)-2,2'-bipyridine Palladium Dichloride Complex [(*R,R*)-**33** · $PdCl_2$ · HCl]: A refluxing solution (85°C oil bath temp.) of 36 mg (0.101 mmol) of (*R,R*)-**33** in 3 ml of methanol was added through a cannula to a preheated brown solution of 18 mg (0.102 mmol) of $PdCl_2$ in 1.5 ml of 2 M HCl (no color change). The mixture was allowed to cool to room temp. and kept in air for slow concentration of the solution. After 7 d, 29 mg (50%) of brown crystals was isolated by filtration. – ^{1}H NMR (CD_3CN/TMS): δ = 0.97 [s, 18H, $C(CH_3)_3$], 3.35 (s, 6H, OCH_3), 4.32 (s, 2H, $CHOCH_3$), 7.83 (d, *J* = 8.0 Hz, 2H, aromatic H), 8.38 (dd, *J* = 7.7, 7.7 Hz, 2H, aromatic H), 8.46 (dd, *J* = 8.1, 0.8 Hz, 2H, aromatic H).

$C_{22}H_{33}Cl_3N_2O_2Pd$ (570.3) Calcd. C 46.33 H 5.66 N 4.91
Found C 46.26 H 5.65 N 5.04

(R,R)-6,6'-Bis(1-methoxy-2,2-dimethylpropyl)-2,2'-bipyridine Copper(I) Complex: A suspension of 3.2 mg (0.009 mmol) of (*R,R*)-**33** in 0.7 ml of [D_3]acetonitrile was slightly warmed and filtered to give a clear solution which was treated with 2.7 mg (0.011 mmol) of $CuSO_3CF_3 \cdot 0.5\ C_6H_6$. A ^{1}H-NMR spectrum was recorded after the addition (slight broadening). – ^{1}H NMR (CD_3CN/TMS): δ = 0.96 [s, 18H, $C(CH_3)_3$], 3.28 (s, 6H, OCH_3), 4.55 (s, 2H, $CHOCH_3$), 7.37 (benzene), 7.69 (d, *J* = 7.6 Hz, 2H, aromatic H), 8.09 (dd, *J* = 7.6, 7.6 Hz, 2H, aromatic H), 8.21 (d, *J* = 7.7 Hz, 2H, aromatic H).

(R,R)-6,6'-Bis(1-methoxy-2,2-dimethylpropyl)-2,2'-bipyridine Silver(I) Complex: A suspension of 4.0 g (0.011 mmol) of (*R,R*)-**33** in 0.7 ml of [D_3]acetonitrile was slightly warmed and added to 4.8 mg (0.019 mmol) of $AgSO_3CF_3$. A clear solution was obtained after filtration, and a ^{1}H-NMR spectrum was recorded. – ^{1}H NMR (CD_3CN/TMS): δ = 0.94 [s, 18H, $C(CH_3)_3$], 3.28 (s, 6H, OCH_3), 4.20 (s, 2H, $CHOCH_3$), 7.62 (d, *J* = 7.7 Hz, 2H, aromatic H), 8.07 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.24 (d, *J* = 7.9 Hz, 2H, aromatic H).

rac-1-(6-Bromopyridin-2-yl)ethyl Trimethylsilyl Ether (*rac*-**34**): A solution of 303 mg (1.5 mmol) of *rac*-**15** in 2 ml of DMF was treated with 225 mg (3.3 mmol) of imidazole followed by 196 mg (0.23 ml, 1.8 mmol) of trimethylsilyl chloride (addition over a period of 15 min). After stirring for 2.5 h at room temp., 50 ml of petroleum ether was added, and the solution was extracted twice with 10 ml each of water. The organic layer was washed with brine and dried with Na_2SO_4. The solvent was removed under reduced pressure to give 350 mg of a colorless oil which was purified by chromatography [CC: 10 g of Al_2O_3, petroleum ether/ethyl acetate (10:1)]. Yield 150 mg (36%) of *rac*-**34** as a colorless oil; TLC: R_f = 0.67 [Al_2O_3, petroleum ether/ethyl acetate (5:1)]. – IR (film): $\tilde{\nu}$ = 2955 cm^{-1}, 1580, 1551, 1430, 1401, 1249, 1128, 858, 838. – ^{1}H NMR: δ = 0.12 [s, 9H, $Si(CH_3)_3$], 1.46 (d, *J* = 6.6 Hz, 3H, CH_3), 4.91 (q, *J* = 6.6 Hz, 1H, $CHCH_3$), 7.33 (d, *J* = 7.2 Hz, 1H, aromatic H), 7.45–7.57 (m, 2H, aromatic H). – ^{13}C NMR: δ = 0.0, 25.3, 71.2, 118.1, 126.0, 139.0, 140.7, 167.4. – MS (EI, 70 eV): *m/z* (%) = 260 (100), 258 (99), 75 (38), 73 (76); (CI, NH_3): *m/z* (%) = 276 (100) [M^+ + 1], 274 (98) [M^+ + 1].

$C_{10}H_{16}BrNOSi$ (274.2) Calcd. C 43.80 H 5.90 N 5.11
Found C 43.76 H 5.43 N 5.01

(S)-1-(6-Bromopyridin-2-yl)ethyl Acetate [(*S*)-**35**]: A solution of 1.68 g (8.3 mmol) of (*S*)-**15** [(*R*)-**15**:(*S*)-**15** < 0.5:99.5] in 1.7 ml of pyridine was cooled to 0°C, and 2.1 ml of acetic anhydride was added dropwise. The solution was allowed to warm to room temp., and stirring was continued for 14 h. Careful addition of 40 ml of ice-cold water was followed by separation of the layers. The aqueous layer was extracted four times with 20 ml each of CH_2Cl_2, and the combined organic layers were washed with 20 ml of brine and dried with Na_2SO_4. The solvent was removed under reduced pressure to give 2.50 g of a slightly yellow oil which was purified by chromatography [CC: 60 g of SiO_2, petroleum ether/ethylacetat (5:1)]. Yield 1.81 g (89%) of (*S*)-**35** [(*R*)-**35**:(*S*)-**35** < 0.5:99.5; determined by HPLC] as a colorless oil; TLC: R_f = 0.44 [SiO_2, petroleum ether/ethyl acetate (2:1)]. – IR (film): $\tilde{\nu}$ = 2965 cm^{-1}, 1721, 1575, 1545, 1424, 1360, 1227, 1120. – ^{1}H NMR: δ = 1.58 (d, *J* = 6.7 Hz, 3H, $CHCH_3$), 2.13 (s, 3H, $COCH_3$), 5.86 (q, *J* = 6.7 Hz, 1H, $CHCH_3$), 7.31 (d, *J* = 8.2 Hz, 1H, aromatic H), 7.39 (d, *J* = 7.9, 1H, aromatic H), 7.55 (dd, *J* = 7.8, 7.8 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 20.6, 21.1, 72.3, 118.9, 127.0, 139.0, 141.4, 161.8, 169.9. – MS (EI, 70 eV): *m/z* (%) = 203 (20), 202 (68), 201 (21), 200 (68), 186 (22), 104 (29), 78 (22), 43 (100); (CI, NH_3): *m/z* (%) = 246 (99) [M^+ + 1], 244 (100) [M^+ + 1]. – $[\alpha]_D^{RT}$ = +65.0 (*c* = 2.58, EtOH) for (*R*)-**35** [(*R*)-**35**:(*S*)-**35** = 95:5; analysis by ^{1}H-NMR spectroscopy of the MTPA ester]. – HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 1% 2-propanol in hexane; retention times: (*R*)-**35**: 8.2 min (*k'* = 1.8); (*S*)-**35**: 9.8 min (*k'* = 2.3); *rac*-**35** gave two base-line-separated signals for (*R*)-**35** and (*S*)-**35** with equal peak areas.

$C_9H_{10}BrNO_2$ (244.1) Calcd. C 44.29 H 4.13 N 5.74
Found C 43.99 H 3.72 N 5.29

(S,S)-6,6'-Bis(1-acetoxyethyl)-2,2'-bipyridine [(*S,S*)-**37**]: A solution of 3.45 g (14.5 mmol) of $NiCl_2 \cdot 6\ H_2O$ in 100 ml of carefully degassed DMF was heated to 70°C (oil bath temp.), and 15.24 g (58.1 mmol) of triphenylphosphane was added to give a blue solution. Addition of 1.03 g (15.7 mmol) of zinc powder resulted in

the formation of a dark red-brown mixture that was stirred at this temp. for 1 h. A solution of 2.95 g (12.1 mmol) of (*S*)-**35** [(*S*)-**35**:(*R*)-**35** > 99.5:0.5] in 3 ml of carefully degassed DMF was added. After 2.25 h at 70°C, the mixture was allowed to cool to room temp., and 120 ml of 5% aqueous NH_3 was added to give a brown precipitate. The mixture was extracted three times with 150 ml each of CH_2Cl_2/diethyl ether (2:1). The combined organic lavers were concentrated under reduced pressure to a volume of ca. 130 ml. After addition of 350 ml of CH_2Cl_2, the mixture was extracted seven times with 200 ml each of water and washed once with 150 ml of brine. Drying with Na_2SO_4 followed by removal of the solvent under reduced pressure gave 15.97 g of an oil which solidified upon standing to give a red solid. Chromatography {FC [column width: 8 cm; packing hight: 15 cm]: Al_2O_3, petroleum ether/ethyl acetate (4:1)} gave 3 fractions (A–C). Fraction A: 130 mg of **37** (slighly impure); fraction B: 670 mg of **37**; fraction C: 170 mg (9%) of (*S*)-1-(pyridin-2-yl)ethyl acetate (**36**). A second chromatography of fraction A [CC: Al_2O_3, petroleum ether/ethyl acetate (7:1)] gave 109 mg of **37**. Yield 779 mg (39%) of (*S,S*)-**37**; TLC: R_f = 0.31 [Al_2O_3, petroleum ether/ethyl acetate (4:1)]. – ^{1}H NMR: δ = 1.66 (d, *J* = 6.6 Hz, 6H, CH_3), 2.15 (s, 6H, $COCH_3$), 6.02 (q, *J* = 6.6 Hz, 2H, $CHCH_3$), 7.35 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.80 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.38 (d, *J* = 7.9 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 20.5, 21.2, 73.0, 119.9, 120.0, 137.3, 155.2, 159.4, 170.1. (*S,S*)-**37** was used without further analysis for the synthesis of (*S,S*)-**38**. – ^{13}C-NMR and MS analysis of a mixture of (*S,S*)-**37** and (*S*)-**36**.

(*S,S*)-**37**: MS (EI, 70 eV, 250°C): *m/z* (%) = 285 (58), 269 (46), 225 (90), 209 (100), 43 (63); (CI, NH_3, 300°C): *m/z* (%) = 329 (19) [M^+ + 1], 271 (19), 213 (100).

(*S*)-**36**: MS (EI, 70 eV, 100°C): *m/z* (%) = 122 (100), 108 (25), 106 (74), 79 (33), 43 (61); (CI, NH_3, 100°C): *m/z* (%) = 166 (41) [M^+ + 1], 108 (100).

(S)-1-(Pyridin-2-yl)ethyl Acetate [(*S*)-**36**][44a]: ^{1}H NMR: δ = 1.60 (d, *J* = 7 Hz, 3H, CH_3), 2.12 (s, 3H, $COCH_3$), 5.91 (q, *J* = 7 Hz, $CHCH_3$), 7.19 (dd, *J* = 8, 4 Hz, 1H, aromatic H), 7.31 (d, *J* = 7 Hz, 1H, aromatic H), 7.67 (ddd, *J* = 7, 7, 2 Hz, 1H, aromatic H), 8.58 (d, *J* = 4 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 20.6, 21.1, 73.0, 120.3, 122.5, 136.6, 149.2, 160.1, 170.1.

(S,S)-6,6'-Bis(1-hydroxyethyl)-2,2'-bipyridine [(*S,S*)-**38**]: A solution of 0.50 g (1.52 mmol) of (*S,S*)-**37** in 10 ml of methanol was treated with 1.58 g (11.43 mmol) of K_2CO_3, and the resulting suspension was stirred at room temp. for 25 min. The solid was separated by filtration and washed with 30 ml of methanol. The combined solutions were concentrated under reduced pressure (to a volume of 3 ml; formation of white precipitate), and 10 ml of water was added to the residue. The mixture was extracted five times with 10 ml each of CH_2Cl_2, and the combined organic layers were washed with 15 ml of brine and dried with Na_2SO_4. Removal of the solvent under reduced pressure gave 337 mg (91%) of a white crystalline solid (no impurities observed by ^{1}H-NMR spectroscopy). Recrystallization from 20 ml of hexane/1 ml of ethyl acetate gave 237 mg of (*S,S*)-**38**. – M.p. 77.5–79°C. – IR (KBr): $\tilde{\nu}$ = 3290 cm^{-1}, 2955, 1568, 1428, 1100, 1074, 791. – ^{1}H NMR: δ = 1.57 (d, *J* = 6.6 Hz, 6H, CH_3), 4.52 (d, *J* = 4.9 Hz, 2H, OH), 4.97 (dq, *J* = 6.6, 5.0 Hz, 2H, $CHCH_3$), 7.31 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.85 (dd, *J* = 7.7, 7.7 Hz, 2H, aromatic H), 8.35 (d, *J* = 7.7 Hz, 2H, aromatic H); (CD_3CN/TMS): δ = 1.49 (d, *J* = 6.5 Hz, 6H, CH_3), 3.98 (br. s, 2H, OH), 4.89 (q, *J* = 6.4 Hz, 2H, $CHCH_3$), 7.47 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.89 (dd, *J* = 7.8 Hz, 2H, aromatic H), 8.36 (d, *J* = 7.8 Hz, 2H, aromatic H). – ^{13}C NMR: δ = 24.3, 68.6, 119.5, 120.1, 137.8, 153.9, 162.3. – MS (EI, 70 eV): *m/z* (%) = 244 (11) [M^+], 229 (100), 227 (19), 226 (15), 225 (23), 211 (87), 209 (26), 183 (32), 78 (21). – $[\alpha]_D^{RT}$ = +39.7 (*c* = 0.32, $CHCl_3$) for (*S,S*)-**38** [no (*R,R*)-**38** or (*S,R*)-**38** detected by ^{1}H-NMR spectroscopy of the MTPA diester].

$C_{14}H_{16}N_2O_2$ (244.3) Calcd. C 68.82 H 6.61 N 11.47
Found C 68.68 H 6.59 N 11.24

e.e. analysis by ^{1}H-NMR spectroscopy of the MTPA diesters derived from (*R*)-MTPA chloride according to procedure A (characteristic signals).

Diastereomer A [from (*S,S*)-**38**]: ^{1}H NMR: δ = 8.41 (dd, *J* = 7.9, 0.9 Hz, 2H, aromatic H).

Diastereomer B (from *meso*-**38**): ^{1}H NMR: δ = 8.32 (dd, *J* = 7.8, 0.9 Hz, 1H, aromatic H), 8.37 (dd, *J* = 7.9, 0.9 Hz, 1H, aromatic H).

Diastereomer C [from (*R,R*)-**38**]: ^{1}H NMR: δ = 8.28 (dd, *J* = 7.9, 0.9 Hz, 2H, aromatic H).

Homocoupling of *rac*-**35** followed by saponification of the corresponding diacetates gave 2 diastereomers (*rac*-**38** and *meso*-**38**) in a ca. 1:1 ratio. Their ^{1}H- and ^{13}C-NMR spectra were indistinguishable. They were identified via their MTPA diesters. Homocoupling of (*S*)-**35** with lower e.e. [(*S*)-**35**:(*R*)-**35** = 96:4] followed by saponification of the corresponding diacetates gave the 2 diastereomers (*S,S*)-**38** and *meso*-**38** in a ratio of ca. 92:8; (*R,R*)-**38** was not detected (analysis by ^{1}H-NMR spectroscopy of the MTPA diesters). – M.p. 72–73°C. Recrystallization from hexane/ethyl acetate (as described above) did not change the d.e. (Δd.e. < 2%).

*MTPA Diesters from rac/meso-***38** *and (R)-MTPA Chloride:* According to procedure A.

Diastereomer A [from (*S,S*)-**38**]: ^{1}H NMR: δ = 1.71 (d, *J* = 6.7 Hz, 6H, CH_3), 3.54 (s, 6H, OCH_3), 6.22 (q, *J* = 6.6 Hz, 2H, $CHCH_3$), 7.30–7.40 (m, 9H, aromatic H), 7.55 (d, *J* = 7.6, 2H, aromatic H), 7.80 (dd, *J* = 7.7, 7.7 Hz, 2H, aromatic H), 8.41 (dd, *J* = 7.9, 0.9 Hz, 2H, aromatic H).

Diastereomer B (from *meso*-**38**): ^{1}H NMR: δ = 1.71 (d, *J* = 6.7 Hz, 3H, CH_3), 1.77 (d, *J* = 6.7 Hz, 3H, CH_3), 3.54 (s, 3H, OCH_3), 3.61 (s, 3H, OCH_3), 6.22 (q, *J* = 6.6 Hz, 1H, $CHCH_3$), 6.23 (q, *J* = 6.6 Hz, 1H, $CHCH_3$), 7.15 (d, *J* = 7.3 Hz, 1H, aromatic H), 7.30–7.40 (m, 7H, aromatic H), 7.54 (m, 3H, aromatic H), 7.73 (dd, *J* = 7.9, 7.9 Hz, 1H, aromatic H), 7.77 (dd, *J* = 7.9, 7.9 Hz, 1H, aromatic H), 8.32 (dd, *J* = 7.9, 0.9 Hz, 1H, aromatic H), 8.37 (dd, *J* = 7.8, 0.9 Hz, 1H, aromatic H).

Diastereomer C [from (*R,R*)-**38**]: ^{1}H NMR: δ = 1.77 (d, *J* = 6.6 Hz, 6H, CH_3), 3.61 (s, 6H, OCH_3), 6.23 (q, *J* = 6.6 Hz, 2H, $CHCH_3$), 7.16 (d, *J* = 7.7 Hz, 2H, aromatic H), 7.30–7.40 (m, 7H, aromatic H), 7.52 (d, *J* = 7.6, 3H, aromatic H), 7.70 (dd, *J* = 7.8, 7.8 Hz, 2H, aromatic H), 8.28 (dd, *J* = 7.9, 0.9 Hz, aromatic H).

(S,S)-6,6'-Bis(1-hydroxyethyl)-2,2'-bipyridine Copper Tetrafluoroborate Complex [(*S,S*)-**38** · $CuBF_4$]: A solution of 2.5 mg (0.010 mmol) of (*S,S*)-**38** in 0.8 ml of [D_3]acetonitrile was treated with 5.5 mg (0.018 mmol) of $CuBF_4 \cdot 4\ CH_3CN$. A clear yellow solution resulted which was examined by ^{1}H-NMR spectroscopy (broadening of some signals was observed). – ^{1}H NMR (CD_3CN/TMS): δ = 1.43 (br. s, 6H, CH_3), 3.77 (br. s, 2H, OH), 5.15 (br. s, 2H, CHOH), 7.84 (d, *J* = 7.4, 2H, aromatic H), 8.14 (dd, *J* = 7.9, 7.9 Hz, 2H, aromatic H), 8.27 (br. d, *J* = 7.6 Hz, 2H, aromatic H).

rac- and (S)-2,2-Dimethyl-1-[6-(naphthalen-2-yl)pyridin-2-yl]-propanol [*rac*-**39** and (*S*)-**39**]: According to procedure E; from 488 mg (2 mmol) of **2**, 70 mg (0.06 mmol) of tetrakis(triphenylphosphane)palladium(0), 424 mg (4 mmol) of Na_2CO_3,

and 413 mg (2.4 mmol) of naphthalen-2-ylboronic acid (**43**) after 6.25 h at 80–85°C (oil bath temp.); 730 mg of crude **39**. Purification by chromatography [CC: 20 g of SiO_2, petroleum ether/ethyl acetate (10:1)]. Yield 480 mg (83%) of **39** as a viscous oil; TLC: R_f = 0.54 [SiO_2, petroleum ether/ethyl acetate (2:1)]. – IR (film): $\tilde{\nu}$ = 3420 cm^{-1}, 2950, 1570, 1450, 1388, 1054, 1011, 795, 733. – ^1H NMR: δ = 1.00 [s, 9H, $C(CH_3)_3$], 4.47 (d, J = 7.5 Hz, 1H, OH), 4.55 (d, J = 7.5 Hz, 1H, C*H*OH), 7.24 (d, J = 8.2 Hz, 1H, aromatic H), 7.45–7.60 (m, 5H, aromatic H), 7.78 (dd, J = 7.8, 7.8 Hz, 1H, aromatic H), 7.93 (d, J = 7.2 Hz, 2H, aromatic H), 8.08 (d, J = 8.2 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 26.1 (CH_3), 36.5 (C), 80.2 (CH), 121.2 (CH), 123.6 (CH), 125.2 (CH), 125.6 (CH), 125.9 (CH), 126.3 (CH), 127.6 (CH), 128.4 (CH), 128.9 (CH), 131.1 (C), 133.8 (C), 135.9 (CH), 138.2 (C), 157.3 (C), 159.4 (C). – MS (EI, 70 eV): m/z (%) = 235 (51), 234 (100), 204 (12); (CI, NH_3): m/z (%) = 293 (22), 292 (100) [M^+ + 1], 276 (17). Reaction of (*S*)-**2** [(*S*)-**2**:(*R*)-**2** = 95:5] gave (*S*)-**39** with the same e.e. – $[\alpha]_D^{RT}$ = +33.9 (c = 3.94, EtOH) [(*S*)-**39**:(*R*)-**39** = 95:5; analysis by ^1H-NMR spectroscopy of the camphanates]. The e.e. was raised by chromatography of the corresponding camphanate followed by saponification. – $[\alpha]_D^{RT}$ = +34.2 (c = 3.8, EtOH) [(*S*)-**39**:(*R*)-**39** = 99:1; analysis by ^1H-NMR spectroscopy of the camphanates].

Data of the corresponding 3,5-dinitrobenzoate: ^1H NMR: δ = 1.19 [s, 9H, $C(CH_3)_3$], 5.98 [s, 1H, C*H*$C(CH_3)_3$], 7.33 (ddd, J = 8.4, 6.8, 1.3 Hz, 1H, aromatic H), 7.39 (dd, J = 7.9, 0.8 Hz, 1H, aromatic H), 7.45 (ddd, J = 8.1, 6.8, 1.2 Hz, 1H, aromatic H), 7.50–7.57 (m, 3H, aromatic H), 7.82 (dd, J = 7.8, 7.8 Hz, 1H, aromatic H), 7.85–7.89 (m, 1H, aromatic H), 7.98 (dd, J = 8.5, 1.0 Hz, 1H, aromatic H), 9.18–9.20 (m, 3H, aromatic H). – ^{13}C NMR: δ = 26.4, 35.6, 86.4, 120.3, 122.3, 124.3, 125.3, 125.6, 125.8, 126.2, 127.6, 128.3, 128.9, 129.4, 131.1, 133.9, 134.2, 136.4, 138.3, 148.7, 156.7, 158.4, 162.0. – MS (EI, 70 eV): m/z (%) = 485 (2) [M^+], 429 (8), 235 (18), 234 (100), 219 (25), 204 (8); (CI, NH_3): m/z (%) = 487 (31), 486 (100) [M^+ + 1], 456 (54), 426 (60), 276 (50), 274 (33).

$C_{27}H_{23}N_3O_6$ (485.5) Calcd. C 66.79 H 4.79 N 8.66
Found C 66.65 H 4.87 N 8.58

e.e. analysis by ^1H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to procedure A (characteristic signals).

Diastereomer A [from (*R*)-**39**]: ^1H NMR: δ = 5.79 [s, 1H, C*H*$C(CH_3)_3$].

Diastereomer B [from (*S*)-**39**]: ^1H NMR: δ = 5.71 [s, 1H, C*H*$C(CH_3)_3$].

*Camphanates Derived from (S)-**39** and (1S)-**3*** (Increase of the e.e. of (*S*)-**39** by Chromatography of the Camphanates): According to procedure A; from 269 mg (0.924 mmol) of (*S*)-**39** in 5 ml of CH_2Cl_2 and 2.5 ml of pyridine, 501 mg (2.311 mmol) of (1*S*)-**3**, and ca. 20 mg of DMAP; 890 mg of crude material. Chromatography [CC: 40 g of SiO_2, petroleum ether/ethyl acetate (5:1)] gave 5 fractions containing the camphanates (A–E; d.e. determined by ^1H-NMR spectroscopy). Fraction A: 76 mg (74% d.e.); fraction B: 177 mg (94% d.e.); fraction C: 93 mg (98% d.e.); fraction D: 33 mg (96% d.e.); fraction E: 22 mg (96% d.e.). Yield 401 mg (92%) of the camphanates. Second chromatography [CC: 13 g of SiO_2, petroleum ether/ethyl acetate (5:1)] of combined fractions B–E gave 4 fractions (a–d; d.e. determined by ^1H-NMR spectroscopy). Fraction a: 40 mg (94% d.e.); fraction b: 202 mg (>99% d.e.); fraction c: 48 mg (98% d.e.); fraction d: 6 mg (>99% d.e.); combined fractions b–d: 256 mg of the camphanates (98% d.e.); TLC: R_f = 0.18 [SiO_2, petroleum ether/ethyl acetate (5:1)]. – ^1H NMR: δ = 0.74 (s, 3H, CH_3), 0.97 (s, 3H, CH_3), 1.03 (s, 3H, CH_3), 1.10 [s, 9H, $C(CH_3)_3$], 1.61–1.69 (m, 1H, CH_2), 1.83–1.92 (m, 1H, CH_2), 1.98–2.07 (m, 1H, CH_2), 2.35–2.48 (m, 1H, CH_2), 5.71 [s, 1H, C*H*$C(CH_3)_3$], 7.36 (d, J = 7.8 Hz, 1H, aromatic H), 7.40–7.56 (m, 5H, aromatic H), 7.79 (dd, J = 7.8, 7.8 Hz, 1H, aromatic H), 7.88–7.91 (m, 2H, aromatic H), 8.04 (dd, J = 8.3, 0.9 Hz, 1H, aromatic H). – MS (EI, 70 eV): m/z (%) = 415 (19), 285 (24), 234 (100), 219 (25), 83 (29); (CI, NH_3): m/z (%) = 473 (30), 472 (90) [M^+ + 1], 276 (100), 274 (28), 216 (33). The product was saponified without further analysis.

A solution of 256 mg (0.544 mmol) of the camphanates (d.e. 98%) in 15 ml of methanol was treated with 286 mg (2.069 mmol) of K_2CO_3. After stirring for 18.5 h at room temp., the solvent was removed under reduced pressure, and 7 ml of water was added to the residue. The mixture was extracted three times with 15 ml each of diethyl ether, and the combined organic layers were washed with water and brine. The solvent was removed under reduced pressure to give 146 mg of an oil which was purified by chromatography [CC: 7 g of SiO_2, petroleum ether/ethyl acetate (7:1)]. Yield 123 mg (78%) of (*S*)-**39** as a highly viscous oil; TLC: R_f = 0.29 [SiO_2, petroleum ether/ethyl acetate (5:1)].

rac- and (R)-2,2-Dimethyl-1-[6-(2-methoxyphenyl)pyridin-2-yl]-propanol [*rac*-**40** and (*R*)-**40**]: According to procedure E; from 293 mg (1.2 mmol) of **2**, 42 mg (0.04 mmol) of tetrakis-(triphenylphosphane)palladium(0), 254 mg (2.4 mmol) of Na_2CO_3, and 228 mg (1.5 mmol) of 2-methoxyphenylboronic acid (**44**) after 8 h at 80–85°C (oil bath temp.); 417 mg of crude **40**. Purification by chromatography [CC: 28 g of SiO_2, petroleum ether/ethyl acetate (15:1)]. Yield 168 mg (52%) of **40** as a viscous oil; TLC: R_f = 0.56 [SiO_2, petroleum ether/ethyl acetate (5:1)]. – IR (film): $\tilde{\nu}$ = 3430 cm^{-1}, 2970, 1591, 1585, 1470, 1265, 1030, 820. – ^1H NMR: δ = 0.96 [s, 9H, $C(CH_3)_3$], 3.84 (s, 3H, OCH_3), 4.39 (d, J = 7.2 Hz, 1H, OH), 4.67 (d, J = 7.1 Hz, 1H, C*H*OH), 6.99 (d, J = 8.2 Hz, 1H, aromatic H), 7.05–7.09 (m, 2H, aromatic H), 7.33–7.39 (m, 1H, aromatic H), 7.62 (dd, J = 7.7, 7.7 Hz, 1H, aromatic H), 7.76–7.82 (m, 2H, aromatic H). – ^{13}C NMR: δ = 25.9 (CH_3), 36.3 (C), 55.5 (CH_3), 80.1 (CH), 111.4 (CH), 120.7 (CH), 120.9 (CH), 123.5 (CH), 128.7 (C), 129.9 (CH), 131.1 (CH), 135.2 (CH), 153.8 (C), 157.0 (C), 159.0 (C). – MS (EI, 70 eV): m/z (%) = 215 (52), 214 (100), 199 (15); (CI, NH_3): m/z (%) = 272 (100) [M^+ + 1], 256 (26). Coupling of (*R*)-**2** (chemical purity ca. 85%; rest: **16**) gave (*R*)-**40** with the same e.e. – $[\alpha]_D^{RT}$ = –7.2 (c = 1.9, $CHCl_3$) for (*R*)-**40**:(*S*)-**40** = 98:2 (analysis by HPLC). – HPLC: Daicel (Chiralcel OD), flow 1 ml/min, UV detector (254 nm), 7.5% 2-propanol in hexane; retention times: (*S*)-**40**: 7.1 min (k' = 1.4); (*R*)-**40**: 22.9 min (k' = 6.6); *rac*-**40** gave two base-line-separated signals for (*R*)-**40** and (*S*)-**40** with equal peak areas.

$C_{17}H_{21}NO_2$ (271.4) Calcd. C 75.25 H 7.80 N 5.16
Found C 75.47 H 7.64 N 5.21

rac- and (R)-1-(6-Phenylpyridin-2-yl)ethanol [*rac*-**41** and (*R*)-**41**]: According to procedure E; from 404 mg (2 mmol) of **15**, 69 mg (0.06 mmol) of tetrakis(triphenylphosphane)palladium(0), 424 mg (4 mmol) of Na_2CO_3, and 293 mg (2.4 mmol) of phenylboronic acid (**42**) after 2.5 h at 80°C (oil bath temp.); 430 mg of **41** as a crude yellow oil. Purification by chromatography [CC: 13 g of SiO_2, petroleum ether/ethyl acetate (2.5:1)]. Yield 208 mg (52%) of **41** as a colorless oil; TLC: R_f = 0.35 [SiO_2, petroleum ether/ethyl acetate (2:1)]. Coupling of (*R*)-**15** gave (*R*)-**41** with the same e.e. – IR (film): $\tilde{\nu}$ = 3385 cm^{-1}, 2960, 1587, 1565, 1440, 1068, 755, 685. – ^1H NMR: δ = 1.55 (d, J = 6.5 Hz, 3H, CH_3), 4.75 (br. s, 1H, OH), 4.95 (q, J = 6.6 Hz, 1H, C*H*CH_3), 7.20 (ddd, J = 7.7, 1.5, 0.7 Hz, 1H, aromatic H), 7.41–7.51 (m, 3H, aromatic H), 7.63–7.66 (m, 1H, aromatic H), 7.76 (dd, J = 7.8, 7.8 Hz, 1H, aromatic H), 8.02 (m, 2H, aromatic H). – MS (EI, 70 eV): m/z (%) = 199 (8) [M^+], 198

(10), 185 (13), 184 (100), 182 (29), 158 (28), 156 (21), 154 (26). Elemental analysis after short-path distillation (ca. 110°C/0.01 mbar).

$C_{13}H_{13}NO$ (199.3) Calcd. C 78.37 H 6.58 N 7.03
Found C 78.19 H 6.75 N 7.06

e.e. analysis by ^{1}H-NMR spectroscopy of the MTPA esters derived from (*R*)-MTPA chloride according to procedure A (characteristic signals).

Diastereomer A [from (*S*)-**41**]: ^{1}H NMR: δ = 1.71 (d, *J* = 6.6 Hz, 3H, CH_3), 7.99–8.01 (m, aromatic H).

Diastereomer B [from (*R*)-**41**]: ^{1}H NMR: δ = 1.76 (d, *J* = 6.7 Hz, 3H, CH_3), 7.93–7.96 (m, aromatic H).

Naphthalen-2-ylboronic Acid (**43**): A solution of 2.67 g (12.9 mmol) of 2-bromonaphthaline in 50 ml of THF was cooled to −78°C, and 8.4 ml of a 1.6 N solution (13.5 mmol) of *n*-butyllithium in *n*-hexane was added dropwise to give a white precipitate in a yellow solution. After 45 min at this temp., 1.40 g (1.50 ml, 13.5 mmol) of trimethoxyborane was added, and the resulting clear solution was stirred at −78°C for 1 h and at room temp. for 3 h. After the addition of 25 ml of 10% HCl followed by 50 ml of ethyl acetate, the layers were separated, and the aqueous layer was extracted four times with 20 ml each of ethyl acetate. The combined organic layers were dried with Na_2SO_4, and the solvent was removed under reduced pressure. The brownish residue was suspended in 50 ml of petroleum ether, and the solid was isolated by filtration and washed with petroleum ether. Drying *in vacuo* (ca. 15 mbar) gave 1.47 g (66%) of **43** which was used without further purification for the synthesis of (*S*)-**39**.

2-Methoxyphenylboronic Acid (**44**)[45]: According to the procedure describing the synthesis of **43**; from 2.41 g (12.9 mmol) of 1-bromo-2-methoxybenzene in 50 ml of THF, 8.24 ml of a 15% solution (13.5 mmol) of *n*-butyllithium in *n*-hexane, and 1.40 g (13.5 mmol) of trimethoxyborane. Yield 1.28 g (65%) of **44** which was used for the synthesis of **40** without further purification.

(R)-6-(1-Hydroxy-2,2-dimethylpropyl)-2,2'-bipyridine [(*R*)-**45**]

a) *From Pyridin-2-ylzinc Chloride* (**46**)[36]: A solution of 111 mg (0.70 mmol) of 2-bromopyridine in 3 ml THF was cooled to −78°C and treated slowly with 0.44 ml (0.70 mmol) of a 1.6 M solution of *n*-butyllithium in *n*-hexane. The resulting red-brown solution was stirred at this temp. for 25 min and transferred through a cannula into a cold (−78°C) solution of 96 mg of dry zinc chloride in 2 ml of THF ($ZnCl_2$ was used after fusion by flame-drying under reduced pressure). The color of the solution remained at this temp. After warming to room temp., the mixture was stirred for 1 h, and the color changed to yellow-brown. Through a cannula, this mixture was transferred into a stirred solution of 85 mg (0.35 mmol) of (*R*)-**2** (chemical purity ca. 92%; rest: **16**) and 40 mg (0.04 mmol) of tetrakis(triphenylphosphane)palladium(0) in 2 ml of THF. After stirring for 17 h at room temp., 10 ml of satd. aqueous $NaHCO_3$ was added, and the layers were separated. The aqueous layer was extracted three times with 20 ml each of CH_2Cl_2, and the combined organic layers were washed with 15 ml of brine. Drying with Na_2SO_4 and removal of the solvent under reduced pressure gave 139 mg of a crude product which was purified by chromatography [CC: 7 g of SiO_2, petroleum ether/ethyl acetate (7:1)]. Yield 47 mg (56%) of (*R*)-**45** as a yellowish oil; TLC: R_f = 0.30 [SiO_2, petroleum ether/ethyl acetate (2:1)]; R_f = 0.14 [petroleum ether/triethylamine (10:1)]. – IR (film): $\tilde{\nu}$ = 3425 cm^{-1}, 2950, 1581, 1428, 1055, 783, 760. – ^{1}H NMR: δ = 0.97 [s, 9H, $C(CH_3)_3$], 4.43 (d, *J* = 7.5 Hz, 1H, OH), 4.45 (d, *J* = 7.5 Hz, 1H, *CH*OH), 7.21 (dd, *J* = 7.7, 1.0 Hz, 1H, aromatic H), 7.31 (ddd, *J* = 7.5, 4.8, 1.2 Hz, 1H, aromatic H), 7.77 (dd, *J* = 7.7, 7.7 Hz, 1H, aromatic H), 7.82 (ddd, *J* = 1.8, 7.5, 7.5 Hz, 1H, aromatic H), 8.34 (dd, *J* = 8.0, 1.0 Hz, 1H, aromatic H), 8.39 (dd, *J* = 8.0, 1.1 Hz, 1H, aromatic H), 8.68 (ddd, *J* = 4.8, 1.8, 0.9 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 25.9 (CH_3), 36.3 (C), 80.2 (CH), 119.7 (CH), 120.9 (CH), 122.9 (CH), 123.8 (CH), 136.6 (CH), 136.9 (CH), 149.2 (CH), 154.3 (C), 155.7 (C), 159.2 (C). – MS (EI, 70 eV): *m/z* (%) = 243 (4) [M^+ + 1], 227 (2), 186 (48), 185 (100), 155 (12).

Calcd. 227.1185 [$M^+ - CH_3$; $C_{14}H_{15}N_2O$]
Found 227.1172 [MS (HR)]

e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to procedure A (characteristic signals).

Diastereomer A [from (*R*)-**45**]: ^{1}H NMR: δ = 5.76 [s, 1H, $CHC(CH_3)_3$].

Diastereomer B [from (*S*)-**45**]: ^{1}H NMR: δ = 5.71 [s, 1H, $CHC(CH_3)_3$].

b) *From Tributyl(pyridin-2-yl)stannane* (**47**): A solution of 177 mg (0.481 mmol) of tributyl(pyridin-2-yl)stannane in 2 ml of toluene was treated with 117 mg (0.484 mmol) of (*R*)-**2** (chemical purity ca. 92%; rest: **16**) followed by 31 mg (0.027 mmol) of tetrakis(triphenylphosphane)palladium(0). After stirring at 95°C (oil bath temp.) for 29 h, the solution was allowed to cool to room temp., and 10 ml of satd. aqueous $NaHCO_3$ was added. The layers were separated, and the aqueous layer was extracted three times with 20 ml each of diethyl ether. The combined organic layers were dried with Na_2SO_4, and the solvent was removed under reduced pressure to give 338 mg of a yellowish oil which was purified by chromatography [CC: 12 g of SiO_2, petroleum ether/ethyl acetate (7:1)]. Yield 58 mg (50%) of **45** as a yellowish oil.

Tributyl(pyridin-2-yl)stannane (**47**)[37]: A solution of 2.37 g (15 mmol) of 2-bromopyridine in 60 ml THF was cooled to −78°C and treated slowly with 9.84 ml (15.8 mmol) of a 1.6 M solution of *n*-butyllithium in *n*-hexane over a period of 5 min. A clear red-brown solution resulted. After stirring for 30 min at this temp., 5.37 g (16.5 mmol) of Bu_3SnCl was added to give a dark brown-green solution which was stirred at −78°C for 1.25 h. The mixture was allowed to warm to room temp. (15 min), and 15 ml of satd. aqueous NH_4Cl was added. The resulting precipitate was dissolved by addition of water, and the layers were separated. The aqueous layer was extracted three times with 50 ml each of diethyl ether, and the combined organic layers were washed with 50 ml of brine and dried with Na_2SO_4. The solvent was removed under reduced pressure to give 6.22 g of a yellow-brown oil. Pure **47** could not be obtained by distillation under reduced pressure (HV). Small amounts of **47** were purified by chromatography right before further transformations [CC: 60 g of SiO_2/2 g of crude product, petroleum ether/ethyl acetate (30:1)]. Yield 0.941 g of **47** (53%) from 2 g of crude product as a colorless oil; TLC: R_f = 0.43 [petroleum ether/ethyl acetate (5:1)]. – IR (film): $\tilde{\nu}$ = 2954 cm^{-1}, 2920, 1567, 1448, 1412, 745. – ^{1}H NMR: δ = 0.85 (t, *J* = 7.3 Hz, 9H, CH_3), 1.00–1.20 (m, 6H, CH_2), 1.26–1.35 (m, 6H, CH_2), 1.42–1.66 (m, 6H, CH_2), 7.08 (ddd, *J* = 6.4, 4.9, 1.5 Hz, 1H, aromatic H), 7.37 (ddd, *J* = 7.5, 1.5, 1.0 Hz, 1H, aromatic H), 7.46 (ddd, *J* = 1.9, 7.5, 7.5 Hz, 1H, aromatic H), 8.71 (ddd, *J* = 2.9, 1.9, 1.0 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 9.8 (CH_2), 13.6 (CH_3), 27.3 (CH_2), 29.1 (CH_2), 121.9 (CH), 132.3 (CH), 133.2 (CH), 150.5 (CH), 174 (C). – MS (EI, 70 eV): *m/z* (%) = 370 (0.4) [M^+], 369 (0.1) [M^+], 368 (0.4) [M^+], 367 (0.03) [M^+], 366 (0.2) [M^+], 313 (14), 312 (52), 311 (23), 310 (39), 309 (17), 308 (21), 198 (100).

$C_{17}H_{31}NSn$ (368.2) Calcd. C 55.45 H 8.50 N 3.81
Found C 55.54 H 8.52 N 3.63

rac- and (S)-2,2-Dimethyl-1-[6-(2-trimethylsilylethinyl)pyridin-2-yl]propanol [*rac*-(**48**) and (*S*)-**48**]: Trimethylsilylacetylene (786 mg, 8.00 mmol) was added to a stirred solution of 488 mg (2.00 mmol) of **2**, 48 mg (0.04 mmol) of tetrakis(triphenylphosphane)palladium(0), and 11 mg (0.08 mmol) of copper(I) bromide in 8 ml of triethylamine. A white precipitate developed which turned brown upon heating at 48°C (oil bath). After 5 h at this temp., the mixture was cooled to room temp., and 70 ml of diethyl ether was added. The solution was washed twice with 15 ml each of satd. aqueous NH_4Cl. After drying with Na_2SO_4, the solvent was removed under reduced pressure to give 657 mg of **48** as a brown oil. Compound **48** was used for the synthesis of **49** without further purification; TLC: R_f = 0.39 [SiO_2, petroleum ether/ethyl acetate (5:1)]. – ^{1}H NMR: δ = 0.23 [s, 9H, $Si(CH_3)_3$], 0.86 [s, 9H, $C(CH_3)_3$], 4.12 (br. s, 1H, OH), 4.30 (br. s, 1H, C*H*OH), 7.10 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.32 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.53 (dd, *J* = 7.7, 7.7 Hz, 1H, aromatic H). – ^{13}C NMR: δ = –0.4, 25.9, 36.2, 80.4, 94.7, 103.8, 122.1, 126.3, 135.4, 141.2, 160.4.

rac- and (S)-2,2-Dimethyl-1-(6-ethinylpyridin-2-yl)propanol [*rac*-(**49**) and (*S*)-**49**]: The crude product of the synthesis of **48** (657 mg, max. 2.00 mmol) was dissolved in 8 ml of THF and treated with 3 ml of a 1 M solution of tetrabutylammonium fluoride in THF (3 mmol) at room temp. After stirring for 15 min, complete conversion of **48** was revealed by TLC {**48**: R_f = 0.39 [SiO_2, petroleum ether/ethyl acetate (5:1)]; **49**: R_f = 0.17 (same solvent system)}. After addition of 80 ml of diethyl ether, the solution was washed twice with 15 ml each of water followed by 15 ml of satd. aqueous NH_4Cl. After drying with Na_2SO_4, the solvent was removed under reduced pressure to give 379 mg of a brown oil which was purified by chromatography [CC: 15 g of SiO_2, petroleum ether/ethyl acetate (7:1)]. Yield 265 mg (70%, overall from **2**) of **49** as white crystals. – M.p. 86–88°C (hexane). – IR (KBr): $\tilde{\nu}$ = 3400 cm^{-1}, 3220, 2970, 2100, 1582, 1448, 1057, 831, 768, 722. – ^{1}H NMR: δ = 0.92 [s, 9H, $C(CH_3)_3$], 3.18 (s, 1H, CCH), 4.09 (d, *J* = 7.3 Hz, 1H, OH), 4.37 (d, *J* = 7.3 Hz, 1H, C*H*OH), 7.22 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.39 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.82 (dd, *J* = 7.7, 7.7 Hz, 1H, aromatic H). – ^{13}C NMR: δ = 25.8, 36.2, 77.1, 80.4, 82.9, 122.6, 126.2, 135.6, 140.4, 160.7. – MS (EI, 70 eV): *m/z* (%) = 156 (4), 133 (99), 132 (100), 102 (13), 78 (15), 57 (15), 41 (16); (CI, NH_3): *m/z* (%) = 190 (100) [M^+ + 1]. Coupling of (*S*)-**2** (chemical purity ca. 92%; rest: **16**) gave (*S*)-**49** with the same e.e. – $[\alpha]_D^{RT}$ = +21.2 (*c* = 2.34, $CHCl_3$) for (*S*)-**49**:(*R*)-**49** = 96:4 (determined by ^{1}H-NMR spectroscopy of the camphanates).

$C_{12}H_{15}NO$ (189.3) Calcd. C 76.14 H 8.00 N 7.40
Found C 76.08 H 8.14 N 7.36

*Camphanates Derived from rac-***49** *and* (1*S*)-**3**: According to procedure A.

Diastereomer A [from (*R*)-**49**]: ^{1}H NMR: δ = 0.99 (s, 3H, CH_3), 1.00 [s, 9H, $C(CH_3)_3$], 1.05 (s, 3H, CH_3), 1.12 (s, 3H, CH_3), 1.66–1.73 (m, 1H, CH_2), 1.89–2.09 (m, 2H, CH_2), 2.43–2.51 (m, 1H, CH_2), 3.13 (s, 1H, CCH), 5.67 [s, 1H, C*H*$C(CH_3)_3$], 7.28–7.40 (m, 1H, aromatic H), 7.39 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.63 (dd, *J* = 7.9, 7.9 Hz, 1H, aromatic H).

Diastereomer B [from (*S*)-**49**]: ^{1}H NMR: δ = 0.97 (s, 3H, CH_3), 1.00 [s, 9H, $C(CH_3)_3$], 1.13 (s, 3H, CH_3), 1.20 (s, 3H, CH_3), 1.66–1.73 (m, 1H, CH_2), 1.89–2.09 (m, 2H, CH_2), 2.43–2.51 (m, 1H, CH_2), 3.11 (s, 1H, CCH), 5.59 [s, 1H, C*H*$C(CH_3)_3$], 7.28–7.40 (m, 1H, aromatic H), 7.39 (d, *J* = 7.7 Hz, 1H, aromatic H), 7.64 (dd, *J* = 7.9, 7.9 Hz, 1H, aromatic H).

e.e. analysis by ^{1}H-NMR spectroscopy of the camphanates derived from (1*S*)-**3** according to procedure A (characteristic signals).

Diastereomer A [from (*R*)-**49**]: ^{1}H NMR: δ = 5.67 [s, 1H, C*H*$C(CH_3)_3$].

Diastereomer B [from (*S*)-**49**]: ^{1}H NMR: δ = 5.59 [s, 1H, C*H*$C(CH_3)_3$].

CAS Registry Numbers

1: 626-05-1 / (±)-**2**: 127127-27-9 / (*S*)-**2**: 127049-52-9 / (*R*)-**2**: 127912-58-7 / (1*S*)-**3**: 39637-74-6 / (1*S*)-**3** [(*R*)-**2** ester]: 139042-73-2 / (1*S*)-**3** [(*S*)-**2** ester]: 139163-62-5 / (1*S*)-**3** [(*S*)-**15** ester]: 139072-39-2 / (1*S*)-**3** [(*R*)-**15** ester]: 139164-56-0 / (1*S*)-**3** [(*R*)-**17** ester]: 139130-51-1 / (1*S*)-**3** [(*S*)-**17** ester]: 139238-59-8 / (1*S*)-**3** [(*R*)-**21** ester]: 139042-79-8 / (1*S*)-**3** [(*S*)-**21** ester]: 139238-58-5 / (1*S*)-**3** [(*R*)-**26** ester]: 139042-80-1 / (1*S*)-**3** [(*S*)-**26** ester]: 139163-67-0 / (1*S*)-**3** [(*R*)-**27** ester]: 139164-59-3 / (1*S*)-**3** [(*S*)-**27** ester]: 139043-01-9 / (1*S*)-**3** [(*R*)-**28** ester]: 139163-68-1 / (1*S*)-**3** [(*S*)-**28** ester]: 139163-69-2 / (1*S*)-**3** [(*R,R*)-**32** diester]: 139164-57-1 / (1*S*)-**3** [*meso*-**32** ester]: 139042-82-3 / (1*S*)-**3** [(*S,S*)-**32** ester]: 139164-58-2 / (1*S*)-**3** [(*R*)-**39** ester]: 139042-93-6 / (1*S*)-**3** [(*S*)-**39** ester]: 139163-72-7 / (1*S*)-**3** [(*S*)-**45** ester]: 139042-97-0 / (1*S*)-**3** [(*R*)-**45** ester]: 139163-76-1 / (1*S*)-**3** [(*R*)-**49** ester]: 139042-98-1 / (1*S*)-**3** [(*S*)-**49** ester]: 139163-74-9 / (1*S*)-**3** [(*R*)-**19** ester]: 139042-99-2 / (1*S*)-**3** [(*S*)-**19** ester]: 139238-60-1 / (1*R*)-**4**: 14602-86-9 / (1*R*)-**4** [(*R*)-**2** ester]: 139042-74-3 / (1*R*)-**4** [(*S*)-**2** ester]: 139072-40-5 / **5**: 127049-48-3 / **7**: 49669-13-8 / **8**: 139042-57-2 / **9**: 624-28-2 / **10**: 626-55-1 / **11**: 139042-58-3 / **12**: 139042-59-4 / **13**: 65321-29-1 / **14**: 350-03-8 / (±)-**15**: 139163-56-7 / (*S*)-**15**: 139026-61-2 / (*R*)-**15**: 138983-64-7 / (*R*)-**15** [(*S*)-MTPA ester]: 139042-76-5 / (*S*)-**15** [(*S*)-MTPA ester]: 139042-77-6 / (*S*)-**16**: 139042-60-7 / (±)-**17**: 139042-61-8 / (±)-**18**: 139042-62-9 / (*S*)-**18**: 139163-63-6 / (*R*)-**18**: 139163-64-7 / (*R*)-**19**: 139042-63-0 / (*S*)-**19**: 139042-78-7 / (*R*)-**20**: 139042-64-1 / (±)-**21**: 139042-65-2 / (*S*)-**21**: 139163-65-8 / (*R*)-**21**: 139163-66-9 / **22**: 139042-66-3 / **24**: 139042-67-4 / **25**: 139042-68-5 / (±)-**26**: 139163-57-8 / (*R*)-**26**: 138982-99-7 / (*S*)-**26**: 136859-86-4 / (±)-**26** (*N*-phenylcarbamate): 139043-00-8 / (±)-**27**: 139163-58-9 / (*R*)-**27**: 138983-65-8 / (*S*)-**27**: 139042-81-2 / (*R*)-**28**: 80459-03-6 / (*S*)-**28**: 80459-04-7 / (*R*)-**29**: 27911-63-3 / (*R*)-**30**: 7606-26-0 / (±)-**31**: 127127-32-6 / (*R*)-**31**: 127049-49-4 / (*S,S*)-**32**: 131726-65-3 / (*R,R*)-**32**: 127049-50-7 / (*S, R*)-**32**: 127127-29-1 / (*S,S*)-**32** ($CuBF_4$ complex): 139042-84-5 / (*R,R*)-**33**: 127049-51-8 / *meso*-**33**: 127127-31-5 / (*R,R*)-**33** ($CoCl_2$ complex): 127146-83-2 / (*R,R*)-**33** ($PdCl_2$ complex): 139042-85-6 / (*R,R*)-**33** ($CuSO_3CF_3$ complex): 139042-87-8 / (*R,R*)-**33** (Ag SO_3CF_3 complex): 139069-72-0 / (±)-**34**: 139042-69-6 / (*S*)-**35**: 139026-62-3 / (*R*)-**35**: 139042-88-9 / (±)-**35**: 139163-75-0 / (*S*)-**36**: 27854-83-7 / (*S,S*)-**37**: 139042-70-9 / (*S,S*)-**38**: 139026-60-1 / (*S,S*)-**38** [(*S*)-MTPA diester]: 139042-89-0 / *meso*-**38** [(*S*)-MTPA diester]: 139163-70-5 / (*R,R*)-**38** [(*S*)-MTPA diester]: 139163-71-6 / (*S,S*)-**38** ($CuBF_4$ complex): 139042-91-4 / (±)-**39**: 139163-59-0 / (*S*)-**39**: 136859-87-5 / (*S*)-**39** (3,5-dinitrobenzoate): 139042-92-5 / (±)-**40**: 139163-60-3 / (*R*)-**40**: 138983-02-5 / (*S*)-**40**: 139042-94-7 / (±)-**41**: 139163-61-4 / (*R*)-**41**: 138983-03-6 / (*R*)-**41** [(*S*)-MTPA ester]: 139042-95-8 / (*S*)-**41** [(*S*)-MTPA ester]: 139042-96-9 / **42**: 98-80-6 / **43**: 32316-92-0 / **44**: 5720-06-9 / (*R*)-**45**: 139042-71-0 / **46**: 81745-83-7 / **47**: 17997-47-6 / (±)-**48**: 139042-72-1 / (*S*)-**48**: 139163-73-8 / (±)-**49**: 137624-63-6 / (*S*)-**49**: 137569-58-5 / (+)-$(Ipc)_2BCl$: 85116-37-6 / (–)-$(Ipc)_2BCl$: 112246-73-8 / pivalaldehyde: 630-19-3 / 1-(6-Chloropyridin-2-yl)-2,2-dimethylpropanone: 139042-75-4 / pivalonitrile: 630-18-2 / methyl pivalate: 598-98-1 / 2-bromonaphthalin: 580-13-2

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