A Practical Enantioselective Synthesis of α,α-Diaryl-2-pyrrolidinemethanol. Preparation and Chemistry of the Corresponding Oxazaborolidines

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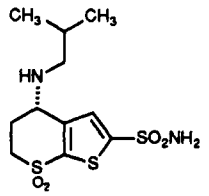
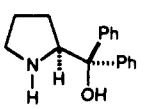
A practical two-step enantioselective synthesis of α,α-diaryl-2-pyrrolidinemethanols (1) from proline, based on the addition of aryl Grignard reagents to proline-*N*-carboxanhydride (3), is reported. An investigation into the chemistry of the corresponding *B*-alkyl- and *B*-aryloxazaborolidines (2) led to the development of a reliable procedure for their preparation.

Introduction

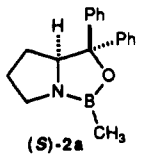
To support our development[1] of a practical, enantioselective synthesis of the carbonic anhydrase inhibitor MK-0417,[2] we required a reproducible procedure for the large-scale preparation of (*S*)-α,α-diphenyl-2-pyrrolidinemethanol [(*S*)-**1a**] and the corresponding *B*-methyloxazaborolidine [(*S*)-**2a**]. Enantiomerically pure α,α-diaryl-2-pyrrolidinemethanols are precursors to several useful asymmetric catalysts,[3a-e] including the corresponding oxazaborolidines.[3f-j] The latter have been used to catalyze the enantioselective reduction of variety of prochiral ketones, including a precursor to MK-0417.[1] Although several routes to (*S*)-**1a** have been reported, none were deemed suitable for our needs (poor yields, multiple steps, difficult isolations).[4-8] We report a practical two-step synthesis of (*S*)-**1a** from (*S*)-proline based on the addition of phenylmagnesium chloride to proline-*N*-carboxanhydride [(*S*)-Pro-NCA, (*S*)-**3**]. Subsequent investigations of the preparation and chemistry of oxazaborolidine (*S*)-**2a** led to the development of a reliable procedure for its preparation based on reaction of trimethylboroxine and (*S*)-**1a**. Using this sequence we prepared a series of enantiomerically pure α,α-diphenyl-2-pyrrolidinemethanols and their corresponding *B*-alkyl- and *B*-aryloxazaborolidines.



MK-0417



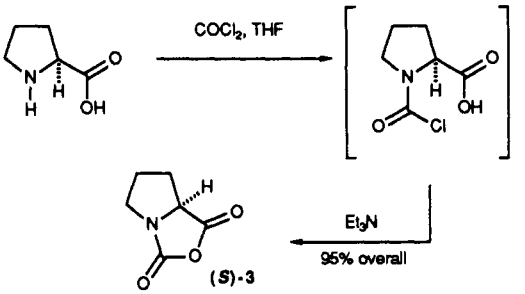
(*S*)-**1a**



(*S*)-**2a**

Results and Discussion

α,α-Diaryl-2-pyrrolidinemethanol Synthesis. (*S*)-Pro-NCA was synthesized from (*S*)-proline[9] in >95% yield by reaction with phosgene[10] in tetrahydrofuran (THF) followed by addition of triethylamine and filtration to remove the resultant triethylamine hydrochloride (eq 1).[11a] In the case of proline, it is necessary to use either triethylamine, or silver(II) oxide,[11b] to effect cyclization of the stable intermediate *N*-(chlorocarbonyl)-(*S*)-proline.[11c] Although (*S*)-**3** can be isolated as a solid,[12] it is preferable that the filtered THF solution be used immediately.[13] Using the same procedure, we also prepared (*R*)-**3** from (*R*)-proline.



(1)

Addition of (*S*)-**3** in THF to phenyllithium (4 equiv) in cyclohexane/diethyl ether afforded, after an acidic workup,

† Department of Biophysical Chemistry.

(1) Jones, T. K.; Mohan, J. J.; Xavier, L. C.; Blacklock, T. J.; Mathre, D. J.; Sohar, P.; Jones, E. T. T.; Reamer, R. A.; Roberts, F. E.; Grabowski, E. J. J. *J. Org. Chem.*, following paper in this issue.

(2) The *S* enantiomer of MK-0927: Baldwin, J. J.; Ponticello, G. S.; Anderson, P. S.; Christy, M. E.; Murcko, M. A.; Randall, W. C.; Schwam, H.; Sugrue, M. F.; Springer, J. P.; Gautheron, P.; Grove, J.; Mallorga, P.; Viader, M.-P.; McKeever, B. M.; Navia, M. A. *J. Med. Chem.* **1989**, *32*, 2510-2513.

(3) Enantioselective addition of diethylzinc to aldehydes: (a) Soai, K.; Ookawa, A.; Kaba, T. *J. Chem. Soc., Chem. Commun.* **1987**, 467-468. (b) Soai, K.; Ookawa, A.; Kaba, T.; Ogawa, K. *J. Am. Chem. Soc.* **1987**, *109*, 7111-7115. Enantioselective addition of methyltitanium diisopropoxides to aldehydes: (c) Takahashi, H.; Kawabata, A.; Higashiyama, K. *Chem. Pharm. Bull.* **1987**, *35*, 1604-1607. Enantioselective reduction of ketones: (d) Kraatz, U. German Patent DE 3609152A1, 1987. (e) Corey, E. J.; Bakshi, R. K.; Shibata, S. *J. Am. Chem. Soc.* **1987**, *109*, 5551-5553. (f) Corey, E. J.; Bakshi, R. K.; Shibata, S.; Chen, C. P.; Singh, V. K. *J. Am. Chem. Soc.* **1987**, *109*, 7925-7926. (g) Corey, E. J.; Shibata, S.; Bakshi, R. K. *J. Org. Chem.* **1988**, *53*, 2861-2863. (h) Corey, E. J.; Reichard, G. A. *Tetrahedron Lett.* **1989**, *30*, 5207-5210. (i) Corey, E. J.; Link, J. O. *Tetrahedron Lett.* **1989**, *30*, 6275-6278. (j) Corey, E. J.; Bakshi, R. K. *Tetrahedron Lett.* **1990**, *31*, 611-614.

(4) Addition of lithiated *N*-nitrosopyrrolidine to benzophenone to give racemic **1a** (58-60% yield based on benzophenone): (a) Seebach, D.; Enders, D.; Renger, B. *Chem. Ber.* **1977**, *110*, 1852-1865. (b) Enders, D.; Pieter, R.; Seebach, D. In *Organic Syntheses*; Noland, W. E., Ed.; John Wiley & Sons: New York, 1988; Collect. Vol. 6, pp 542-549.

(5) Addition of phenylmagnesium chloride to methyl pyrroglutamate followed by reduction with borane to give racemic **1a** (3 steps, 51% yield from pyroglutamic acid) which was then resolved as its *O*-acetylmandelate salt to give (*R*)- or (*S*)-**1a** (2 steps, 3 recrystallizations, 30% yield from racemic **1a**): ref 3f.

(6) Addition of (*S*)-proline ethyl ester to phenylmagnesium chloride to give (*S*)-**1** (2 steps, 21% yield from (*S*)-proline): (a) Roussel-Uclaf. French Patent FR 3638M, 1965. An earlier report (26% yield) did not indicate the enantiomeric purity of the product: (b) Kapfhammer, J.; Matthes, A. *Hoppe-Seylers Zeit. Physiol. Chem.* **1933**, *223*, 43-52. In our hands, addition of (*S*)-proline methyl ester hydrochloride to phenylmagnesium chloride afforded (*S*)-**1a** in 20% yield and 80% ee. See also ref 3d.

(7) Addition of *N*-(benzyloxycarbonyl)-(*S*)-proline methyl ester to phenylmagnesium chloride to give (*S*)-**1a** (3 steps, 5 isolations, 0-50% yield from (*S*)-proline): refs 3e and 3g. It should be noted that 6-10 equiv of the Grignard reagent are required to drive this reaction to completion. Quenching the excess phenylmagnesium bromide affords benzene—an environmental and health issue.

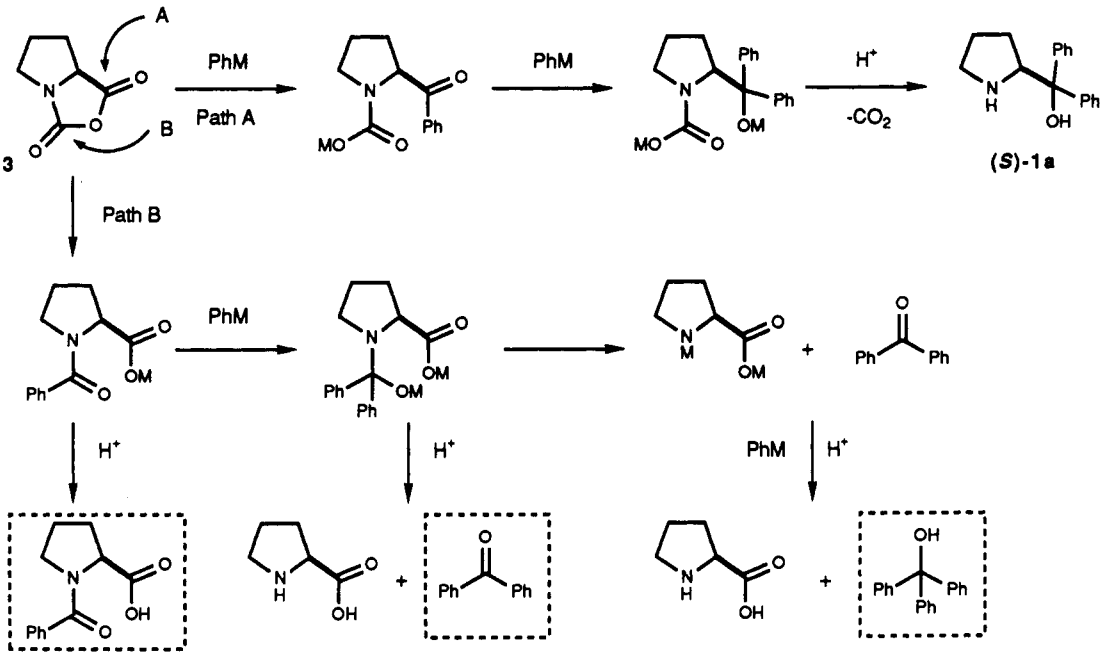
0022-3263/91/1956-0751$02.50/0

Table I. Pro-NCA Addition to Grignard

entry	grignard	substrate, M	solvent	temp, °C	time, h	yield, %	ee,[a] %
1	PhMgCl	0.1	THF	−78	4	12	99.4%
2	PhMgCl	0.4	THF	−20	3	78	99.4
3	PhMgCl	0.4	THF	0	3	73	99.2
4	PhMgCl	0.4	THF	25	3	64	99.2
5	PhMgCl	0.4	THF	45	2	43	98.2
6	PhMgCl[b]	0.2	THF	−20	3	56	99.0
7	PhMgCl	0.2	THF/tol	−15	3	69	99.2
8	PhMgCl	0.2	THF/CH_2Cl_2	−15	3	61	99.2
9	PhMgBr	0.2	THF/Et_2O	−15	3	62	99.2
10	PhMgCl	0.4	THF	−15	3	78	99.4
11	PhMgCl	0.2	THF	−15	3	76	99.4
12	PhMgCl	0.1	THF	−15	3	72	99.2
13	PhMgCl	0.05	THF	−15	3	73	99.2

[a] Enantiomeric excess (ee) determined by capillary GC analysis of the (*R*)-MPTA amide derivative. [b] Inverse addition.

Scheme I



a 93% yield of (*S*)-1a (92% ee, determined by capillary GC analysis of the (*R*)-α-methoxy-α-(trifluoromethyl)-phenylacetic acid ((*R*)-MTPA) amide derivative.[14] Presumably, racemization occurred at the phenyl ketone intermediate stage. We were able to minimize racemization by reacting the Pro-NCA with phenylmagnesium chloride (Scheme I, Table I). The best yield (78%) was obtained by running the reaction at −20 °C using purified Pro-NCA. The major byproducts of the reaction were identified to be proline, the *N*-benzamide derivative of proline, benzophenone, and triphenylmethanol (Scheme I, path B). The inverse addition mode (Grignard added to Pro-NCA) resulted in a lower yield (56%), due to base-catalyzed polymerization of the Pro-NCA.[11d]

We developed a convenient workup for isolation of the amino alcohol from the excess magnesium salts. The re-

Table II. α,α-Diaryl-2-pyrrolidinemethanols

compd	R	yield,[a] %	ee,[b] %
1a	phenyl	73	99.4
1b	4-fluorophenyl	89	99.4
1c	4-chlorophenyl	59	99.4
1d	4-methylphenyl	57	99.4
1e	4-(trifluoromethyl)phenyl	46	99.4
1f	4-*tert*-butylphenyl	50	99.4
1g	4-methoxyphenyl	53	99.4
1h	3-chlorophenyl	62	97.6
1i	3,5-dichlorophenyl	68	99.4
1j	3,5-dimethylphenyl	60	99.4
1k	2-naphthyl	64	99.4

[a] Isolated yield. [b] Enantiomeric excess (ee) determined by HPLC analysis of the (*R*)-MTPA amide derivative.

(8) Addition of *N*-benzyl-(*S*)-proline ethyl ester to phenylmagnesium chloride followed by catalytic hydrogenolysis affording (*S*)-1a (4 steps, 3 isolations, 51% yield from (*S*)-proline): Enders, D.; Kipphard, H.; Gerdes, P.; Brena-Valle, L. J.; Bhushan, V. *Bull. Soc. Chim. Belg.* **1988**, *97*, 691–704. This method has also been used to prepare other (*S*)-α,α-diaryl-2-pyrrolidinemethanols: ref 3i.

(9) The enantiomeric purity of the (*S*)-proline (Ajinomoto, >99.8% ee) and (*R*)-proline (Tanabe, 99.7% ee) was determined by HPLC analysis of the 1-fluoro-2,4-dinitrophenyl-5(*S*)-alanineamide (FDAA) derivative. See Marfey, P. *Carlsberg Res. Commun.* **1984**, *49*, 591–596.

(10) We used either neat or commercially available 1.93 M phosgene in toluene (Fluka). We have also successfully used bis(trichloromethyl)carbonate (Triphosgene, Aldrich) as a phosgene substitute. See: Daly, W. H.; Poché, D. *Tetrahedron Lett.* **1988**, *29*, 5859–5862.

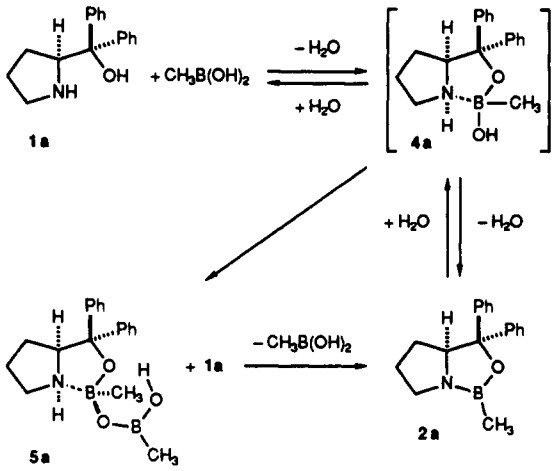
(11) (a) Fuller, W. D.; Verlander, M. S.; Goodman, M. *Biopolymers* **1976**, *15*, 1869–1871. (b) Kurtz, J.; Fasman, G. D.; Berger, A.; Katchalski, E. *J. Am. Chem. Soc.* **1958**, *80*, 393–397. (c) Kricheldorf, H. R. *Chem. Ber.* **1971**, *104*, 87–91. For a review of α-amino acid-*N*-carboxanhydrides, see: (d) Blacklock, T. J.; Hirschmann, R.; Veber, D. F. In *The Peptides. Analysis, Synthesis, and Biology*; Udenfriend, S., Meienhofer, J., Eds.; Academic Press: San Diego, 1987; Vol. 9, Chapter 2.

(12) Solid (*S*)-3 is stable if stored protected from moisture at −20 °C for 2–3 months.

(13) THF solutions of (*S*)-3 should be used immediately. On standing, even at 0 °C, the Pro-NCA can rapidly polymerize—releasing 1 mol of CO_2. See ref 11d.

(14) Dale, J. A.; Dull, D. L.; Mosher, H. S. *J. Org. Chem.* **1969**, *34*, 2543–2549.

Scheme II



action was quenched into aqueous H_2SO_4, affording an easily stirred precipitate of $MgSO_4$, which was removed from the aqueous THF solution by filtration. The sulfate salt of (*S*)-**1a** is soluble in aqueous THF but not water. Removal of THF thus afforded an insoluble precipitate of (*S*)-**1a** sulfate which was isolated by filtration. The filter cake was washed with water to remove excess H_2SO_4, followed by ethyl acetate to remove the neutral byproducts (benzophenone and triphenylmethanol). The purity of (*S*)-**1a** sulfate, isolated in this manner, was >99 wt %, as determined by HPLC, titration, and microanalysis.

We reacted Pro-NCA with several other Grignard reagents to determine the scope and limitations of the reaction. The results are summarized in Table II. Except for phenylmagnesium chloride, the yields are not optimized. The reaction works with para- and meta-substituted aryl Grignard reagents. With ortho-substituted aryl Grignard reagents, only 1 equiv adds to Pro-NCA, affording an unstable ketone intermediate which is too hindered for further addition. Alkyl Grignard reagents also do not afford the desired product. In this case we recommend the procedure described by Enders.[8] Since the sulfate salts are soluble in aqueous THF, but not in aqueous diethyl ether mixtures, the isolation procedure described above works best for reactions run in THF.

Oxazaborolidine Formation. The methods reported for preparation of (*S*)-**2a** include reaction of (*S*)-**1a** with methylboronic acid (1.1 equiv) (1) in toluene at 23 °C in the presence of 4-Å molecular sieves for 1.5 h or (2) in toluene at reflux for 3 h using a Dean–Stark trap for water removal; both followed by evaporation of solvent, and molecular distillation (0.1 mm, 170 °C).[3f] An alternate method reported for preparation of (*S*)-**2k** involved heating a toluene solution of (*S*)-**1k** and methylboronic acid (1.2 equiv) at reflux for 10 h using a Soxhlet extractor containing 4-Å molecular sieves.[3i] The key to these procedures is irreversible removal of 2 equiv of water, thus driving the reaction to completion (Scheme II). In our hands, enantioselective reductions using oxazaborolidine (*S*)-**2a** prepared via these methods afforded erratic results.[1] We therefore undertook a closer examination of the preparation and chemistry of (*S*)-**2a**.

Examination of distilled oxazaborolidine (*S*)-**2a** by ^{13}C NMR and GC[15] revealed 2–13% unreacted amino alcohol (*S*)-**1a**. The ^1H NMR spectrum contained numerous broad resonances, attributed to a "dimer",[3e-j] that initially obscured interpretation. The presence of unreacted (*S*)-**1a**, despite the 10–20 mol % excess methylboronic acid employed, was not surprising since methylboronic acid (crystalline solid) was observed to collect on the reflux condenser and in the Dean–Stark trap. Under the azeotropic conditions employed to drive the reaction to completion, methylboronic acid is converted to trimethylboroxine, which codistills with the toluene. The trimethylboroxine then reacts with the azeotroped water to afford solid methylboronic acid. Methylboronic acid is not soluble in toluene and thus is not returned to the reaction.

We performed a series of experiments to determine the effect of excess (*S*)-**1a** or methylboronic acid on the enantioselection of (*S*)-**2a**-catalyzed ketone reductions.[1] Based on the results, we planned to optimize the preparation of oxazaborolidine (*S*)-**2a**. For reductions employing 10 mol % catalyst, we found that 1 mol % of either (*S*)-**1a** or methylboronic acid significantly decreased enantioselection. We also noted that ≪1 mol % water was also deleterious to enantioselection.

Our initial method to drive formation of oxazaborolidine (*S*)-**2a** to completion was the sequential addition of methylboronic acid (1.1, 0.3, 0.2, and 0.1 equiv) and azeotropic distillation (removal of both water and excess methylboronic acid). This was followed by three subsequent toluene flushes (addition of toluene followed by distillation at 1 atm) to insure complete removal of the excess methylboronic acid (as trimethylboroxine). The oxazaborolidine catalyst prepared via this method (either as a 1 M solution in toluene, the solid obtained by evaporation of toluene, or the material purified by molecular distillation (0.01 mBar, 140 °C)) reproducibly afforded high levels of enantioselection. In whichever form, the oxazaborolidine *must*, however, be protected from moisture in order to effect high levels of enantioselection.[1]

The ^1H NMR spectrum of oxazaborolidine (*S*)-**2a** prepared via this method *did not* contain the broad "dimer" resonances in a variety of solvents ($CDCl_3$, THF-d_8, toluene-d_8, CD_3CN, and DMSO-d_6) over a range of concentrations (0.01–0.4 M) and temperatures (Figure 1). We did note at very low concentrations, if the solvent contained water (as D_2O), the appearance of broad resonances. These broad resonances, however, were not seen if molecular sieve dried (water content <5 μg/mL, Karl Fisher (KF) titration) solvents were employed. The ^{11}B NMR spectrum of oxazaborolidine (*S*)-**2a** prepared via this method contained a single resonance (δ 34.3 ppm). The reported "dimer" resonance (7.9 ppm) was completely absent.[3e-j] In a related example, the oxazaborolidine derived from (*S*)-2-pyrrolidinemethanol and phenylboronic acid is reported to exhibit a single ^{11}B NMR resonance at δ 32 ppm.[16a,b] We therefore suspected the presence of **4a**, a water addition product, in batches containing broad ^1H NMR resonances or a ^{11}B NMR resonance at ca. 8 ppm. Indeed, Brown reports an intermediate related to **4** during the preparation of *B*-allyl-3-methyl-1,3,2-oxazaborolidine which by ^{11}B NMR showed a clean species at δ 6.3 ppm.[16c] To test this hypothesis, we performed the following series of experiments.

Addition of 1 equiv of either H_2O or D_2O to the solution of (*S*)-**2a** resulted in the appearance (^{11}B NMR) of a single

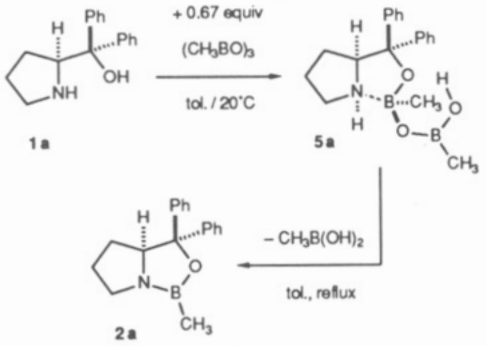
(15) Capillary GC analysis is not a valid method for determining the progress of the reaction (oxazaborolidine formation), since the intermediates **4** and **5** are converted in the injector (250 °C) to a mixture of (*S*)-**1a** and (*S*)-**2a**. The identity of the two peaks as (*S*)-**1a** ($[M + H]^+$ at 254.1) and (*S*)-**2a** ($[M + H]^+$ at 278.2; $[M + NH_4]^+$ at 295.2) was confirmed by GC/MS (chemical ionization with NH_3).

(16) (a) Bielawski, J.; Niedenzu, K. *Synth. React. Inorg. Met.-Org. Chem.* **1980**, *10*, 479–489. (b) The presence of "dimers" was not indicated in the related *B*-methylephedrine derived oxazaborolidine: Joshi, N. N.; Srebnik, M.; Brown, H. C. *Tetrahedron Lett.* **1989**, *30*, 5551–5554. (c) Brown, H. C.; Racherla, U. S.; Pellechia, P. J. *J. Org. Chem.* **1990**, *55*, 1868–1874.

major resonance (8.9 ppm) that quickly changed to two resonances (7.8 and 30.4 ppm). By ^{1}H NMR the single sharp B-CH_3 resonance (δ 0.45 ppm) of (*S*)-**2a** became broad (δ −0.25 ppm) and quickly changed to several sharp singlets (δ 0.22, 0.02, −0.12, and −0.40 ppm). We were unable to acquire sufficient data by ^{13}C NMR on the initially formed intermediate, **4a**. Over time, the ^{13}C NMR spectrum indicated a ca. 1:1 mixture of (*S*)-**1a** and another component, **5a** (Scheme II).

On a larger scale, when D_2O (1 equiv) was added to a THF solution of (*S*)-**2a**, a white crystalline precipitate appeared after ca. 15 min, which was immediately filtered. By ^{1}H NMR it appeared to be the initially formed, transient intermediate **4a** (Figure 1). Microanalysis was employed to confirm the formula of **4a**. We were unable to grow a crystal (for X-ray analysis) since, as noted above, **4a** is not stable in solution.

When we attempted to prepare **4a** by addition of trimethylboroxine (0.333 equiv) to a toluene solution of (*S*)-**2a**, we obtained after ca. 15 min a different white crystalline solid. In this case NMR analysis indicated that we isolated the unknown component, **5a**, formed by reaction of **4a** in solution. The ^{1}H spectrum integrated for two B-CH_3 groups per molecule (Figure 1). Therefore, it was more efficiently prepared by adding 0.667 equiv of trimethylboroxine to (*S*)-**2a** (eq 2).



(2)

The structure of **5a** was determined by single-crystal X-ray analysis on a crystal grown in benzene. The crystal structure of **5a** is shown in Figure 2 and represents the absolute configuration this molecule assumes in the solid state, with the bridgehead carbon atom in the known *S* configuration. The hydrogen atom of the hydroxyl group at the trigonal boron atom was located in the final electron density difference map and is involved in an intramolecular hydrogen bond (2.754 Å) with the oxazaborole ring oxygen atom. There are no unusual bond distances and angles present in this structure.

Variable-temperature ^{1}H NMR studies were used to characterize the solution behavior of **5a**. At ambient temperature, **5a** exists as two isomers in dynamic equilibrium, the major isomer having the structure identified by single-crystal X-ray analysis. NOE difference studies at ambient temperature clearly show saturation transfer between the two species, and NOE's are observed to resonances in both the major and minor species even when a major or minor resonance is irradiated individually. However, by lowering the temperature this transfer of magnetization was essentially eliminated. Diagnostic NOE's from work at −10 °C in $CDCl_3$ are shown on the structures in Figure 3.

Based on this data we feel that previously prepared material[3f-j] was contaminated with **4a** and **5a**.[17] The

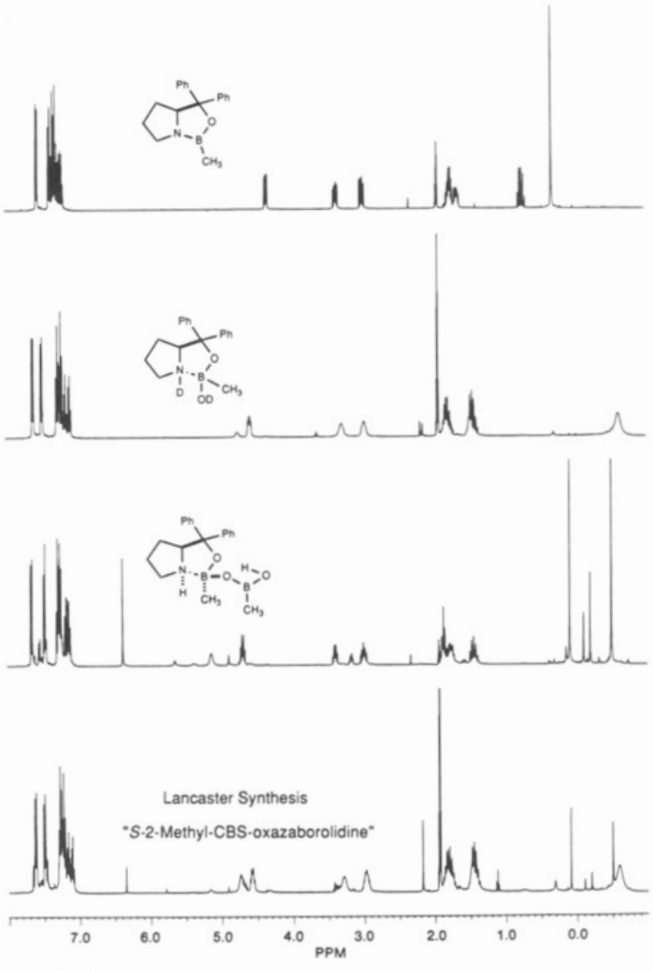
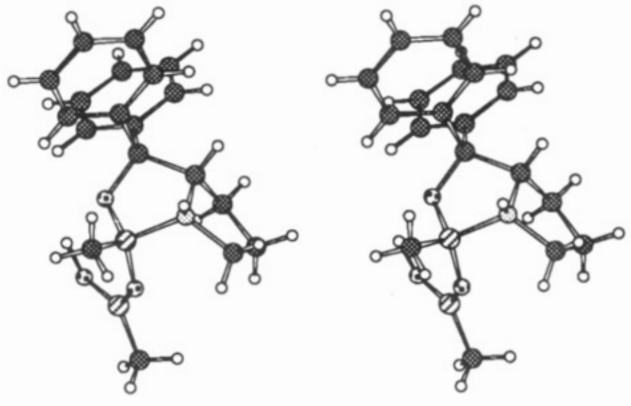


Figure 1.



Chem3D Representation of the X-Ray Structure of ***5a***

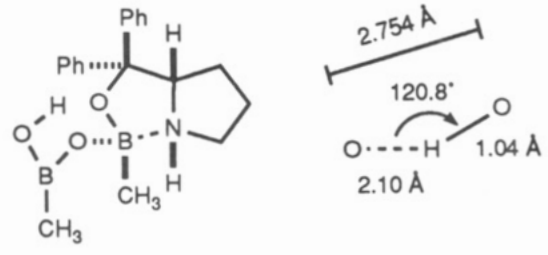


Figure 2.

presence of a "dimer" is not consistent with experimental data of which we are aware.[16] We believe that these

(17) We recently examined a commercial sample (Lancaster Synthesis) of oxazaborolidine (*S*)-**2a** by ^{1}H NMR and found it to contain mainly **4a**, **5a**, and (*S*)-**1a**, with <5% (*S*)-**2a**.

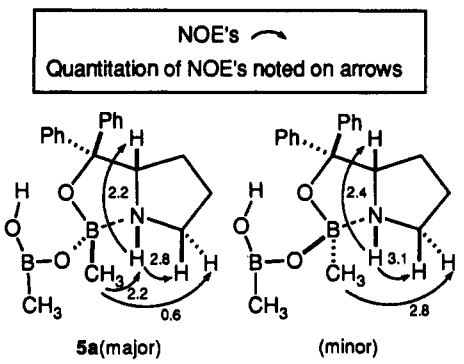


Figure 3.

Table III. Oxazaborolidines

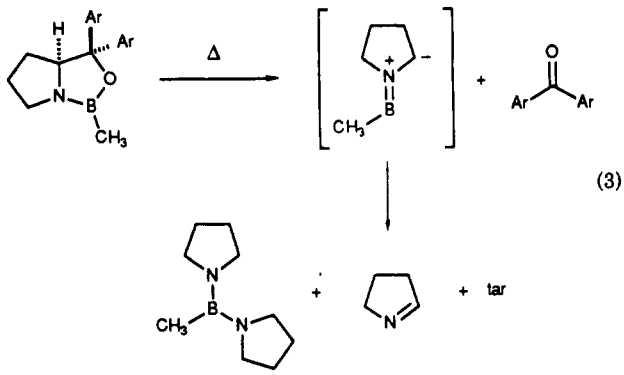
compd	R	R′	purity,[a] %	yield,[b] %
2a	phenyl	methyl	>99	>99
2b	4-fluorophenyl	methyl	98	98
2c	4-chlorophenyl	methyl	99	
2d	4-methylphenyl	methyl	99	99
2e	4-(trifluoromethyl) phenyl	methyl	99	99
2f	4-*tert*-butylphenyl	methyl	99	99
2g	4-methoxyphenyl	methyl	99	99
2h	3-chlorophenyl	methyl	99	99
2i	3,5-dichlorophenyl	methyl	99	99
2j	3,5-dimethylphenyl	methyl	99	99
2k	2-naphthyl	methyl	99	99
6	phenyl	*n*-butyl	98	98
7	phenyl	phenyl	98	98
8	phenyl	4-fluorophenyl	98	98
9	phenyl	4-chlorophenyl	97	97
10	phenyl	4-methylphenyl	99	99
11	phenyl	4-(trifluoromethyl) phenyl	97	97
12	phenyl	4-methoxyphenyl	97	97
13	phenyl	2,4,6-trimethyl-phenyl	97	97

[a] Analysis by capillary GC. [b] Isolated yield (wt × purity)

structures are more in accord with established facts.

The unstable nature of **4a** in solution (two molecules of **4a** irreversibly disproportionating to (*S*)-**1a** + **5a**) explains the difficulty in driving oxazaborolidine formation to completion (Scheme II). To circumvent this problem we made use of the observation that a toluene solution of **5a** heated at reflux is cleanly converted to (*S*)-**2a** (eq 2).[18] Thus, our preferred method for the preparation of (*S*)-**2a** is as follows: to a toluene solution of (*S*)-**1a** is added trimethylboroxine (0.67 equiv). The solution is stirred at 20–25 °C for 0.5 h to insure formation of **5a** and then heated to reflux with removal of toluene and methylboronic acid (as trimethylboroxine). This is followed by three subsequent toluene flushes (addition of toluene followed by distillation at 1 atm) to insure complete removal of water and excess methylboronic acid (as trimethylboroxine). Using a similar protocol, we also prepared a series of phenyl-substituted oxazaborolidine catalysts (Table III, entries 2a–k). The use of these catalysts is reported in the following paper.[1]

During the preparation of phenyl-substituted oxazaborolidines containing electron-withdrawing substitutents (i.e. (*S*)-**2b**, 4-fluorophenyl; (*S*)-**2c**, 4-chlorophenyl; and (*S*)-**2e**, 4-(trifluoromethyl)phenyl) we observed varying amounts (2–10%) of the corresponding benzophenones by GC and ^{1}H and ^{13}C NMR. These are presumably formed via a thermal [3 + 2] cycloreversion (eq 3).[19] Minimization of this side reaction can be accomplished by running the reaction in benzene (bp 80 °C) rather than toluene (bp 110 °C). The presence of small amounts of the benzophenones, however, does not appear to have a significant effect on the enantioselection of the catalyst.[1]



(3)

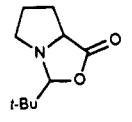
We also reacted (*S*)-**1a** with tri-*n*-butylboroxine and various triarylboroxines to afford the corresponding *B*-*n*-butyl- and *B*-aryloxazaborolidines (Table III, entries 6–13). Unlike trimethylboroxine, these boroxines are not significantly volatile and thus are not removed by the toluene distillation. We therefore used exactly 0.333 equiv of the boroxine.[20] The 1 equiv of water generated was removed by distillation using a Dean–Stark trap. These reactions took significantly longer (12–24 h) to drive to completion.[21] The progress of the reaction was followed by GC[15] and/or ^{1}H NMR. Even with the extended reaction times, the ^{1}H NMR spectra of *B*-aryloxazaborolidines prepared via this protocol indicated the presence of 1–3% of other components.[22] Although the *B*-aryloxazaborolidines can be distilled (180–220 °C, 0.01 mbar), we observed some decomposition (thermal [3 + 2] cycloreversion, 0–5% depending on temperature and substrate). Therefore, we recommend that the toluene solution of the *B*-aryloxazaborolidine catalyst be used without isolation. The use of *B*-aryloxazaborolidines as catalysts is reported in the following paper.[1]

Summary

An efficient synthesis of enantiomerically pure α,α-diphenyl-2-pyrrolidinemethanol from proline has been described, the key step being addition of Pro-NCA to phe-

(18) High-temperature ^{1}H NMR studies in CD_3CN (up to 75 °C) and DMSO-d_6 (up to 120 °C) indicate a temperature-dependent equilibrium as shown below. At ambient temperature **5a** (and its isomer) is favored, whereas at higher temperatures oxazaborolidine (*S*)-**2a** is favored.

(19) In a related example, the thermal [3 + 2] cycloreversion of i occurs at 100 °C: (a) Eschenmoser, A. *J. Chem. Soc. Rev.* **1976**, *5*, 377–410. (b) Seebach, D.; Boes, M.; Naef, R.; Schweizer, W. B. *J. Am. Chem. Soc.* **1983**, *105*, 5390–5398. For a review, see also: (c) Bianchi, G.; De Micheli, C.; Gandolfi, R. *Angew. Chem., Int. Ed. Engl.* **1979**, *18*, 721–738.



i

(20) Boroxines, rather than the corresponding boronic acids were used to achieve the correct stoichiometry. Boronic acids typically contain varying amounts of the boroxines.

(21) Use of the higher boiling xylenes (bp 137–142 °C) to increase the rate of cyclization also increased the rate of thermal cycloreversion (ca. 0.5%/12 h).

(22) The other components are presumably structurally related to **4** and **5**.

nylmagnesium chloride. A practical scheme for isolation of the amino alcohol from the magnesium salts was developed. Using the same methodology, related α,α-diaryl-2-pyrrolidinemethanols were prepared. The preparation and chemistry of the corresponding *B*-aryloxazaborolidines was also investigated. Based on the results, a reliable procedure for the preparation of *B*-alkyl- and *B*-aryloxazaborolidines was developed.

Experimental Section

General. Melting points were determined on a Haake-Buchler melting point apparatus and are uncorrected. IR spectra were recorded on a Perkin-Elmer 1420 (as solutions in CCl_4) or a Nicolet 60SX FTIR spectrometer on microcrystalline solids using a Spectrascope accessory run at 4 cm^{-1} resolution. NMR spectra were recorded in deuteriochloroform or deuterioacetonitrile on a Bruker AM-250 (^1H, ^{13}C), WM-250 (^1H, ^{11}B, ^{13}C), or AM-400 (^1H, ^{11}B, ^{13}C) spectrometer. ^1H chemical shifts are reported in ppm from an internal standard of residual chloroform (7.27 ppm) or acetonitrile (1.93 ppm). ^{11}B chemical shifts are reported in ppm from an external reference of boron trifluoride etherate (0.0 ppm). ^{13}C chemical shifts are reported in ppm from the central peak of deuteriochloroform (77.0 ppm) or deuterioactonitrile (1.3 ppm). Specific rotations were determined on a Perkin-Elmer 241 polarimeter. Concentrations (c) for specific rotations are reported in units of g/100 mL. Analytical gas chromatography (GC) was carried out on a Hewlett-Packard 5890A gas chromatograph equipped with a 7673A auto-sampler, split-mode injector, and flame-ionization detector, with helium as the carrier gas. The following capillary columns were employed: 30 m × 0.32 mm DB-1 (J&W Associates) and 30 m × 0.32 mm DB-23 (J&W Associates). Analytical high-performance liquid chromatography (HPLC) was carried out on a Hewlett-Packard Modular 1050 HPLC (quaternary pump and programmable variable-wavelength detector) using a 250 × 0.46 mm DuPont Zorbax RX column. Analytical thin-layer chromatography (TLC) was carried out on EM 0.25-mm silica gel 60F HPTLC plates using the following solvent systems: solvent A (45:45:9:1 hexane/dichloromethane/2-propanol/28% aqueous NH_4OH; solvent B (7:3 hexane/EtOAc). Visualization was accomplished with UV light and/or by spraying with aqueous cerric ammonium molybdate followed by heating. Mass spectra were obtained on a Finnigan-MAT TSQ 70B mass spectrometer using either GC/MS with chemical ionization (NH_3) or FAB/MS using a DTT/DTE matrix. Combustion analyses were obtained in-house from our Analytical Research Department.

Reactions were carried out under an atmosphere of dry N_2. As necessary Et_3N, THF, and toluene were dried over 3-Å or 4-Å molecular sieves. Residual water content was determined by Karl Fisher (KF) titration. (*S*)-Proline was obtained from Ajinomoto, (*R*)-proline from Tanabe USA, Inc. Phosgene (1.93 M in toluene) was obtained from Fluka. Phenylmagnesium chloride (2 M in THF) was obtained from Boulder Scientific. Other Grignard reagents were either obtained from Aldrich, or prepared from the corresponding aryl bromide. Trimethylboroxine and *n*-butylboronic acid were obtained from Aldrich. Triarylboroxines were prepared from the corresponding arylboronic acids[23] by heating a toluene solution at reflux for 3–4 h using a Dean–Stark trap for water removal, followed by evaporation of the solvent. (*R*)-MTPA[14] (Aldrich) was converted to the acid chloride using oxalyl chloride (1.2 equiv) and catalytic DMF (0.05 equiv) in dichloromethane at 20–25 °C for 4 h followed by Kugelrohr distillation (45 °C, 0.1 mbar).[24]

(*S*)-Tetrahydro-1*H*,3*H*-pyrrolo[1,2-*c*]oxazole-1,3-dione ((*S*)-3). A 5-L, three-necked flask, fitted with a mechanical stirrer, nitrogen inlet tube, 1-L addition funnel, and Teflon-coated thermocouple probe, containing dry THF (1.15 L), was charged with (*S*)-proline (115 g, 1.00 mol). To the well-stirred, cooled (15–20 °C) suspension was added a solution of phosgene in toluene (1.93 M, 622 mL, 1.20 mol) over a 0.5–1.0-h period, maintaining the internal temperature at 15–20 °C. *Caution: phosgene is an insidious poison. All manipulations with phosgene should be performed in a hood with good ventilation. Any excess phosgene should be decomposed in cold aqueous base.* After the phosgene addition was complete, the mixture was warmed to 30–40 °C and aged for 0.5 h. During this time the mixture became homogeneous as proline reacted with phosgene to afford the intermediate *N*-carbamoyl chloride. Once homogeneous, the reaction mixture was aged an additional 0.5 h at 30–35 °C and then cooled to 15–20 °C. While maintaining the internal temperature at 15–20 °C, the reaction mixture was concentrated in vacuo (1000 down to 50 mbar) to a volume of ca. 150 mL. *Caution: hydrogen chloride (1 mol) and excess phosgene (200 mmol) are removed during the distillation. The use of appropriate traps and venting of the vacuum pump to the hood are required.* The reaction can be assayed at this point by ^1H NMR (ca. 30 μL dissolved in 0.6 mL $CDCl_3$): δ 11.5–10.0 (br s, 1 H, CO_2H), 7.3–7.1 (m, toluene), 4.62 (dd, 0.4 H, C2-H rotamer), 4.50 (dd, 0.6 H, C2-H rotamer), 3.9–3.5 (m, 2 H, C5-H_2), 2.5–1.8 (m, 4 H, C3-H_2, C4-H_2). [The spectrum should not contain resonances at δ 4.9 (dd, 0.4 H, C2-H rotamer) and 4.7 (dd, 0.6 H, C2-H rotamer) corresponding to proline-*N*-carbamoyl chloride, acid chloride.] The residue was dissolved in dry THF (1.15 L), and the solution was cooled to 0–5 °C. With good agitation, dry Et_3N (106 g, 1.05 mol) was added over 15 min while maintaining the internal temperature at 0–5 °C. After the addition was complete, the mixture was aged for 0.5 h at 0–5 °C and then filtered through an enclosed, medium frit, sintered-glass funnel. The resultant cake of Et_3N·HCl was washed with THF (3 × 200 mL). The filtrate and THF washes were combined to afford a solution containing (*S*)-3 (ca. 0.95–1.0 mol) in THF (ca. 1.75 L) that was used immediately "as is" without further purification.[12,13]

For analysis, a portion of the THF solution was concentrated in vacuo (20 °C, 50 mbar), and the resultant white solid was dried in vacuo (20 °C, 0.01 mbar) overnight: mp 51–52 °C; IR (CCl_4) 2980, 1845, 1780, 1350, 950, 920 cm^{-1}; ^1H NMR ($CDCl_3$) δ 4.34 (dd, *J* = 7.4, 8.7 Hz, 1 H, C2-H), 3.72–3.68 (m, 1 H, C5-H_2), 3.32–3.18 (m, 1 H, C5-H_2), 2.4–1.8 (m, 4 H, C3-H_2, C4-H_2); ^{13}C NMR ($CDCl_3$) δ 168.9 (C3), 154.9 (C1), 63.1 (C3a), 46.5 (C6), 27.6 (C4), 26.9 (C5). Anal. Calcd for $C_6H_7NO_3$: C, 51.06; H, 4.96; N, 9.93. Found: C, 51.23; H, 4.84; N, 9.65.

(*R*)-Tetrahydro-1*H*,3*H*-pyrrolo[1,2-*c*]oxazole-1,3-dione ((*R*)-3). Prepared from (*R*)-Proline (57.5 g, 0.500 mol) and 1.93 M phosgene in toluene (311 mL, 0.600 mol) according to the procedure described for (*S*)-3, affording a solution of (*R*)-3 (ca. 0.45–0.50 mol) in THF (1.0 L). The solution was used immediately without further purification.

(*S*)-α,α-Diphenyl-2-pyrrolidinemethanol ((*S*)-1a). A 5-L three-necked flask fitted with a mechanical stirrer, nitrogen inlet tube, 2-L addition funnel containing the THF solution of (*S*)-3, and a Teflon-coated thermocouple probe was charged with a solution of phenylmagnesium chloride in THF (2.0 M, 1.5 L, 3.0 mol). The Grignard reagent was cooled to −15 °C. The THF solution of (*S*)-3 (ca. 0.95–1.0 mol) was added over a 1-h period while maintaining the internal temperature at −10 to −15 °C. After the addition was complete, the mixture was aged for 3 h at −15 °C and for 1 h at 0 °C. The reaction was quenched into a 12-L mechanically stirred flask, containing a precooled (0 °C) solution of 2 M aqueous H_2SO_4 (2.0 L, 4.0 mol), over a 0.5–1.0-h period, while maintaining the internal temperature below 20 °C. During the quench, a thick white precipitate of $MgSO_4$ formed. The mixture was agitated for 1 h at 0 °C and filtered through a 3-L, medium-frit, sintered-glass funnel. The $MgSO_4$ cake was washed free of residual product with THF (3 × 1.0 L). The filtrate and THF washes were combined and concentrated at atmospheric pressure to a volume of 2.0 L. *Caution: benzene (ca. 82 g), formed during the quench of excess PhMgCl, is removed during the concentration.* The product as its sulfate salt, Ph_2CO, and Ph_3COH precipitate during the concentration. The mixture was

(23) (a) Kabalka, G. W.; Sastry, U.; Sastry, K. A. R.; Knapp, F. F., Jr.; Srivastava, P. C. *J. Organomet. Chem.* **1983**, *259*, 269–274. (b) Csuk, R.; Haas, J.; Hönig, H.; Weidmann, H. *Montash.* **1981**, *112*, 879–882. (c) Yalpani, M.; Köster, R. *Chem. Ber.* **1983**, *116*, 3332–3337. (d) Breuer, S. W.; Broster, F. A. *Tetrahedron Lett.* **1972**, 2193–2194.

(24) The enantiomeric purity of the (*R*)-MTPA (ref 14, Aldrich) used to prepare the acid chloride was determined to be 99.4% by derivatization with (4*S*)-4-(phenylmethyl)-2-oxazolidinone (>99.9% ee). The enantiomeric purity of the (*S*)-acid was found to be lower (97.4%). By using the (*R*)-acid chloride, the maximum ee that can be determined via this method is 99.4%. See reference 6 of ref 3e. For another method of determining the enantiomeric purity of MTPA, see: Jeanneret-Gris, G.; Pousaz, P. *Tetrahedron Lett.* **1990**, *31*, 75–76.

cooled to 0–5 °C, aged for 1 h, and filtered. The cake was washed with H_2O (2 × 200 mL) to remove excess H_2SO_4 and with EtOAc (3 × 350 mL) to remove the Ph_2CO and Ph_3COH. The cake was dried in vacuo (40 °C, 50 mbar), affording 221 g (73% from proline) of (*S*)-**1a** sulfate, as a white solid: mp 275–290 °C dec. Anal. Calcd for $C_{34}H_{40}N_2O_6S$: C, 67.52; H, 6.67; N, 4.63. Found: C, 67.75; H, 6.67; N, 4.51.

A portion of the sulfate salt was converted to the free base as follows: to a mechanically stirred solution of THF (50 mL) and 2 M aqueous NaOH (50 mL, 100 mmol) at 20 °C was added (*S*)-**1a** sulfate (15.1 g, 25.0 mmol). The mixture was stirred at 20 °C until all solids dissolved and was then diluted with toluene (200 mL). The two-phase mixture was filtered through a medium-frit sintered-glass funnel and partitioned, and the organic layer was washed with H_2O (25 mL). The organic layer was concentrated in vacuo (50 °C, 1 mbar), affording 12.5 g (99% yield) of (*S*)-**1a** as a colorless oil that crystallized on standing. An analytical sample was prepared by recrystallization from hexane: mp 79–79.5 °C [lit.[3e] mp 76.5–77.5 °C (H_2O/MeOH); lit.[8] mp 80–82 °C (EtOH)]; IR (CCl_4) 3600–3300 (br), 3160, 3140, 2980, 2790, 1490, 1450, 1400, 1170 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.7–7.5 (m, 4 H, Ar-H), 7.4–7.1 (m, 6 H, Ar-H), 4.65 (s, 1 H, OH), 4.3 (t, *J* = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H_2), 1.9–1.5 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 148.21, 145.41 (C1′, C1″), 128.24, 127.98 (C3′, C3″, C5′, C5″), 126.46, 126.36 (C4′, C4″), 125.88, 125.55 (C2′, C2″, C6′, C6″), 77.1 (Cα), 64.41 (C2), 46.68 (C5), 26.30 (C3), 25.51 (C4); GC/MS $[M + H]^+$ at *m/z* 254.1; TLC (solvent A) R_f = 0.32; $[\alpha]^{21}_{589}$ −54.3° (*c* = 0.261, MeOH) [lit.[3e] $[\alpha]^{24}_{589}$ −58.8° (*c* = 3.0, MeOH)]. Anal. Calcd for $C_{17}H_{19}NO$: C, 80.60; H, 7.50; N, 5.53. Found: C, 80.80; H, 7.64; N, 5.49.

Enantiomeric Purity Assay. To a magnetically stirred suspension of (*S*)-**1a** sulfate (30 mg, 50 μmol) in THF (1 mL) was added 1.0 M aqueous NaOH (210 μL, 210 μmol). The mixture was stirred until all of the solid dissolved (ca. 15 min), and then (*R*)-MTPA acid chloride[24] (27 mg, 107 μmol) was added, and the mixture stirred for 1 h at 20 °C. The reaction can be monitored by TLC (solvent B) (*S*)-**1a** (R_f = 0.05), *R,R* derivative (R_f = 0.78), *R,S* derivative (R_f = 0.71). After completion, the mixture was diluted into hexane (9 mL) and centrifuged, and the upper, organic layer was eluted through a Baker silica SPE (1 g) column (previously washed with hexane). The column was eluted with additional 8:2 (v/v) hexane/THF (5 mL). The combined eluate was analyzed by either GC (DB-23, 250 °C) to detect 0.3% of the *R,R* derivative (19.1 min) and 99.7% of the *R,S* derivative (20.7 min) or HPLC[3e] (Zorbax Si, 9:1 hexane/THF, 210 nm) to detect 0.3% of the *R,R* derivative (*k′* = 1.21) and 99.7% of the *R,S* derivative (*k′* = 1.66).

(*R*)-α,α-Diphenyl-2-pyrrolidinemethanol ((*R*)-1a). Prepared by the addition of (*R*)-**3** (ca. 0.45–0.50 mol) in THF (1.0 L) to phenylmagnesium chloride in THF (2.0 M, 750 mL, 1.50 mol) according to the procedure described for (*S*)-**1a**, affording 98.2 g (65%) of (*R*)-**1a** sulfate, which was converted to 81.0 g (64% overall from (*R*)-proline) of (*R*)-**1a** as a white crystalline solid. HPLC analysis [(*R*)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 99.7% of the *R,R* derivative (*k′* = 1.21) and 0.3% of the *R,S* derivative (*k′* = 1.66). The material was identical in all respects (except specific rotation, equal but opposite sign) to the *S* enantiomer.

(*S*)-α,α-Bis(4-fluorophenyl)-2-pyrrolidinemethanol ((*S*)-1b). Prepared by the addition of (*S*)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (4-fluorophenyl)magnesium bromide (1.0 M in THF, 300 mL, 300 mmol) according to the procedure described for **1a**, affording 30.5 g (90.2%) of (*S*)-**1b** sulfate, which was converted to 25.8 g (89.5% overall) of (*S*)-**1b** as a white solid. HPLC analysis [(*R*)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the *R,R* derivative (*k′* = 1.44) and 99.7% of the *R,S* derivative (*k′* = 2.29). An analytical sample was prepared by recrystallization from hexane: mp 89.5–90 °C; IR (CCl_4) 3600–3200 (br), 2980, 2880, 1600, 1520, 1230, 1160 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.6–7.4 (m, 4 H, Ar-H), 7.05–6.90 (m, 4 H, Ar-H), 4.7–4.4 (br s, 1 H, OH), 4.2 (t, *J* = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H), 1.85–1.50 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 161.51, 161.41 (2 d, J_{CF} = 245 Hz, C4′, C4″), 143.80, 141.11 (2 d, J_{CF} = 3 Hz, C1′, C1″), 127.46, 127.09 (2 d, J_{CF} = 8 Hz, C2′, C2″, C6′, C6″), 114.98, 114.77 (2 d, J_{CF} = 21 Hz, C3′, C3″, C5′, C5″), 77.1 (Cα), 64.46 (C2), 46.76 (C5), 26.29 (C3), 25.46 (C4); TLC (solvent A) R_f = 0.37; $[\alpha]^{22}_{589}$ −48.5° (*c* = 0.323, MeOH). Anal. Calcd for $C_{17}H_{17}F_2NO$: C, 70.57, H, 5.92; N, 4.82. Found: C, 70.54; H, 6.00; N, 4.82.

(*S*)-α,α-Bis(4-chlorophenyl)-2-pyrrolidinemethanol ((*S*)-1c). Prepared by the addition of (*S*)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (4-chlorophenyl)magnesium bromide (1.0 M in Et_2O, 300 mL, 300 mmol) according to the procedure described for **1a**, affording 22.3 g (60.4%) of (*S*)-**1c** sulfate, which was converted to 19.0 g (59.2% overall) of (*S*)-**1c** as a white solid. HPLC analysis [(*R*)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the *R,R* derivative (*k′* = 1.34) and 99.7% of the *R,S* derivative (*k′* = 2.22). An analytical sample was prepared by recrystallization form hexane: mp 114.5–115 °C; IR (CCl_4) 3600–3200 (br), 2980, 2880, 1490, 1405, 1100, 1020 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.55–7.35 (m, 4 H, Ar-H), 7.35–7.25 (m, 4 H, Ar-H), 4.7–4.4 (br s, 1 H, OH), 4.2 (t, 1 H, *J* = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H), 1.9–1.5 (m, 5 H, C3-H_2, C4-H_2, N-H); ^{13}C NMR ($CDCl_3$) δ 146.4, 143.6 (C1′, C1″), 132.6, 132.4 (C4′, C4″), 128.4, 128.2 (C3′, C3″, C5′, C5″), 127.3, 126.9 (C2′, C2″, C6′, C6″), 77.1 (Cα), 64.5 (C2), 46.8 (C5), 26.3 (C3), 25.5 (C4); TLC (solvent A) R_f = 0.43; $[\alpha]^{22}_{589}$ −37.3° (*c* = 0.339, MeOH). Anal. Calcd for $C_{17}H_{17}Cl_2NO$: C, 63.74; H, 5.35; N, 4.37; Cl, 22.14. Found: C, 64.09; H, 5.39; N, 4.43; Cl, 21.95.

(*S*)-α,α-Bis(4-methylphenyl)-2-pyrrolidinemethanol ((*S*)-1d). Prepared by the addition of (*S*)-**3** (1.0 M in THF, 100 mL, 100 mmol) to 4-tolylmagnesium bromide (1.0 M in Et_2O, 300 mL, 300 mmol) according to the procedure described for (*S*)-**1a**, affording 19.8 g (60%) of (*S*)-**1d** sulfate which was converted to 15.1 g (57% overall) of (*S*)-**1d** as a white solid. HPLC analysis [(*R*)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the *R,R* derivative (*k′* = 0.89) and 99.7% of the *R,S* derivative (*k′* = 1.24). An analytical sample was prepared by molecular distillation (150 °C, 0.02 mbar): mp 94–94.5 °C; IR (CCl_4) 3500–3300 (br), 3030, 2980, 2930, 2880, 1510, 1400, 1100 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.50–7.35 (m, 4 H, Ar-H), 7.15–7.05 (m, 4 H, Ar-H), 4.8–4.5 (br s, 1 H, OH), 4.25 (t, *J* = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H_2), 2.3 (s, 6 H, Ar-CH_3), 1.85–1.50 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 145.5, 142.8 (C1′, C1″), 135.9, 135.7 (C4′, C4″), 128.9, 128.7 (C3′, C3″, C5′, C5″), 125.7, 125.4 (C2′, C2″, C6′, C6″), 76.8 (Cα), 64.5 (C2), 46.8 (C5), 26.3 (C3), 25.5 (C4), 21.0, 20.9 (2 Ar-CH_3); TLC (solvent A) R_f = 0.27; $[\alpha]^{20}_{589}$ −43.4° (*c* = 0.305, MeOH). Anal. Calcd for $C_{19}H_{23}NO$: C, 81.10; H, 8.24; N, 4.98. Found: C, 80.85; H, 8.22; N, 4.88.

(*S*)-α,α-Bis(4-(trifluoromethyl)phenyl)-2-pyrrolidinemethanol ((*S*)-1e). Prepared by the addition of (*S*)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (4-(trifluoromethyl)phenyl)-magnesium bromide (1.0 M in THF, 300 mL, 300 mmol) to according to the procedure described for (*S*)-**1a**. In this case the sulfate salt dissolved in wet EtOAc. The EtOAc solution was washed with 1 M aqueous NaOH (100 mL) and brine (100 mL), dried over Na_2SO_4, and concentrated in vacuo to afford 30.0 g of a pale yellow oil. Both TLC and ^1H NMR analysis indicated that the material was not pure. The crude free base was dissolved in Et_2O (200 mL) and converted to the HCl salt by addition of 4 M ethanolic HCl (17 mL). The HCl salt (24.5 g) was recrystallized from MeCN (1.2 L, 2 crops) to afford 21.9 g of (*S*)-**1e** HCl as white needles: mp 280–300 °C (sublimes). HPLC analysis [(*R*)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the *R,R* derivative (*k′* = 1.52) and 99.7% of the *R,S* derivative (*k′* = 2.68). Anal. Calcd for $C_{19}H_{18}ClF_6NO$: C, 53.59; H, 4.26; N, 3.29. Found: C, 53.59; H, 4.28; N, 3.29.

The recrystallized HCl salt (21.8 g) was added to a well-stirred mixture of *i*-PrOAc (200 mL) and 1 M aqueous NaOH (50 mL). After all of the solid dissolved, the mixture was partitioned. The upper (product) layer was washed with H_2O and brine, dried over Na_2SO_4, and concentrated in vacuo (50 °C, 0.02 mbar), affording 20.0 g (45.6% overall) of (*S*)-**1e** as a pale yellow, viscous oil: IR (CCl_4) 3500–3200 (br), 2970, 2870, 1610, 1410, 1370, 1160, 1130, 1060 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.80–7.52 (m, 8 H, Ar-H), 5.1–4.5 (br s, 1 H, OH), 4.31 (t, *J* = 7.4 Hz, 1 H, C2-H), 3.15–2.90 (m, 2 H, C5-H_2), 1.90–1.55 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR (CDC_3) δ 151.4, 148.5 (C1′, C1″), 129.2, 129.0 (2 q, J_{CF} = 32 Hz, C4′, C4″), 126.3, 125.8 (C2′, C2″, C6′, C6″), 125.4, 125.2 (2 q, J_{CF} = 3.7 Hz, C3′, C3″, C5′, C5″), 124.12, 124.08 (2 q, J_{CF} = 272 Hz, Ar-CF_3), 76.9 (Cα), 64.2 (C2), 46.8 (C5), 26.4 (C3), 24.9 (C4); TLC

(solvent A) R_f = 0.47; $[\alpha]^{20}_{589}$ -34.2° (c = 0.789, MeOH). Anal. Calcd for $C_{19}H_{17}F_6NO$: C, 58.61; H, 4.40; N, 3.60. Found: C, 58.56; H, 4.44; N, 3.54.

(S)-α,α-Bis(4-(1,1-dimethylethyl)phenyl)-2-pyrrolidinemethanol ((S)-1f). Prepared by the addition of (S)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (4-*tert*-butylphenyl)magnesium bromide (2.0 M in Et_2O, 150 mL, 300 mmol) according to the procedure described for (S)-**1a**, affording 21.0 g (50.6%) of (S)-**1f** sulfate which was converted to 18.3 g (50% overall) of (S)-**1f** as a white solid. HPLC analysis [(R)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the R,R derivative (k' = 0.46) and 99.7‰ of the R,S derivative (k' = 0.63). An analytical sample was prepared by recrystallization from hexane: mp 165.7–166.1 °C; IR (CCl_4) 3500–3300 (br), 2980, 2920, 2880, 1510, 1400, 1360, 1270, 1110 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.55–7.40 (m, 4 H, Ar-H), 7.35–7.25 (m, 4 H, Ar-H), 4.8–4.3 (br s, 1 H, OH), 4.25 (t, J = 7.4 Hz, 1 H, C2-H), 3.10–2.85 (m, 2 H, C5-H_2), 1.8–1.5 (m, 5 H, C3-H_2, C4-H_2, NH), 1.3 (s, 18H, Ar-C-$(CH_3)_3$); ^{13}C NMR ($CDCl_3$) 148.9, 148.8 (C4′, C4″), 145.3, 142.5 (C1′, C1″), 125.5, 125.1, 125.0, 124.8 (C2′, C2″, C3′, C3″, C5′, C5″, C6′, C6″), 76.8 (Cα), 64.8 (C2), 46.7 (C5), 34.3 (Ar-$C(CH_3)_3$), 31.4 (Ar-$C(CH_3)_3$), 26.3 (C3), 25.5 (C4); TLC (solvent A) R_f = 0.32; $[\alpha]^{20}_{589}$ -25.1° (c = 0.398, MeOH). Anal. Calcd for $C_{25}H_{35}NO$: C, 82.14; H, 9.65; N, 3.83. Found: C, 82.19; H, 9.74; N, 3.80.

(S)-α,α-Bis(4-methoxyphenyl)-2-pyrrolidinemethanol ((S)-1g). Prepared by the addition of (S)-**2** (1.0 M in THF, 100 mL, 100 mmol) to (4-methoxyphenyl)magnesium bromide (1.0 M in THF, 300 mL, 300 mmol) according to the procedure described for (S)-**1a**, affording 20.7 g (56.7%) of (S)-**1g** sulfate which was converted to 16.7 (53% overall) of (S)-**1g** as a pale yellow semisolid. HPLC analysis [(R)-MTPA amide derivative,[24] Zorbax Si, 8:2 hexane/THF, 210 nm] detected 0.3% of the R,R derivative (k' = 1.27) and 99.7% of the R,S derivative (k' = 1.59). An analytical sample was prepared by molecular distillation (bp 190 °C, 0.01 mbar): IR (CCl_4) 3500–3200 (br), 2960, 2840, 1605, 1500, 1250, 1180, 1040 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.55–7.35 (m, 4 H, Ar-H), 6.95–6.80 (m, 4 H, Ar-H), 4.2 (t, J = 7.4 Hz, 1 H, C2-H), 3.8 (s, 6 H, OCH_3), 3.6–3.1 (br s, 1 H, OH), 3.1–2.9 (m, 2 H, C5-H_2), 1.9–1.5 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 158.1, 158.0 (C4′, C4″), 140.6, 138.1 (C1′, C1″), 127.0, 126.6 (C2′, C2″, C6′, C6″), 113.6, 113.3 (C3′, C3″, C5′, C5″), 76.5 (Cα), 64.7 (C2), 55.22, 55.16 (OCH_3), 46.8 (C5), 26.3 (C3), 25.5 (C4); TLC (solvent A) R_f = 0.17; $[\alpha]^{20}_{589}$ -44.1° (c = 0.607, MeOH). Anal. Calcd for $C_{19}H_{23}NO_3$: C, 72.88; H, 7.40; N, 4.47. Found: C, 72.90; H, 7.40; N, 4.47.

(S)-α,α-Bis(3-chlorophenyl)-2-pyrrolidinemethanol ((S)-1h). Prepared by the addition of (S)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (3-chlorophenyl)magnesium bromide (1.0 M in THF, 300 mL, 300 mmol) according to the procedure described for (S)-**1a**, affording 24.0 g (64.2%) of (S)-**1h** sulfate which was converted to 20.0 g (62% overall) of (S)-**1h** as a pale-yellow, viscous oil. HPLC analysis [(R)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 1.2% of the R,R derivative (k' = 1.72) and 98.8% of the R,S derivative (k' = 2.80). An analytical sample was prepared by molecular distillation (175 °C, 0.02 mbar): IR (CCl_4) 3500–3200 (br), 2980, 2860, 1585, 1565, 1470, 1420, 1185, 1080 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.65–7.15 (m, 8 H, Ar-H), 4.9–4.5 (br s, 1 H, OH), 4.18 (t, J = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H_2), 1.85–1.50 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 149.8, 146.8 (C1′, C1″), 134.4, 134.2 (C3′, C3″), 129.6, 129.4 (C5′, C5″), 127.0, 126.8, (C2′, C2″), 126.2, 125.8 (C4′, C4″), 124.0, 123.7 (C6′, C6″), 76.6 (Cα), 64.2 (C2), 46.8 (C5), 26.3 (C3), 25.5 (C4); TLC (solvent A) R_f = 0.39; $[\alpha]^{20}_{589}$ -49.1° (c = 0.804, MeOH). Anal. Calcd for $C_{17}H_{17}Cl_2NO$: C, 63.37; H, 5.32; N, 4.35; Cl, 22.00. Found: C, 63.31; H, 5.37; N, 4.36; Cl, 21.91.

(S)-α,α-Bis(3,5-dichlorophenyl)-2-pyrrolidinemethanol ((S)-1i). Prepared by the addition of (S)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (3,5-dichlorophenyl)magnesium bromide (1.0 M in THF, 300 mL, 300 mmol) according to the procedure described for (S)-**1a**, affording 31.1 g (70.6%) of (S)-**1i** sulfate which was converted to 26.6 g (68% overall) of (S)-**1i** as a pale-yellow glass. HPLC analysis [(R)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the R,R derivative (k' = 0.74) and 99.7% of the R,S derivative (k' = 1.35). An analytical sample was purified by molecular distillation (190 °C, 0.015 mbar): mp 118–119 °C; IR (CCl_4) 3500–3200, 2980, 2880, 1570, 1555, 1415, 1185, 870 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.42 (d, J = 1.8 Hz, 2 H, Ar-H), 7.36 (d, J = 1.8 Hz, 2 H, Ar-H), 7.25–7.15 (m, 2 H, Ar-H), 4.9–4.7 (br s, 1 H, OH), 4.1 (t, J = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H_2), 1.85–1.45 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 150.6, 147.6 (C1′, C1″), 135.2, 134.9 (C3′, C3″, C5′, C5″), 127.3, 127.2 (C4′, C4″), 124.6, 124.1 (C2′, C2″, C6′, C6″), 76.4 (Cα), 63.8 (C2), 46.8 (C5), 26.4 (C3), 25.5 (C4); TLC (solvent A) R_f = 0.49; $[\alpha]^{17}_{589}$ -36.6° (c = 1.409, MeOH). Anal. Calcd for $C_{17}H_{15}Cl_4NO$: C, 52.21; H, 3.87; N, 3.58; Cl, 26.26. Found: C, 52.34; H, 3.94; N, 3.62; Cl, 36.01.

(S)-α,α-Bis(3,5-dimethylphenyl)-2-pyrrolidinemethanol ((S)-1j). Prepared by the addition of (S)-**3** (1.0 M in THF, 100 mL, 100 mmol) to (3,5-dimethylphenyl)magnesium bromide (1.0 M in THF, 300 mL, 300 mmol) according to the procedure described for (S)-**1a**, affording 23.7 g (66.2%) of (S)-**1j** sulfate, which was converted to 18.5 g (60% overall) of (S)-**1j** as a white solid. HPLC analysis [(R)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the R,R derivative (k' = 0.65) and 99.7% of the R,S derivative (k' = 0.83). An analytical sample was prepared by recrystallization from hexane: mp 97.5–98.0 °C; IR (CCl_4) 3500–3200 (br), 2980, 2920, 2880, 1600, 1450, 1400, 1375, 1155, 1115, 855 cm^{-1}; ^1H NMR ($CDCl_3$) δ 7.20, 7.12 (2 s, 4 H, Ar-H), 6.85 (s, 2 H, Ar-H), 5.0–4.6 (br s, 1 H, OH), 4.25 (t, J = 7.4 Hz, 1 H, C2-H), 3.1–2.9 (m, 2 H, C5-H_2), 2.35 (s, 12 H, Ar-CH_3), 1.9–1.5 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 148.3, 145.4 (C1′, C1″), 137.5, 137.2 (C3′, C3″, C5′, C5″), 128.1, 128.0 (C4′, C4″), 123.6, 123.3 (C2′, C2″, C6′, C6″), 76.9 (Cα), 64.5 (C2), 46.8 (C5), 26.3 (C3), 25.6 (C4), 21.61, 21.59 (Ar-CH_3); TLC (solvent A) R_f = 0.33; $[\alpha]^{20}_{589}$ -63.0° (c = 0.318, MeOH). Anal. Calcd for $C_{21}H_{27}NO$: C, 81.51; H, 8.73; N, 4.52. Found: C, 81.65; H, 8.86; N, 4.46.

(S)-α,α-Di-2-naphthyl-2-pyrrolidinemethanol ((S)-1k). Prepared by the addition of (S)-**3** (1.0 M in THF, 100 mL, 100 mmol) to 2-naphthylmagnesium bromide (1.0 M in THF, 300 mL, 300 mmol) according to the procedure described for (S)-**1a**. In this case the sulfate salt was not soluble in aqueous THF. The $MgSO_4$/product sulfate cake was washed with hot H_2O (1 L) and EtOAc (2 × 100 mL) and then dried in vacuo to afford 25.7 g (63.8%) of (S)-**1k** sulfate which was converted to 22.5 g (63.6% overall) of (S)-**1k** as a white solid. HPLC analysis [(R)-MTPA amide derivative,[24] Zorbax Si, 9:1 hexane/THF, 210 nm] detected 0.3% of the R,R derivative (k' = 1.83) and 99.7% of the R,S derivative (k' = 2.65). An analytical sample was prepared by recrystallization from hexane/*i*-PrOAc: mp 142.5–143.5 °C [lit.[3i] mp 137–138 °C]; IR (CCl_4) 3500–3200 (br), 3060, 2960, 2870, 1595, 1500, 1400, 1320, 1120 cm^{-1}; ^1H NMR ($CDCl_3$) δ 8.2–7.4 (m, 14 H, Ar-H), 5.5–4.6 (br s, 1 H, OH), 4.5 (t, J = 7.4 Hz, 1 H, C2-H), 3.15–2.95 (m, 2 H, C5-H_2), 1.90–1.55 (m, 5 H, C3-H_2, C4-H_2, NH); ^{13}C NMR ($CDCl_3$) δ 145.4, 142.7 (C2′, C2″), 133.3, 133.2 (C4a′, C4a″), 132.30, 132.26 (C8a′, C8a″), 128.3, 128.2, 128.1, 127.7, 127.5, 126.1, 125.9, 125.8, 125.7, 125.3, 124.5, 124.1, 123.8 (Ar), 77.6 (Cα), 64.1 (C2), 46.9 (C5), 26.5 (C3), 25.6 (C4); TLC (solvent A) R_f = 0.33; $[\alpha]^{21}_{589}$ -99.1° (c = 0.702, MeOH) [lit.[3i] $[\alpha]^{23}_{589}$ -130.4° (c = 2.56, $CHCl_3$)]. Anal. Calcd for $C_{25}H_{23}NO$: C, 84.95; H, 6.56; N, 3.96. Found: C, 84.86; H, 6.72; N, 3.94.

(S)-Tetrahydro-1-methyl-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((S)-2a). A 3-L, three-necked flask fitted with a mechanical stirrer, nitrogen inlet tube, and Teflon-coated thermocouple was charged with (S)-**1a** sulfate (89.1 g, 148 mmol), THF (300 mL), and 2 M aqueous NaOH (300 mL). The mixture was stirred at 20–25 °C until all of the solid dissolved (ca. 0.5 h). Toluene (1.2 L) was added, and the mixture was stirred an additional 0.5 h, filtered through a medium-frit, sintered-glass funnel, and partitioned. The upper (product) layer was washed with water (150 mL) and concentrated (1 atm) to a volume of 500 mL. The toluene solution of (S)-**1a** (ca. 295 mmol) was cooled to 20–25 °C and charged with trimethylboroxine (24.7 g, 197 mmol). The temperture of the mixture rose ca. 5 °C, and a white precipitate of **4a** formed. The mixture was aged 0.5 h at 20–25 °C. The flask was fitted with a distillation head. Toluene (500 mL) was added, and the mixture was concentrated (1 atm) to a volume of 300 mL. During the initial distillation, an air-cooled condenser was used to prevent methylboronic acid from plugging the condenser. The toluene addition, followed by concentration, was repeated two times to insure complete removal of water and excess methylboronic acid (as trimethylboroxine). The suitability

of the catalyst was determined by both capillary GC [(DB-1, 200 °C) <1% **1a** (5.5 min), >99% **2a** (4.9 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.3 (t), trimethylboroxine δ 0.45 (s), **5a** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4a** δ −0.25 (br s, B-CH_3). The toluene solution of (*S*)-**2a** (ca. 1.0 M), stored under an atmosphere of N_2 protected from moisture, was used "as is" as a catalyst for the enantioselective reduction of ketones with borane.

For analysis, a portion of the toluene solution (10.0 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 2.77 g of (*S*)-**2a** as a white solid: mp 79–81 °C [lit.[3f] mp 74–87 °C]; IR (CCl_4) 2960, 2880, 1440, 1330, 1310, 1235, 1000 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.65–7.15 (m, 10 H, Ar-H), 4.4 (dd, *J* = 5.8, 10.0 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.55 (m, 3 H, C4-H, C5-H_2), 0.95–0.75 (m, 1 H, C4-H), 0.40 (s, 3 H, BCH_3); ^{11}B NMR (0.2 M in $CDCl_3$) δ 34.3; ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.6, 144.0 (C1′, C1″), 128.2, 127.7 (C3′, C3″, C5′, C5″), 127.1, 126.6 (C4′, C4″), 126.3, 126.2 (C2′, C2″, C6′, C6″), 87.8 (C3), 72.7 (C3a), 42.9 (C6), 30.2 (C4), 26.4 (C5), −5.6 (br, B-CH_3); FAB/MS (DTT/DTE matrix) $[M + H]^+$ at *m/z* 278.1. Isotopic cluster consistent with the presence of one boron. Anal. Calcd for $C_{18}H_{20}BNO$: C, 78.00; H, 7.27; N, 5.05. Found: C, 77.81; H, 7.37; N, 4.91.

(*R*)-Tetrahydro-1-methyl-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*R*)-2a). Prepared from (*R*)-**1a** (13.45 g, 53.1 mmol) and trimethylboroxine (4.44 g, 35.4 mmol) according to the procedure described for (*S*)-**2a**, affording 45 mL (1.18 M) of (*R*)-**2a** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 200 °C) <1% **1a** (5.5 min), >99% **2a** (4.9 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.3 (t), trimethylboroxine δ 0.45 (s), **5a** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4a** δ −0.25 (br s, B-CH_3). For analysis, a portion of the solution (5.00 mL) was concentrated in vacuo (50 °C, 0.01 mbar) to afford 1.63 g of a white solid, identical in all respects (except specific rotation) with the *S* enantiomer.

(*S*)-Tetrahydro-1-methyl-3,3-bis(4-fluorophenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2b). A solution of (*S*)-**1b** (10.2 g, 35.1 mmol) and trimethylboroxine (2.20 g, 17.5 mmol) in toluene (35 mL) was aged for 0.5 h at 20–25 °C and then heated at reflux for 2 h. Toluene (35 mL) was added, and the solution was concentrated (1 atm) to a volume of ca. 35 mL. The toluene addition, followed by concentration, was repeated two times to insure complete removal of excess methylboronic acid (as trimethylboroxine). Analysis of the reaction mixture by capillary GC detected the presence of 3.3% 4,4′-difluorobenzophenone.

The reaction was repeated using benzene as the solvent. In this case, the reaction was heated at reflux for 24 h. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 250 °C) <0.1% 4,4′-difluorobenzophenone (3.3 min), <1% **1b** (8.9 min), >98% **2b** (8.4 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1b** δ 4.2 (t), trimethylboroxine δ 0.45 (s), **5b** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4b** δ −0.25 (br s, B-CH_3). Based on the final volume of 31 mL, the concentration of (*S*)-**2b** was calculated to be 1.14 M. The benzene solution, stored under an atmosphere of N_2 protected from moisture, was used as a catalyst for the enantioselective reduction of ketones with borane.

For analysis, a portion of the benzene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.78 g of (*S*)-**2b** as a pale-yellow viscous oil: IR (CCl_4) 2970, 2880, 1600, 1500, 1230 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.55–7.45 (m, 2 H, Ar-H), 7.35–7.25 (m, 2 H, Ar-H), 7.10–6.95 (m, 4 H, Ar-H), 4.30 (dd, *J* = 6.0, 10.0 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.75–1.90 (m, 2 H, C4-H, C5-H), 1.70–1.50 (m, 1 H, C5-H), 0.90–0.70 (m, 1 H, C4-H), 0.40 (s, 3 H, BCH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 161.95, 161.65 (2 d, J_{CF} = 246 Hz, C4′, C4″), 143.3, 139.6 (2 d, J_{CF} = 3.2 Hz, C1′, C1″), 128.05, 127.45 (2 d, J_{CF} = 8.3 Hz, C2′, C2″, C6′, C6″), 114.95, 114.59 (2 d, J_{CF} = 22.3 Hz, C3′, C3″, C5′, C5″), 86.97 (C3), 72.74 (C3a), 42.93 (C6), 30.20 (C4), 26.30 (C5), −5.6 (br, B-CH_3). Anal. Calcd for $C_{18}H_{18}BF_2NO$: C, 69.04; H, 5.79; N, 4.47. Found: C, 69.02; H, 5.82; N, 4.47.

(*S*)-Tetrahydro-1-methyl-3,3-bis(4-chlorophenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2c). Prepared from (*S*)-**1c** (10.7 g, 33.2 mmol) and trimethylboroxine (2.78 g, 22.2 mmol) according to the procedure described for (*S*)-**1b**, using benzene as the solvent, affording 35 mL (0.95 M) of (*S*)-**2c** in benzene. The suitability of the catalyst was determined by both capillary GC: [(DB-1, 225 °C) <1% **1c** (8.75 min), >99% **2c** (7.29 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1c** δ 4.2 (t), trimethylboroxine δ 0.45 (s), **5c** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4c** δ −0.25 (br s, B-CH_3).

For analysis, a portion of the benzene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.64 g of (*S*)-**2c** as a pale-yellow viscous oil: IR (CCl_4) 2970, 2880, 1490, 1325, 1315, 1235, 1090, 1010 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.5–7.2 (m, 8 H, Ar-H), 4.3 (dd, *J* = 5.7, 10.0 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.75 (m, 2 H, C4-H, C5-H), 1.70–1.50 (m, 1 H, C5-H), 0.90–0.70 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 145.8, 142.2 (C1′, C1″), 133.2, 132.7 (C4′, C4″), 128.4, 128.0, 127.7, 127.5 (C2′, C2″, C3′, C3″, C5′, C5″, C6′, C6″), 86.9 (C3), 72.5 (C3a), 42.9 (C6), 30.2 (C4), 26.3 (C5), −5.6 (br, B-CH_3). Anal. Calcd for $C_{18}H_{18}BCl_2NO$: C, 62.47; H, 5.24; N, 4.05; Cl, 20.49. Found: C, 61.92; H, 5.33; N, 3.90; Cl, 20.19.

(*S*)-Tetrahydro-1-methyl-3,3-bis(4-methylphenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2d). Prepared from (*S*)-**1d** (3.84g, 13.7 mmol) and trimethylboroxine (1.15 g, 9.16 mmol) according to the procedure described for (*S*)-**1b**, using toluene as the solvent, affording 20 mL (0.68 M) of (*S*)-**2d** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 225 °C) <1% **1d** (5.13 min), >99% **2d** (4.48 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1d** δ 4.25 (t), trimethylboroxine δ 0.45 (s), **5d** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4d** δ −0.25 (br s, B-CH_3).

For analysis, a portion of the toluene solution (2.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 415 mg of (*S*)-**2d** as a pale-yellow viscous oil: IR (CCl_4) 3020, 2970, 2880, 1505, 1450, 1325, 1315, 1240, 1000 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.55–7.05 (m, 8 H, Ar-H), 4.35 (dd, *J* = 5.7, 9.9 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 2.35 (s, 6 H, Ar-CH_3), 1.90–1.70 (m, 2 H, C4-H, C5-H), 1.70–1.55 (m, 1 H, C5-H), 0.95–0.75 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 145.0, 141.3 (C1′, C1″), 136.6, 136.0 (C4′, C4″), 128.8, 128.4 (C3′, C3″, C5′, C5″), 126.2, 126.1 (C2′, C2″, C6′, C6″), 87.6 (C3), 72.6 (C3a), 43.0 (C6), 30.2 (C4), 26.4 (C5), 21.0 (Ar-CH_3), −5.6 (br B-CH_3). Anal. Calcd for $C_{20}H_{24}BNO$: C, 78.70; H, 7.93; N, 4.59. Found: C, 78.36; H, 7.97; N, 4.41.

(*S*)-Tetrahydro-1-methyl-3,3-bis(4-(trifluoromethyl)-phenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2e). Prepared from (*S*)-**1e** (13.65g, 35.1 mmol) and trimethylboroxine (2.93 g, 23.3 mmol) according to the procedure described for (*S*)-**1b**, using toluene as the solvent, affording 39 mL (0.89 M) of (*S*)-**2e** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 200 °C) <1% **1e** (5.00 min), >99% **2e** (4.32 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1e** δ 4.31 (t), trimethylboroxine δ 0.45 (s), **5e** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4e** δ −0.25 (br s, B-CH_3).

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.84 g of (*S*)-**2e** as a pale-yellow viscous oil: IR (CCl_4) 2970, 2880, 1615, 1410, 1320, 1235, 1170, 1130, 1075 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.75–7.45 (m, 8 H, Ar-H), 4.35 (dd, *J* = 5.6, 10.2 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 2.35 (s, 6 H, Ar-CH_3), 1.90–1.75 (m, 2 H, C4-H, C5-H), 1.75–1.60 (m, 1 H, C5-H), 0.90–0.70 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 152.5, 150.7 (C1′, C1″), 136.6, 136.0 (C4′, C4″), 129.23, 129.19 (2 q, J_{CF} = 32 Hz, C4′, C4″), 126.5, 126.4 (C2′, C2″, C6′, C6″), 125.3, 125.9 (2 q, J_{CF} = 3.7 Hz, C3′, C3″, C5′, C5″), 124.1, 124.0 (2 q, J_{CF} = 272 Hz, Ar-CF_3), 87.0 (C3), 72.4 (C3a), 42.9 (C6), 30.2 (C4), 26.1 (C5), −5.7 (br, B-CH_3). Anal. Calcd for $C_{20}H_{18}BF_6NO$: C, 58.14; H, 4.39; N, 3.39. Found: C, 57.99; H, 4.53; N, 3.29.

(*S*)-Tetrahydro-1-methyl-3,3-bis(4-(1,1-dimethylethyl)-phenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2f). Prepared from (*S*)-**1f** (12.5 g, 34.2 mmol) and trimethylboroxine (2.86 g, 22.8 mmol) according to the procedure described for (*S*)-**1b**, using toluene as the solvent, affording 47 mL (0.73 M) of (*S*)-**2f** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 250 °C) <1% **1f** (5.52 min), >99% **2f** (4.78 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1f** δ 4.25 (t), trimethylboroxine δ 0.45 (s), **5f** δ 0.35 to −0.50 (multiple B-CH_3 singlets), and/or **4f** δ −0.25 (br s, B-CH_3).

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.41 g of (*S*)-**2f** as a pale-yellow viscous oil: IR (CCl_4) 2970, 2910, 2880, 1505, 1470, 1360, 1325, 1240 cm^{-1}; ^1H NMR (0.2 M in $CDCl_3$) δ 7.75–7.15 (m, 8 H, Ar-H), 4.32 (dd, J = 5.6, 9.8 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.70 (m, 2 H, C4-H, C5-H), 1.70–1.55 (m, 1 H, C5-H), 1.35 (s, 18 H, Ar-C(CH_3)$_3$), 0.95–0.75 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 149.6, 149.1 (C4′, C4″), 144.9, 141.0 (C1′, C1″), 125.8, 125.0, 124.5 (C2′, C2″, C3′, C3″, C6′, C6″, C5′, C5″), 87.6 (C3), 73.1 (C3a), 42.9 (C6), 34.4 (Ar-*C*(CH_3)$_3$), 31.4 (Ar-C(CH_3)$_3$), 30.2 (C4), 26.5 (C5), –5.6 (br B-CH_3). Anal. Calcd for $C_{26}H_{36}BNO$: C, 80.20; H, 9.32; N, 3.60. Found: C, 79.98; H, 9.36; N, 3.42.

(*S*)-Tetrahydro-1-methyl-3,3-bis(4-methoxyphenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2). Prepared from (*S*)-**1g** (5.00 g, 15.1 mmol) and trimethylboroxine (1.26 g, 10.1 mmol) according to the procedure described for (*S*)-**1b**, using toluene as the solvent, affording 18 mL (0.82 M) of (*S*)-**2g** in toluene. The suitability of the catalyst was determined by both capillary GC: [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.4% 4,4′-dimethoxybenzophenone, <1% **1g** (13.7 min), >99% **2g** (13.4 min)[15]] and ^1H NMR: ($CDCl_3$) no **1g** δ 4.25 (t), trimethylboroxine δ 0.45 (s), **5g** δ 0.35 to –0.50 (multiple B-CH_3 singlets), and/or **4g** δ –0.25 (br s, B-CH_3).

For analysis, a portion of the toluene solution (4.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.11 g of (*S*)-**2g** as a pale-yellow viscous oil: IR (CCl_4) 2950, 2840, 1605, 1505, 1250, 1180, 1040 cm^{-1}; ^1H NMR (0.2 M in $CDCl_3$) δ 7.50–7.35 (m, 2 H, Ar-H), 7.30–7.15 (m, 2 H, Ar-H), 6.95–6.75 (m, 4 H, Ar-H), 4.30 (dd, J = 5.6, 9.8 Hz, 1 H, C3a-H), 3.78 (s, 6 H, Ar-OCH_3), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.70 (m, 2 H, C4-H, C5-H), 1.70–1.55 (m, 1 H, C5-H), 1.35 (s, 18 H, Ar-C(CH_3)$_3$), 0.95–0.75 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 158.6, 158.2 (C4′, C4″), 140.2, 136.6 (C1′, C1″), 127.6, 127.3 (C2′, C2″, C6′, C6″), 113.4, 113.3 (C3′, C3″, C5′, C5″), 87.3 (C3), 72.8 (C3a), 55.3, 55.2 (Ar-OCH_3), 43.0 (C6), 30.1 (C4), 26.4 (C5), –5.6 (br B-CH_3). Anal. Calcd for $C_{20}H_{24}BNO_3$: C, 71.23; H, 7.17; N, 4.15. Found: C, 71.00; H, 7.39; N, 4.06.

(*S*)-Tetrahydro-1-methyl-3,3-bis(3-chlorophenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2h). Prepared from (*S*)-**1h** (15.0 g, 46.6 mmol) and trimethylboroxine (3.89 g, 31.0 mmol) according to the procedure described for (*S*)-**1b**, using benzene as the solvent, affording 64 mL (0.73 M) of (*S*)-**2h** in benzene. The suitability of the catalyst was determined by both capillary GC: [(DB-1, 160 °C for 3 min then 10 °C/min to 300 °C) <0.2% 3,3′-dichlorobenzophenone (7.2 min), <1% **1h** (12.1 min), >99% **2h** (11.7 min)[15]] and ^1H NMR: ($CDCl_3$) no **1h** δ 4.2 (t), trimethylboroxine δ 0.45 (s), **5h** δ 0.35 to –0.50 (multiple B-CH_3 singlets), and/or **4h** δ –0.25 (br s, B-CH_3).

For analysis, a portion of the benzene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.26 g of (*S*)-**2h** as a colorless viscous oil: IR (CCl_4) 2960, 2880, 1585, 1560, 1465, 1415, 1330, 1310, 1230 cm^{-1}; ^1H NMR (0.2 M in $CDCl_3$) δ 7.60–7.15 (m, 8 H, Ar-H), 4.3 (dd, J = 5.7, 10.0 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.75 (m, 2 H, C4-H, C5-H), 1.70–1.50 (m, 1 H, C5-H), 0.90–0.70 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 149.1, 145.6 (C1′, C1″), 134.3, 134.0 (C3′, C3″), 129.6, 129.2 (C5′, C5″), 127.6, 127.0 (C2′, C2″), 126.5, 126.1 (C4′, C4″), 124.4 (C6′, C6″), 86.7 (C3), 72.4 (C3a), 42.9 (C6), 30.2 (C4), 26.2 (C5), –5.6 (br, B-CH_3). Anal. Calcd for $C_{18}H_{18}BCl_2NO$: C, 62.47; H, 5.24; N, 4.05; Cl, 20.49. Found: C, 61.97; H, 5.27; N, 4.03; Cl, 20.27.

(*S*)-Tetrahydro-1-methyl-3,3-bis(3,5-dichlorophenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2i). Prepared from (*S*)-**1i** (19.3 g, 49.3 mmol) and trimethylboroxine (4.13 g, 32.9 mmol) according to the procedure described for (*S*)-**1b**, using benzene as the solvent, affording 41 mL (1.20 M) of (*S*)-**2i** in benzene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min then 10 °C/min to 300 °C) <0.2% 3,3′,5,5′-tetrachlorobenzophenone (12.7 min), <1% **1i** (14.6 min), >99% **2i** (13.8 min)[15]] and ^1H NMR: ($CDCl_3$) no **1h** δ 4.2 (t), trimethylboroxine δ 0.45 (s), **5i** δ 0.35 to –0.50 (multiple B-CH_3 singlets), and/or **4i** δ –0.25 (br s, B-CH_3).

For analysis, a portion of the benzene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 2.34 g of (*S*)-**2i** as colorless crystals: mp 158–159 °C; IR (CCl_4) 3080, 2960, 2880, 1575, 1555, 1410, 1225, 860 cm^{-1}; ^1H NMR (0.2 M in $CDCl_3$) δ 7.45–7.15 (m, 6 H, Ar-H), 4.2 (dd, J = 5.7, 10.0 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.75 (m, 2 H, C4-H, C5-H), 1.70–1.50 (m, 1 H, C5-H), 0.90–0.70 (m, 1 H, C4-H), 0.45 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 149.8, 146.4 (C1′, C1″), 135.1, 134.9 (C3′, C3″, C5′, C5″), 127.9, 127.4 (C4′, C4″), 124.8, 124.5 (C2′, C2″, C6′, C6″), 86.1 (C3), 72.0 (C3a), 42.8 (C6), 30.3 (C4), 26.0 (C5), –5.7 (br, B-CH_3). Anal. Calcd for $C_{18}H_{18}BCl_2NO$: C, 62.47; H, 5.24; N, 4.05; Cl, 20.49. Found: C, 52.19; H, 3.99; N, 3.38; Cl, 33.94.

(*S*)-Tetrahydro-1-methyl-3,3-bis(3,5-dimethylphenyl)-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2j). Prepared from (*S*)-**1j** (13.3 g, 43.0 mmol) and trimethylboroxine (3.60 g, 28.7 mmol) according to the procedure described for (*S*)-**1b**, using toluene as the solvent, affording 57 mL (0.76 M) of (*S*)-**2j** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 225 °C) <1% **1j** (5.21 min), >99% **2j** (4.32 min)[15]] and ^1H NMR: ($CDCl_3$) no **1j** δ 4.25 (t), trimethylboroxine δ 0.45 (s), **5j** δ 0.35 to –0.50 (multiple B-CH_3 singlets), and/or **4j** δ –0.25 (br s, B-CH_3).

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.27 g of (*S*)-**2j** as a white crystalline solid: mp 128–129 °C; IR (CCl_4) 2970, 2920, 2880, 1600, 1450, 1335, 1315, 1250 cm^{-1}; ^1H NMR (0.2 M in $CDCl_3$) δ 7.15, 6.95 (2 s, 4 H, Ar-H), 6.90, 6.85 (2 s, 2 H, Ar-H), 4.32 (dd, J = 5.6, 9.9 Hz, 1 H, C3a-H), 3.50–3.35 (m, 1 H, C6-H), 3.20–3.05 (m, 1 H, C6-H), 2.35, 2.33 (2 s, 12 H, Ar-CH_3), 1.90–1.75 (m, 2 H, C4-H, C5-H), 1.75–1.55 (m, 1 H, C5-H), 1.00–0.80 (m, 1 H, C4-H), 0.40 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.7, 144.2 (C1′, C1″), 137.5, 137.0 (C3′, C3″, C5′, C5″), 128.8, 128.2 (C4′, C4″), 124.1, 123.9 (C2′, C2″, C6′, C6″), 87.67 (C3), 72.4 (C3a), 43.1 (C6), 30.3 (C4), 26.2 (C5), 21.6, 21.59 (Ar-CH_3), –5.6 (br, B-CH_3). Anal. Calcd for $C_{22}H_{28}BNO$: C, 79.28; H, 8.47; N, 4.20. Found: C, 79.74; H, 8.64; N, 4.11.

(*S*)-Tetrahydro-1-methyl-3,3-di-2-naphthyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-2k). Prepared from (*S*)-**1k** (11.0g, 31.1 mmol) and trimethylboroxine (2.60 g, 20.7 mmol) according to the procedure described for (*S*)-**1b**, using toluene as the solvent, affording 35 mL (0.88 M) of (*S*)-**2k** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 275 °C) <1% **1k** (9.68 min), >99% **2k** (8.17 min)[15]] and ^1H NMR: ($CDCl_3$) no **1k** δ 4.50 (t), trimethylboroxine δ 0.45 (s), **5k** δ 0.35 to –0.50 (multiple B-CH_3 singlets), and/or **4k** δ –0.25 (br s, B-CH_3).

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.65 g of (*S*)-**2k** as a pale-yellow viscous oil: IR (CCl_4) 3060, 2970, 2880, 1325, 1315, 1240 cm^{-1}; ^1H NMR (0.2 M in $CDCl_3$) δ 8.2–7.4 (m, 14 H, Ar-H), 4.65 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.55–3.40 (m, 1 H, C6-H), 3.25–3.10 (m, 1 H, C6-H), 1.90–1.65 (m, 3 H, C4-H, C5-H_2), 1.05–0.85 (m, 1 H, C4-H), 0.50 (s, 3 H, B-CH_3); ^{13}C NMR (0.2 M in $CDCl_3$) δ 144.5, 141.4 (C2′, C2″), 133.0 (C4a′, C4a″), 132.7, 132.3 (C8a′, C8a″), 128.44, 128.38, 128.15, 127.54, 127.49, 127.32, 126.11, 126.02, 125.87, 125.61, 125.32, 124.65, 124.49 (Ar), 88.0 (C3), 72.0 (C3a), 43.0 (C6), 30.4 (C4), 26.4 (C5), –5.6 (br, B-CH_3). Anal. Calcd for $C_{26}H_{24}BNO$: C, 82.77; H, 6.41; N, 3.71. Found: C, 82.93; H, 6.58; N, 3.53.

Intermediate 4a. To a magnetically stirred solution of oxazaborolidine (*S*)-**2a** (2.93 g, 10.6 mmol) in dry THF (10 mL) at 20 °C was added D_2O (211 mg, 10.5 mmol). The reaction was exothermic, raising the temperature to 35 °C. The solution was allowed to cool to 20–25 °C. After ca. 15 min a white crystalline solid began to form. The mixture was aged an additional 15 min and then filtered. The solid was dried in vacuo (30 °C, 0.1 mbar) to afford 1.54 g (49%) of **4a**: mp 123–124 °C; IR (solid) 3639, 3134, 3086–2831, [2685, 2346 OD and ND stretches], 1594, 1490, 1448, 1296, 1221, 1151, 1105, 1091, 1070, 1058, 1017, 934, 829, 781, 758, 747, 710, 697; ^1H NMR ($CDCl_3$) δ 7.65–7.45 (m, 4 H, Ar-H), 7.40–7.05 (m, 6 H, Ar-H), 4.45 (dd, J = 6.9, 9.7 Hz, 1 H, C3a-H), 3.35 (br, 1 H, C6-H), 3.05 (m, 1 H, C6-H), 2.05–1.40 (m, 4 H, C4-H_2, C5-H_2), –0.25 (br s, 3 H, B-CH_3); ^{11}B NMR ($CDCl_3$) δ 8.9; ^{13}C NMR ($CDCl_3$, 500 scans) δ 128.3, 127.8 (C3′, C5′, C3″, C5″), 127.1, 126.3 (C4′, C4″), 125.9, 125.6 (C2′, C4′, C2″, C4″), 86.2 (weak, C3), 67.6 (C3a), 27.8 (C4), 24.3 (C5). [Note: the NMR spectra were obtained as soon as the sample dissolved. Upon standing, the solution of **4a** decomposes to a 1:1 mixture of **1a** and **5a**.] Anal. Calcd for

$C_{18}H_{20}D_2BNO_2$: C, 72.75; H, 7.46; N, 4.71. Found: C. 72.84; H, 7.58; N, 4.65.

Intermediate 5a. To a magnetically stirred solution of (*S*)-**1a** (5.06 g, 20.0 mmol) in dry toluene (20 mL) at 20 °C was added trimethylboroxine (1.67 g, 13.3 mmol). The reaction was exothermic, raising the temperature to 33 °C. The solution was allowed to cool to 20 °C and then aged at that temperature for 1 h. The resultant solid was isolated by filtration. The solid was dried in vacuo (45 °C, 0.1 mbar) to afford 6.07 g (90%) of **5a** An analytical sample was prepared by recrystallization from EtOAc: mp 147–148 °C; IR (solid) 3435, 3270, 3066–2885, 1596, 1492, 1447, 1384, 1302, 1247, 1141, 1046, 1030, 1015, 1006, 762, 752, 717, 701; ^{1}H NMR (CD_3CN, major diasteromer) δ 7.66 (m, 2 H, *o*-AR-H), 7.47 (m, 2 H, *o*-Ar-H), 7.3–7.1 (overlapping m, 6 H, Ar-H), 6.37 (s, 1 H, B-OH), 5.13 (br, 1 H, NH), 4.68 (dt, J = 11.1, 6.5, 1 H, C3a-H), 3.39 (m, 1 H, C6-H), 2.99 (m, 1 H, C6-H), 1.9–1.7 (overlapping m, 3 H, C5-H_2, C4-H), 1.44 (m, 1 H, C4-H), 0.09 (s, 3 H, OB(OH)CH_3), –0.49 (s, 3 H, B1-CH_3); ^{11}B NMR ($CDCl_3$, major diasteromer) δ 30.4 (OB(OH)CH_3), 7.8 (B1); ^{13}C NMR (CD_3CN, major diasteromer) δ 148.4, 147.9 (C1′, C1″), 129.0, 128.8 (C3′, C5′, C3″, C5″), 127.7, 127.2 (C4′, C4″), 126.8, 126.1 (C2′, C6′, C2″, C6″), 83.6 (C3), 68.6 (C3a), 45.6 (C6), 28.7 (C4), 24.6 (C5), 7.0 (v br, B1-CH_3), –0.2 (v br, OB(OH)C_3); FAB MS (DTT/DTE matrix) $[M + H]^+$ at m/z 338.2. Isotopic cluster consistent with the presence of two borons. Anal. Calcd for $C_{19}H_{25}B_2NO_3$: C, 67.71; H, 7.48; N, 4.16. Found: C, 67.59; H, 7.47; N, 4.15.

Crystals of **5a**, grown from benzene, formed in space group $P2_1$ with a = 8.376 (1), b = 14.324 (3), and c = 8.748 (2) Å; β = 115.89 (2)° for Z = 2 and a calculated density of 1.185 g/cm^3. An automatic four circle diffractometer equipped with Cu Kα radiation (1.5418 Å) was used to measure 1881 potential diffraction peaks of which 1587 were observed ($I \geq 3\sigma(I)$). The structure was solved with a direct methods approach and was subsequentially refined with least-squares and Fourier methods. Anisotropic temperature factors were refined for the non-hydrogen atoms while isotropic temperature factors were applied to the hydrogen atoms but not refined. The function $\sum w(|F_o| - |F_c|)^2$ with $w = 4F_o^2/\sigma^2(F_o)^2$ was minimized with full-matrix least-squares analyses to give an unweighted residue of 0.043.

(*S*)-Tetrahydro-1-*n*-butyl-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-6). A solution of (*S*)-**1a** (20.1 g, 79.4 mmol) and tri-*n*-butylboroxine (6.66 g, 26.5 mmol) in toluene (200 mL) was aged 0.5 h at 20–25 °C and then heated at reflux for 16 h using a Dean–Stark trap for water removal. The solution was concentrated (1 atm) to a volume of 70.3 mL. The suitability of the catalyst was determined by both capillary GC [(DB-1, 200 °C) <0.1% tri-*n*-butylboroxine (1.3 min), <1% **1a** (5.7 min), >98% **6** (9.7 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t). Based on the final volume of 70 mL, the concentration of (*S*)-**6** was calculated to be 1.13 M. The toluene solution, stored under an atmosphere of N_2 protected from moisture, was used as a catalyst for the enantioselective reduction of ketones with borane.

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.80 g of (*S*)-**6** as a colorless oil: IR (CCl_4) 3060, 3020, 2960, 2930, 2880, 1480, 1440, 1240, 1000 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.65–7.45 (m, 2 H, Ar-H), 7.45–7.05 (m, 8 H, Ar-H), 4.35 (dd, J = 5.6, 9.9 Hz, 1 H, C3a-H), 3.45–3.30 (m, 1 H, C6-H), 3.15–3.00 (m, 1 H, C6-H), 1.90–1.25 (m, 7 H, C4-H, C5-H_2, C2′-H_2, C3′-H_2), 1.05–1.70 (m, 6 H, C4-H, C1′-H_2, C4′-H_3); ^{11}B NMR ($CDCl_3$) δ 34.3; ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.8, 144.1 (C1″, C1‴), 128.1, 127.7 (C3″, C3‴, C5″, C5‴), 127.1, 126.5 (C4″, C4‴), 126.22, 126.16 (C2″, C2‴, C6″, C6‴), 87.4 (C3), 73.1 (C3a), 42.8 (C6), 30.2 (C4), 26.9 (C2′), 26.5 (C5), 25.7 (C3′), 14.0 (C4′). Anal. Calcd for $C_{21}H_{26}BNO$: C, 79.01; H, 8.21; N, 4.39. Found: C, 78.58; H, 8.37; N, 4.37.

(*S*)-Tetrahydro-1,3,3-triphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-7). A solution of (*S*)-**1a** (10.3 g, 40.7 mmol) and triphenylboroxine[23] (4.25 g, 13.6 mmol) in toluene (100 mL) was aged for 0.5 h at 20–25 °C and then heated at reflux for 16 h using a Dean–Stark trap for water removal. The solution was concentrated (1 atm) to a volume of 46.8 mL. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.1% benzophenone (2.6 min), <1% **1a** (7.5 min), <1% triphenylboroxine (10.8 min), >98% **7** (14.2 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t). Based on the final volume of 47 mL, the concentration of (*S*)-**8** was calculated to be 0.87 M. The toluene solution, stored under an atmosphere of N_2 protected from moisture, was used as a catalyst for the enantioselective reduction of ketones with borane.

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.48 g of (*S*)-**7** as a colorless glass: IR (CCl_4) 3060, 3020, 2960, 2870, 1595, 1445, 1300, 1000 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 8.05–7.95 (m, 2 H, Ar-H), 7.70–7.60 (m, 2 H, Ar-H), 7.55–7.15 (m, 11 H, Ar-H), 4.65 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.70–3.55 (m, 1 H, C6-H), 3.45–3.30 (m, 1 H, C6-H), 2.05–1.75 (m, 3 H, C4-H, C5-H_2), 1.05–0.90 (m, 1 H, C4-H); ^{11}B NMR ($CDCl_3$) δ 30.8; ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.4, 143.8 (C1″, C1‴), 134.6 (C2′, C6′), 130.3 (C4′), 128.2, 127.77 (C3″, C3‴, C5″, C5‴), 127.85 (C3′, C5′), 127.2, 126.7 (C4″, C4‴), 126.41, 126.35 (C2″, C2‴, C6″, C6‴), 87.7 (C3), 74.4 (C3a), 43.8 (C6), 30.0 (C4), 27.6 (C5). Anal. Calcd for $C_{23}H_{22}BNO$: C, 81.43; H, 6.54; N, 4.13. Found: C, 81.35; H, 6.56; N, 4.12.

(*S*)-Tetrahydro-1-(4-fluorophenyl)-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-8). Prepared from (*S*)-**1a** (3.84 g, 15.2 mmol) and tris(4-fluorophenyl)boroxine[23] (1.85 g, 5.06 mmol) according to the procedure described for (*S*)-**7**, affording 22 mL (0.69 M) of (*S*)-**8** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.1% benzophenone (2.6 min), <0.5% **1a** (7.5 min), <0.5% tris(4-fluorophenyl)boroxine (11.7 min), >98% **8** (14.2 min)[15]] and ^{1}H NMR ($CDCl_3$) no **1a** δ 4.25 (t).

For analysis, a portion of the toluene solution (5.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.23 g of (*S*)-**8** as a colorless glass: IR (CCl_4) 2960, 2880, 1595, 1440, 1230 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 8.05–7.95 (m, 2 H, Ar-H), 7.70–7.60 (m, 2 H, Ar-H), 7.50–7.10 (m, 10 H, Ar-H), 4.65 (dd, J = 5.6, 9.9 Hz, 1 H, C3a-H), 3.70–3.55 (m, 1 H, C6-H), 3.45–3.30 (m, 1 H, C6-H), 2.05–1.70 (m, 3 H, C4-H, C5-H_2), 1.05–0.95 (m, 1 H, C4-H); ^{13}C NMR (0.2 M in $CDCl_3$) δ 164.5 (d, J_{CF} = 250 Hz, C4′), 147.2, 143.7 (C1″, C1‴), 136.7 (d, J_{CF} = 8 Hz, C2′, C6′), 128.2, 127.8 (C3″, C3‴, C5″, C5‴), 127.2, 126.8 (C4″, C4‴), 126.37, 126.30 (C2″, C2‴, C6″, C6‴), 114.9 (d, J_{CF} = 20 Hz, C3′, C5′), 87.8 (C3), 74.4 (C3a), 43.7 (C6), 30.0 (C4), 27.6 (C5). Anal. Calcd for $C_{23}H_{21}BFNO$: C, 77.33; H, 5.93; N, 3.92. Found: C, 76.90; H, 6.17; N, 3.82.

(*S*)-Tetrahydro-1-(4-chlorophenyl)-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-9). Prepared from (*S*)-**1a** (11.6 g, 45.8 mmol) and tris(4-chlorophenyl)boroxine[23] (6.35 g, 15.3 mmol) according to the procedure described for (*S*)-**7**, affording 60 mL (0.76 M) of (*S*)-**9** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.1% benzophenone (2.6 min), <1% **1a** (7.5 min), <0.1% tris(4-chlorophenyl)boroxine (17.2 min), >97% **9** (15.8 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t).

For analysis, a portion of the toluene solution (10.0 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 2.84 g of (*S*)-**8** as a colorless glass: IR (CCl_4) 3060, 3020, 2960, 2870, 1590, 1440, 1300, 1090 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.90 (d, 2 H, Ar-H), 7.70–7.60 (m, 2 H, Ar-H), 7.50–7.20 (m, 10 H, Ar-H), 4.67 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.65–3.50 (m, 1 H, C6-H), 3.45–3.30 (m, 1 H, C6-H), 2.10–1.70 (m, 3 H, C4-H, C5-H_2), 1.05–0.85 (m, 1 H, C4-H); ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.2, 143.6 (C1″, C1‴), 136.4 (C4′), 135.9 (C2′, C6′), 128.2, 127.8 (C3″, C3‴, C5″, C5‴), 128.1 (C3′, C5′), 127.3, 126.8 (C4″, C4‴), 126.35, 126.27 (C2″, C2‴, C6″, C6‴), 87.9 (C3), 74.4 (C3a), 43.7 (C6), 29.9 (C4), 27.6 (C5). Anal. Calcd for $C_{23}H_{21}BClNO$: C, 73.93; H, 5.66; N, 3.75; Cl, 9.49. Found: C, 73.52; H, 5.75; N, 3.65; Cl, 9.40.

(*S*)-Tetrahydro-1-(4-methylphenyl)-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-10). Prepared from (*S*)-**1a** (13.8 g, 54.5 mmol) and tris(4-methylphenyl)boroxine[23] (6.42 g, 18.1 mmol) according to the procedure described for (*S*)-**7**, affording 67 mL (0.81 M) of (*S*)-**10** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.1% benzophenone (2.6 min), <0.1% **1a** (7.5 min), <0.1% tris(4-methylphenyl)-boroxine (15.3 min), >99% **10** (15.1 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t).

For analysis, a portion of the toluene solution (10.0 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 2.86 g of (*S*)-**10** as a colorless glass: IR (CCl_4) 3060, 3020, 2960, 2870, 1500, 1440, 1300, 1005 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.9 (d, 2 H, Ar-H),

7.65 (d, 2 H, Ar-H), 7.50–7.20 (m, 10 H, Ar-H), 4.65 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.70–3.55 (m, 1 H, C6-H), 3.45–3.30 (m, 1 H, C6-H), 2.45 (s, 3 H, Ar-CH_3), 2.05–1.70 (m, 3 H, C4-H, C5-H_2), 1.05–0.95 (m, 1 H, C4-H); ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.4, 143.9 (C1″, C1‴), 140.4 (C4′), 134.7 (C2′, C6′), 128.6 (C3′, C5′), 128.1, 127.7 (C3″, C3‴, C5″, C5‴), 127.1, 126.7 (C4″, C4‴), 126.38, 126.36 (C2″, C2‴, C6″, C6‴), 87.6 (C3), 74.4 (C3a), 43.8 (C6), 29.9 (C4), 27.6 (C5), 21.7 (Ar-CH_3). Anal. Calcd for $C_{24}H_{24}BNO$: C, 81.60; H, 6.85; N, 3.96. Found: C, 81.24; H, 6.98; N, 3.90.

(*S*)-Tetrahydro-1-(4-(trifluoromethyl)phenyl)-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-11). Prepared from (*S*)-**1a** (7.25 g, 28.6 mmol) and tris(4-(trifluoromethyl)phenyl)boroxine[23] (4.92 g, 9.54 mmol) according to the procedure described for (*S*)-**7**, affording 70 mL (0.41 M) of (*S*)-**11** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.1% benzophenone (2.6 min), <0.1% **1a** (7.5 min), <0.1% tris(4-(trifluoromethyl)phenyl)boroxine (11.8 min), >97% **11** (13.9 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t).

For analysis, a portion of the toluene solution (10.0 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 1.67 g of (*S*)-**11** as a colorless glass: IR (CCl_4) 2970, 2870, 1520, 1440, 1320, 1170, 1130, 1100, 1070 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 8.05 (d, 2 H, Ar-H), 7.70 (d, 2 H, Ar-H), 7.60 (d, 2 H, Ar-H), 7.50–7.15 (m, 8 H, Ar-H), 4.70 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.65–3.50 (m, 1 H, C6-H), 3.50–3.35 (m, 1 H, C6-H), 2.10–1.70 (m, 3 H, C4-H, C5-H_2), 1.10–0.90 (m, 1 H, C4-H); ^{13}C NMR (0.2 M in $CDCl_3$) δ 147.0, 143.5 (C1″, C1‴), 134.8 (C2′, C6′), 132.0 (q, J_{CF} = 32 Hz, C4′), 128.2, 127.8 (C3″, C3‴, C5″, C5‴), 127.3, 126.8 (C4″, C4‴), 126.33, 126.22 (C2″, C2‴, C6″, C6‴), 124.5 (q, J_{CF} = 3.7 Hz, C3′, C5′), 124.2 (q, J_{CF} = 273 Hz, Ar-CF_3), 88.0 (C3), 74.5 (C3a), 43.6 (C6), 29.9 (C4), 27.6 (C5). Anal. Calcd for $C_{24}H_{21}BF_3NO$: C, 70.78; H, 5.20; N, 3.44. Found: C, 70.46; H, 5.42; N, 3.39.

(*S*)-Tetrahydro-1-(4-methoxyphenyl)-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-12). Prepared from (*S*)-**1a** (10.8 g, 42.6 mmol) and tris(4-methoxyphenyl)-boroxine[23] (5.69 g, 14.2 mmol) according to the procedure described for (*S*)-**7**, affording 75 mL (0.57 M) of (*S*)-**12** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.1% benzophenone (2.6 min), <0.1% **1a** (7.5 min), <0.1% tris(4-methoxyphenyl)boroxine (19.1 min), >97% **12** (16.3 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t).

For analysis, a portion of the toluene solution (10.0 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 2.10 g of (*S*)-**12** as a colorless glass: IR (CCl_4) 2960, 2870, 1600, 1445, 1240, 1170 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.95 (d, 2 H, Ar-H), 7.65 (d, 2 H, Ar-H), 7.50–7.20 (m, 8 H, Ar-H), 7.00 (d, 2 H, Ar-H), 4.63 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.87 (s, 3 H, Ar-OCH_3), 3.70–3.55 (m, 1 H, C6-H), 3.45–3.30 (m, 1 H, C6-H), 2.05–1.70 (m, 3 H, C4-H, C5-H_2), 1.05–0.95 (m, 1 H, C4-H); ^{13}C NMR (0.2 M in $CDCl_3$) δ 161.5 (C4′), 147.4, 143.9 (C1″, C1‴), 136.3 (C2′, C6′),[21a] 128.2, 127.7 (C3″, C3‴, C5″, C5‴), 127.1, 126.7 (C4″, C4‴), 126.4, 126.3 (C2″, C2‴, C6″, C6‴), 123 (br C1′), 113.5 (C3′, C5′), 87.6 (C3), 74.4 (C3a), 55.1 (ArOCH_3), 43.9 (C6), 30.0 (C4), 27.6 (C5). Anal. Calcd for $C_{24}H_{24}BNO_2$: C, 78.07; H, 6.55; N, 3.79. Found: C, 77.72 H, 6.70; N, 3.56.

(*S*)-Tetrahydro-1-(2,4,6-trimethylphenyl)-3,3-diphenyl-1*H*,3*H*-pyrrolo[1,2-*c*][1,3,2]oxazaborole ((*S*)-13). Prepared from (*S*)-**1a** (4.86 g, 19.2 mmol) and tris(2,4,6-trimethylphenyl)boroxine[23] (2.80 g, 6.39 mmol) according to the procedure described for (*S*)-**7**, affording 20 mL (0.96 M) of (*S*)-**13** in toluene. The suitability of the catalyst was determined by both capillary GC [(DB-1, 160 °C for 3 min, then 10 °C/min to 300 °C) <0.2% benzophenone (2.6 min), <0.1% **1a** (7.5 min), <0.1% tris(2,4,6-trimethylphenyl)boroxine (17.4 min), >97% **13** (15.5 min)[15]] and ^{1}H NMR: ($CDCl_3$) no **1a** δ 4.25 (t).

For analysis, a portion of the toluene solution (2.00 mL) was concentrated in vacuo (50 °C, 0.001 mbar) to afford 0.732 g of (*S*)-**13** as a colorless glass: IR (CCl_4) 2960, 2880, 1600, 1440, 1295, 1240 cm^{-1}; ^{1}H NMR (0.2 M in $CDCl_3$) δ 7.75–7.65 (d, 2 H, Ar-H), 7.65–7.55 (d, 2 H, Ar-H), 7.45–7.25 (m, 6 H, Ar-H), 6.92 (s, 2 H, Ar-H), 4.45 (dd, J = 5.5, 9.7 Hz, 1 H, C3a-H), 3.40–3.25 (m, 1 H, C6-H), 3.20–3.05 (m, 1 H, C6-H), 2.35 (s, 9 H, Ar-CH_3), 2.00–1.70 (m, 3 H, C4-H, C5-H_2), 1.20–1.00 (m, 1 H, C4-H); ^{13}C NMR (0.2 M in $CDCl_3$) δ 148.1, 144.3 (C1″, C1‴), 141.2 (C2′, C6′), 138.4 (C4′), 128.2, 127.9 (C3″, C3‴, C5″, C5‴), 127.2 (C3′, C5′, C4″), 126.6 (C4‴), 126.2, 126.1 (C2″, C2‴, C6″, C6‴), 87.9 (C3), 73.0 (C3a), 43.3 (C6), 31.0 (C4), 25.3 (C5), 22.2 (2′,6′-Ar-$(CH_3)_2$), 21.3 (4′-Ar-CH_3). Anal. Calcd for $C_{26}H_{28}BNO$: C, 81.90; H, 7.40; N, 3.67. Found: C, 81.54; H, 7.54; N, 3.53.

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Supplementary Material Available: Experimental details and tables containing fractional coordinates, temperature factors, and bond distances and angles for **5a** (6 pages). Ordering information is given on any current masthead page.