Alkylation of Tricarbonylchromium-Stabilized Benzylic Anions of 3-(Dipropylamino)chroman

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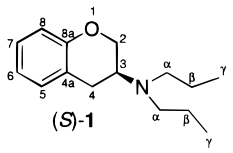
Tricarbonylchromium complexes of racemic and resolved 3-(dipropylamino)chromans were prepared. Benzylic alkylation of the complexes provided access to 4-alkylated derivatives. Alkylations of the endo complex gave only the expected trans products. Unexpectedly, the exo complex predominantly (with methyl iodide) or almost exclusively (with allyl and benzyl bromide) produced the trans derivatives. Steric effects and the nature of the electrophiles appear to direct the outcome of the alkylations.

Studies on benzylic deprotonation and subsequent alkylations of (η^6-arene)tricarbonylchromium complexes[1] have demonstrated (i) that the benzylic hydrogen being antiperiplanar to the chromium arene centroid axis has an increased kinetic acidity and (ii) that the electrophile is introduced from the face of the arene opposite to that complexed with the tricarbonylchromium tripod.[2] Consequently, methylations of benzylic anions of (η^6-arene)-tricarbonylchromium proceed in a stereospecific fashion, anti to the tricarbonylchromium tripod. As part of an ongoing exploration of various synthetic approaches to stereochemically well-defined bicyclic amines of potential biological interest,[2j,3,4] we have now utilized the tricarbonylchromium-induced acidity of benzylic protons to regio- and stereoselectively alkylate deprotonated tricarbonylchromium complexes of 3-(dipropylamino)chroman (**1**).[5] The results are noteworthy because of an unexpected stereochemical outcome in the alkylation of deprotonated chromium complexes *exo*-**5**,[6] in which alkylation predominantly, or exclusively, occurs syn and not anti to the tricarbonylchromium tripod.



The deprotonations and subsequent alkylations were carried out on both racemic and enantiomerically pure tricarbonylchromium complexes of **1**, i.e., *exo*- and *endo*-**5**. Racemic **1**[5] and **3**[7] and the enantiomers of **4**[8] have been reported previously but were now prepared by an alternative synthetic sequence (Scheme 1).

The enantiomers of **1** were prepared from 3-chromanone[9] (**2**) as follows (Scheme 1): Reductive amination[10] of **2** with benzylamine and $NaCNBH_3$ at pH 4−5 gave the amine **3**. Racemic **3** was resolved into the enantiomers by fractional crystallization of the diastereomeric salts formed with L-(+)- and D-(−)-mandelic acid. The enantiopurities of (*R*)- and (*S*)-**3** were determined

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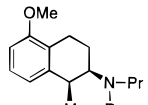
(1) For reviews on tricarbonylchromium chemistry, see: (a) Solladié-Cavallo, A. *Polyhedron* **1985**, *4*, 901−927. (b) Solladié-Cavallo, A. In *Advances in Metal−Organic Chemistry*; JAI Press Inc.: Greenwich, CT, 1989; Vol. 1, pp 99−133. (c) Davies, S. G.; Coote, S. J.; Goodfellow, C. L. In *Advances in Metal−Organic Chemistry*; JAI Press Ltd.: London, 1991; Vol. 2, pp 1−57. (d) Uemura, M. In *Advances in Metal−Organic Chemistry*; JAI Press Ltd.: London, 1991; Vol. 2, pp 195−245. (e) Uemura, M. In *Chains, Clusters, Inclusion Compounds, Paramagnetic Labels and Organic Rings*; Zanello, P., Ed.; Elsevier Science Ltd.: New York, 1994; Vol. 5, pp 507−555.

(2) For articles dealing with benzylic alkylation of tricarbonylchromium complexes, see: (a) Simonneaux, G.; Jaouen, G. *Tetrahedron* **1979**, *35*, 2249−2254. (b) Arzeno, H. B.; Barton, D. H. R.; Davies, S. G.; Lusinchi, X.; Meunier, B.; Pascard, C. *Nouv. J. Chim.* **1980**, *4*, 369−375. (c) Jaouen, G.; Top, S.; Laconi, A.; Couturier, D.; Brocard, J. *J. Am. Chem. Soc.* **1984**, *106*, 2207−2208. (d) Top, S.; Vessieres, A.; Abjean, J.-P.; Jaouen, G. *J. Chem. Soc., Chem. Commun.* **1984**, 428−429. (e) Blagg, J.; Davies, S. G. *J. Chem. Soc., Chem. Commun.* **1985**, 653−654. (f) Jaouen, G. *Pure Appl. Chem.* **1986**, *58*, 597−616. (g) Mathews, N.; Sainsbury, M. *J. Chem. Res., Synop.* **1988**, 82−83. (h) Davies, S. G.; Goodfellow, C. L. *J. Organomet. Chem.* **1989**, *370*, C5−C8. (i) Coote, S. J.; Davies, S. G.; Goodfellow, C. L.; Sutton, K. H.; Middlemiss, D.; Naylor, A. *Tetrahedron: Asymmetry* **1990**, *1*, 817−842. (j) Persson, M.; Hacksell, U. *J. Chem. Soc., Perkin Trans. 1* **1992**, 131−135. (k) Davies, S. G.; Goodfellow, C. L.; Sutton, K. H. *Tetrahedron: Asymmetry* **1992**, *3*, 1303−1316. (l) Uemura, M.; Miyake, R.; Nakayama, K.; Shiro, M.; Hayashi, Y. *J. Org. Chem.* **1993**, *58*, 1238−1244.

(3) Persson, M.; Hacksell, U.; Csöregh, I. *J. Chem. Soc., Perkin Trans. 1* **1991**, 1453−1459.

(4) The products are analogues of the pharmacologically interesting (1*S*,2*R*)-AJ76 and (1*S*,2*R*)-UH232. Johansson, A. M.; Arvidsson, L.-E.; Hacksell, U.; Nilsson, J. L. G.; Svensson, K.; Hjorth, S.; Clark, D.; Carlsson, A.; Sanchez, D.; Andersson, B.; Wikström, H. *J. Med. Chem.* **1985**, *28*, 1049−1053.



(1*S*,2*R*)-AJ76: R=H
(1*S*,2*R*)-UH232: R=Pr

(5) The racemate has been synthesized previously: Podona, T.; Guardiola-Lemaître, B.; Caignard, D.-H.; Adam, G.; Pfeiffer, B.; Renard, P.; Guillaumet, G. *J. Med. Chem.* **1994**, *37*, 1779−1793.

(6) Throughout this paper, the exo and endo nomenclature is used to denote the stereochemical relationship between the tricarbonylchromium tripod and the 2-(dipropylamino) substituent.

(7) Sarda, N.; Grouiller, A.; Pacheco, H. *Acad. Sci., Ser. C* **1974**, 281−284.

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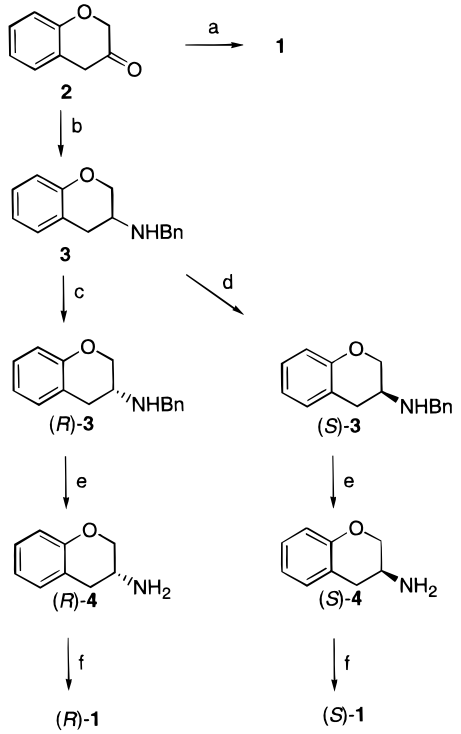
Scheme 1[a]



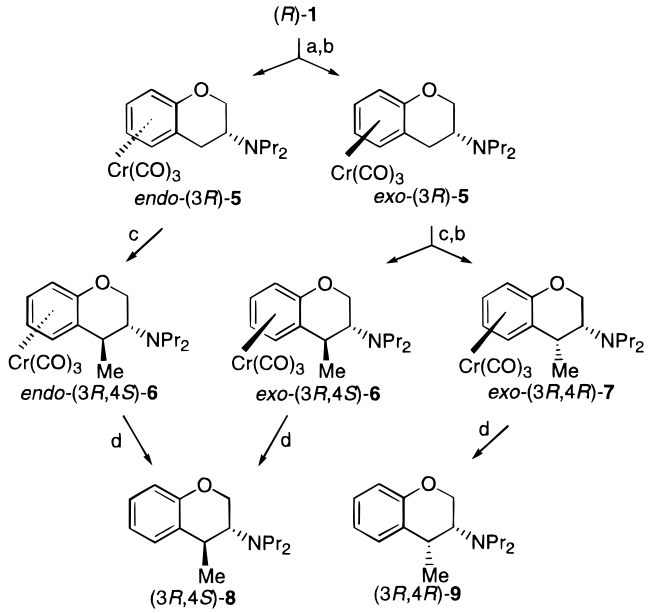
[a] Reagents: (a) (i) Pr_2NH, *p*-TsOH, C_6H_6; (ii) H_2, PtO_2, MeOH; (b) $BnNH_2$, HOAc, $NaCNBH_3$, THF; (c) D-(−)-mandelic acid, EtOH (95%); (d) L-(+)-mandelic acid, EtOH (95%); (e) H_2, Pd/C, MeOH: (f) PrI, K_2CO_3, DMF.

by GC analysis of the corresponding diastereomeric (*S*)-2-methoxy-2-(trifluoromethyl)phenylacetamides to be >99.5% ee. The enantiomers of **3**·HCl were N-debenzylated to the primary amines [(*R*)- and (*S*)-**4**], which were N,N-dialkylated with 1-iodopropane to give (*R*)- and (*S*)-**1**, respectively.

The formation of tricarbonylchromium complexes **5** was accomplished by heating a solution of racemic or enantiopure **1** with $Cr(CO)_6$ in Bu_2O/THF (10:1) (Scheme 2). Separation of the stereoisomers using flash column chromatography gave the pure endo and exo complexes in acceptable yields (>40%). The structure of *exo*-(3*R*)-**5**·HCl was determined by X-ray crystallography (Figure 1).[11] This made it possible to unambiguously establish the stereochemistries of the stereoisomers of **5** as well as of the resolved intermediate amines **1**, **3**, and **4**.

Benzylic deprotonation[2] of *endo*-(3*R*)-**5** with potassium bis(trimethylsilyl)amide[12] [$KN(SiMe_3)_2$] followed by methylation using methyl iodide produced the expected 4-methyl-substituted complex *endo*-(3*R*,4*S*)-**6** (81% yield), in which the methyl group had been introduced anti to

Scheme 2[a]



[a] Reagents: (a) $Cr(CO)_6$, Bu_2O:THF (10:1); (b) column chromatography; (c) (i) $KN(SiMe_3)_2$, THF, (ii) MeI; (d) light, O_2, MeCN.

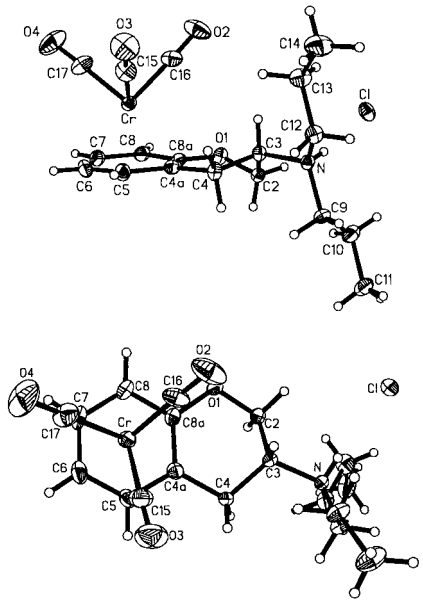


Figure 1. Two views of *exo*-(3*R*)-**5**·HCl with crystallographic labeling of the atoms. Displacement ellipsoids are drawn at the 50% probability level.

the tricarbonylchromium tripod and trans to the amino group (Scheme 2). Similarly, deprotonation followed by alkylation of *endo*-(3*S*)-**5** produced *endo*-(3*S*,4*R*)-**6** in 70% yield. This reaction was highly stereoselective, as no epimeric product could be detected. In contrast, deprotonation followed by methylation of the enantiomers of *exo*-**5** gave 2:1 epimeric mixtures, in which methylation had occurred syn or anti to the tricarbonylchromium tripod, respectively (Scheme 2). Light-induced decomplexation[2d,13] of *endo*- and *exo*-(3*R*,4*S*)-**6** produced (3*R*,4*S*)-**8** and of *exo*-(3*R*,4*R*)-**7** gave (3*R*,4*R*)-**9** in high yields. Similarly, the corresponding enantiomers, *endo*- and *exo*-(3*S*,4*R*)-**6** and *exo*-(3*S*,4*S*)-**7**, gave the decomplexed products in high yields upon irradiation.

(11) An interesting feature of the aromatic ring is that C-6 and C-8a deviate from the least-squares plane of the aromatic ring by as much as 0.026(4) and 0.035(2) Å, respectively. They are positioned away from the tricarbonylchromium moiety. The tricarbonylchromium tripod is positioned slightly excentric above the aromatic ring. The distance between a perpendicular projection of Cr on the aromatic least-squares plane and the ring centroide is 0.059 Å toward C-5. The three CO groups are approximately eclipsed with carbon atoms C-5, C-7, and C-8a. This conformation of the tricarbonylchromium tripod is expected because it has previously been observed that tricarbonylchromium prefers to be oriented eclipsed with electron-donating groups, such as alkoxy groups: see Hunter, A. D.; Mozol, V.; Tsai, S. D. *Organometallics* **1992**, *11*, 2251−2262.

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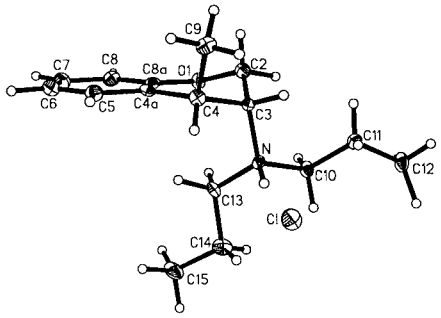
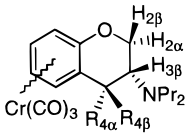


Figure 2. View of (3*R*,4*S*)-**8**·HCl with crystallographic labeling of the atoms. Displacement ellipsoids are drawn at the 50% probability level.

Table 1. Selected ^{1}H NMR Coupling Constants (Hz) of Tricarbonylchromium Complexes 5−7, 10, and 11 Used for Stereochemical Assignment



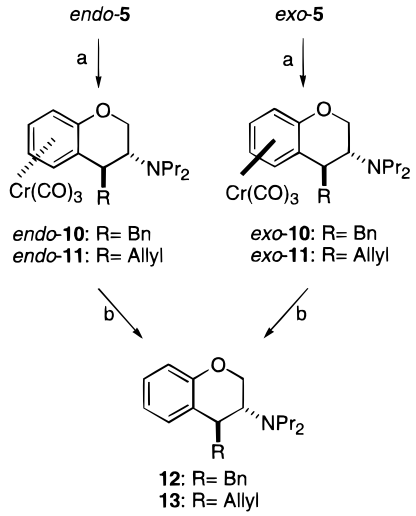
compd	$R_{4\alpha}$	$R_{4\beta}$	$J_{2\alpha,3\beta}$	$J_{2\beta,3\beta}$	$J_{3\beta,4\beta}$	$J_{3\beta,4\alpha}$
exo-(3*R*)-**5**	H	H	10.5	4	6	11.5
endo-(3*R*)-**5**	H	H	11	4	6.5	11
endo-(3*R*,4*S*)-**6**	H	Me	10.5	3.5		10.5
exo-(3*R*,4*S*)-**6**	H	Me	9.5	3		10.5
exo-(3*R*,4*R*)-**7**	Me	H	10.5	4	4	
endo-**10**	H	Bn	11	4		10
endo-**11**	H	allyl	11	4		10.5
exo-**10**	H	Bn	5.5	2.5		5.0
exo-**11**	H	allyl	6	3.5		5.5

The stereochemistries of the methylated products were assigned by a combination of NMR-spectroscopic data (Table 1) and chemical correlation. The coupling constant between H-3 and H-4 in *endo*-(3*R*,4*S*)-**6** and *exo*-(3*R*,4*S*)-**6** was large (10.5 and 10.5 Hz), indicating a dipseudoaxial relationship between the vicinal hydrogens and, hence, a *trans*-(dipseudoequatorial) relationship between the methyl and the amino substituents. In contrast, $J_{3\beta,4\beta}$ in *exo*-(3*R*,4*R*)-**7** was much smaller (4 Hz), and because the large $J_{2\alpha,3\beta}$ (10.5 Hz) establishes H-3 as axial, this provides support for a coupling between a pseudoaxial and a pseudoequatorial hydrogen, thus indicating a cis relationship between the methyl and the amino substituents.

Decomplexation of *endo*-(3*R*,4*S*)-**6** and *exo*-(3*R*,4*S*)-**6** afforded the same compound, (3*R*,4*S*)-**8**, the stereochemistry of which was unambiguously established by X-ray crystallography (Figure 2).[14]

To learn more about the unexpected stereochemical outcome of the alkylation of deprotonated *exo*-**5**, we performed reactions with deprotonated racemic *endo*- and *exo*-**5** using the larger and softer electrophiles allyl bromide and benzyl bromide (Scheme 3). As expected,

Scheme 3[a]



[a] Reagents: (a) (i) $KN(SiMe_3)_2$, THF, (ii) BnBr or CH_2═$CHCH_2Br$; (b) light, O_2, MeCN.

benzylation and allylation of *endo*-**5** afforded stereochemically pure products (*endo*-**10** and *endo*-**11**) in which the alkylation had occurred anti to the tricarbonylchromium tripod and trans to the amino substituent. The only isolable products obtained in the allylation and benzylation of the anion of *exo*-**5** were *exo*-**10** and *exo*-**11**, respectively, in which the alkylation had occurred syn to the tricarbonylchromium tripod and trans to the amino substituent. The stereochemistries of chromium complexes **10** and **11** were assigned using a combination of NMR-spectroscopic data (Table 1) and chemical correlation. The large dipseudoaxial coupling constants $J_{2,3}$ and $J_{3,4}$ established the trans relationship between the C-4 substituent and the C-3 amino group in *endo*-**10** and *endo*-**11**. The 5−6 Hz values observed for the $J_{2,3}$ vicinal coupling constants in *exo*-**10** and *exo*-**11** probably reflect an equilibrium between two closely populated halfchair conformations of the nonaromatic ring. However, decomplexation of *exo*- and *endo*-**10** as well as *exo*-and *endo*-**11** afforded the same products (**12** and **13**, respectively), thereby confirming the relative trans stereochemistries of the alkylated products.

The stereochemical outcome of alkylation of deprotonated *endo*-**5** is consistent with an initial formation of a C-4 anion followed by alkylation on the sterically less hindered face of the ring system. The results obtained with deprotonated *exo*-**5** are more complicated to interpret because the alkylations occur predominantly (with methyl iodide) or almost exclusively (with allyl and benzyl bromide) syn to the tricarbonylchromium group. As suggested by the reviewers, the unexpected stereochemical outcomes of the alkylations of deprotonated *exo*-**5** could perhaps be rationalized by taking into account steric effects caused by coordination of the potassium ion to the nitrogen of an axial dipropylamino group and the oxygen of the chroman ring system. This would lead to a situation where the steric effect of the tricarbonylchromium tripod would be at least partially outweighed.

To summarize, the present study indicates that the directing effect of tricarbonylchromium complexation upon alkylation of benzylic anions may be counteracted by other steric effects.

(13) (a) Birch, A. J.; Cross, P. E.; Connor, D. T.; Subba Rao, G. S. R. *J. Chem. Soc.* **1966**, *C*, 54−56. (b) Uemura, M.; Nishikawa, N.; Take, K.; Ohnishi, M.; Hirotsu, K.; Higuchi, T.; Hayashi, Y. *J. Org. Chem.* **1983**, *48*, 2349−2356. (c) Blagg, J.; Coote, S. J.; Davies, S. G.; Mobbs, B. E. *J. Chem. Soc., Perkin Trans. 1* **1986**, 2257−2261.

(14) A steric interaction between the trans methyl group and a pseudoequatorial 3-dipropylammonium group is probably unfavorable. Thus, the 3-dipropylammonium prefers to be pseudoaxial, as has been observed previously in the hydrochloride salt of 3-aminochromans.[8b] The tetrahydropyran ring adopts a half-chair conformation that is slightly more twisted than that observed for *exo*-(3*R*)-**5**·HCl.

Experimental Section

General Methods. Melting points (uncorrected) were determined in open glass capillaries using a melting point microscope. Optical rotation measurements were obtained on a polarimeter at room temperature. Infrared spectra were recorded on a FTIR spectrophotometer. ^{1}H and ^{13}C NMR spectra were recorded at 270.2 and 67.8 MHz, respectively, or at 399.8 and 100.5 MHz, respectively, using tetramethylsilane as internal standard. Thin-layer chromatography was performed on aluminum sheets precoated with either silica gel 60 F_{254} (0.2 mm, Merck) or aluminum oxide F_{254} T (1.5 mm, Merck). Column chromatography was performed on silica gel 60 (230−400 mesh, Merck) or aluminum oxide 90 (70−230 mesh, Merck). Capillary GC analyses were preformed on a GC instrument equipped with a HP-1 (25m × 0.32 mm × 0.52μm) column. Mass spectroscopy was carried out at 70 eV (EI). Elemental analyses (C, H, and N), were carried out by Mikro Kemi AB, Uppsala, Sweden, or by Analytische Laboratorien, Gummersbach, Germany. All reactions involving (η^6-arene)$Cr(CO)_3$ complexes were performed in the dark. Decomplexation reactions were performed using a 300 W bulb. THF was distilled from sodium and benzophenone before use.

3-(Benzylamino)chroman (3).[7] Glacial HOAc (20 mL) was added to a stirred mixture of **2**[9] (10.2 g, 0.069 mol) and benzylamine (14.8 g, 15.1 mL, 0.138 mol) in THF (50 mL). After 0.5 h at room temperature, $NaCNBH_3$ (4.76 g, 0.076 mol) was added in portions, and the reaction mixture was stirred overnight. The volatiles were evaporated, and the residue was dissolved in CH_2Cl_2 (50 mL) and washed with brine (3 × 50 mL). The organic phase was dried (K_2CO_3), filtered, and concentrated. The residue was chromatographed [SiO_2; ether/petroleum ether (3:2)] to yield 12.1 g (73%) of **3**. A small sample of **3** was converted into the hydrochloride salt **3**·HCl.

3·HCl: mp 201−204 °C;^{1}H NMR (CD_3OD, 270 MHz) δ 7.62−7.42 (m, 5H), 7.20−7.10 (m, 2H), 6.90−6.85 (m, 1H), 6.85−6.83 (m, 1H), 4.38 (s, 2H), 4.43−4.34 (m, 1H), 4.33−4.25 (m, 1H), 3.88−3.80 (m, 1H), 3.36 (dd, J = 17, 6 Hz, 1H), 3.07 (dd, J = 17, 4 Hz, 1H); ^{13}C NMR (CD_3OD, 270 MHz) δ 155.3, 132.3, 131.3 (2C), 130.8, 130.4 (2C), 131.2, 129.2, 123.0, 119.0, 118.1, 65.7, 52.1, 50.4, 28.3.

Resolution of 3 into (*R*)- and (*S*)-3-(Benzylamino)-chroman [(*R*)-3 and (*S*)-3]. D-(−)-mandelic acid (6.4 g, 0.042 mol) and **3** (10.0 g, 0.042 mol) were dissolved in ethanol (95%, 150 mL) and allowed to stand overnight at room temperature. The salt obtained was recrystallized three times from ethanol (95%). The crystals were treated with NaOH (1 M, 30 mL), and the amine was extracted with ether (2 × 50 mL). The combined organic phases were dried (K_2CO_3), filtered, and concentrated to give 2.5 g (50%) of (*R*)-**3**. The amine (7.3 g, 0.031 mol) isolated from the combined mother liquors from the preparation of (*R*)-**3** was treated with L-(+)-mandelic acid (4.6 g, 0.030 mol) as described above for (*R*)-**3** to give 2.4 g (48%) of (*S*)-**3**. Small samples of (*R*)-**3** and (*S*)-**3** were converted into the hydrochloride salts, (*R*)-**3**·HCl and (*S*)-**3**·HCl, respectively.

(*R*)-**3**·HCl: mp 230−232 °C; $[\alpha]_D$ +24.6° (*c* 1.0, MeOH). Anal. Calcd for $C_{16}H_{18}ClNO$: C, 69.7; H, 6.6; N, 5.1. Found: C, 69.5; H, 6.3; N, 4.9.

(*S*)-**3**·HCl: mp 227−229 °C; $[\alpha]_D$ −23.7° (*c* 0.5, MeOH). Anal. Calcd. for $C_{16}H_{18}ClNO$: C, 69.7; H, 6.6; N, 5.1. Found: C, 69.3; H, 6.4; N, 5.0.

Determination of the Enantiomeric Excess. The enantiomeric excess of (*R*)- and (*S*)-**3** was determined as follows: (*S*)-(−)-α-Methoxy-α-(trifluoromethyl)phenylacetyl chloride[15] in CH_2Cl_2 (0.5 mL) was added to a solution of (*R*)-**3** or (*S*)-**3** (5 mg) in CH_2Cl_2 (0.5 mL). The stirred reaction mixture was heated at 40 °C overnight. The volatiles were evaporated, and the residue was partitioned between H_2O and CH_2Cl_2. The organic phase was dried ($MgSO_4$), filtered, and concentrated. The diastereomeric excess of the prepared amides and indirectly the enantiomeric excess of (*R*)-**3** and (*S*)-**3** was determined by capillary GC to be >99.5% ee.

(15) Ward, D. E.; Rhee, C. K. *Tetrahedron Lett.* **1991**, *32*, 7165−7166.

(*R*)-3-Aminochroman [(*R*)-4].[8] A stirred mixture of (*R*)-**3**·HCl (5.52 g, 0.023 mol) and Pd(C) (10%, 0.63 g) in anhydrous methanol (50 mL) was hydrogenated at atmospheric pressure and room temperature overnight. The solution was filtered through Celite, and the volatiles were evaporated. The residue was partitioned between CH_2Cl_2 and aqueous 6 M NaOH. The combined organic phases was dried (K_2CO_3), filtered, and concentrated. The residue was chromatographed [SiO_2; CH_2Cl_2/MeOH (9:1)] to give 2.89 g (84%) of (*R*)-**4**. The amine was converted into the hydrochloride salt, (*R*)-**4**·HCl, which was recrystallized from MeOH/ether. (*R*)-**4**·HCl: mp 240−241 °C dec (lit.[8] mp 210 °C); $[\alpha]_D$ +61.3° (*c* 0.5, MeOH) (lit.[8] $[\alpha]_D$ +58.7° (*c* 0.8, H_2O)); ^{1}H NMR (270 MHz, CD_3OD) δ 7.19−7.09 (m, 2H), 6.97−6.89 (m, 1H), 6.86 (app d, 1H), 4.33−4.25 (m, 1H), 4.25−4.18 (m, 1H), 3.91−3.84 (m, 1H), 3.32 (dd, J = 17.5, 5.5 Hz, 1H), 2.92 (dd, J = 17.5, 3 Hz, 1H); ^{13}C NMR (270 MHz, CD_3OD) δ 155.0, 131.3, 129.2, 123.0, 118.8, 118.1, 66.9, 45.7, 29.4. Anal. Calcd for $C_9H_{12}ClNO$: C, 58.2; H, 6.5; N, 7.5. Found: C, 58.6; H, 6.2; N, 7.3.

(*S*)-3-Aminochroman [(*S*)-4].[8] (*S*)-**4** was prepared from (*S*)-**3**·HCl (7.76 g, 0.032 mol), using the same procedure as for the synthesis of (*R*)-**4**, to give 4.08 g (84%) of (*S*)-**4**. The amine was converted into the hydrochloride salt, (*S*)-**4**·HCl, which was recrystallized from MeOH/ether. (*S*)-**4**·HCl: mp 241−242 °C dec (lit.[8] mp 215 °C); $[\alpha]_D$ −61.6° (*c* 0.5, MeOH) [lit.[8] $[\alpha]_D$ −47° (*c* 0.83, H_2O)]. Anal. Calcd for $C_9H_{12}ClNO$: C, 58.2; H, 6.5; N, 7.5. Found: C, 58.4; H, 6.3; N, 7.4.

3-(Dipropylamino)chroman (1).[5] A mixture of **2**[9] (4.3 g, 0.029 mol), dipropylamine (8.8 g, 0.087 mol), and *p*-toluensulfonic acid (traces) in benzene (50 mL) was heated to reflux under nitrogen in a Dean−Stark apparatus (16 h). The volatiles were evaporated, and the residue was dissolved in MeOH (50 mL). PtO_2 (50 mg) was added, and the mixture was hydrogenated at atmospheric pressure and room temperature overnight. The reaction mixture was filtered through Celite, and the volatiles were evaporated. The residue was chromatographed [Al_2O_3; ether/petroleum ether (1:4)] to give 4.1 g (61%) of **1**. A small sample of **1** was converted into the hydrochloride salt, **1**·HCl, which was recrystallized from MeOH/ether. **1**·HCl: mp 118−119 °C.

(*R*)-3-(Dipropylamino)chroman [(*R*)-1]. A mixture of (*R*)-**4** (1.08 g, 7.24 mmol), 1-iodopropane (3.69 g, 0.022 mol), K_2CO_3 (3.0 g, 0.022 mol), and naphthalene (internal standard for GC monitoring, 50 mg) in DMF (5 mL) was heated at 60 °C for 6 h.[5] The reaction mixture was filtered through silica using *n*-hexane as eluent and evaporated. The residue was chromatographed [Al_2O_3; ether/*n*-hexane (1:10)] to give 1.48 g (88%) of (*R*)-**1**. The amine was converted into the hydrochloride salt, (*R*)-**1**·HCl, which was recrystallized from MeOH/ether. (*R*)-**1**·HCl: mp 134−135 °C; $[\alpha]_D$ +3.0° (*c* 1.0, MeOH); ^{1}H NMR (CD_3OD, 270 MHz) δ 7.21 (app d, 1H), 7.17 (app t, 1H), 6.97 (app t, 1H), 6.88 (app d, 1H), 4.54−4.38 (m, 2H), 4.05−3.94 (m, 1H), 3.45−3.15 (m, 6H), 1.92−1.70 (m, 4H), 1.03 (t, J = 7 Hz, 6H); ^{13}C NMR (CD_3OD, 270 MHz) δ 155.2, 131.0, 129.2, 123.1, 119.7, 117.9, 65.2, 57.5, 54.1, 26.7, 19.1, 11.3. Anal. Calcd for $C_{15}H_{24}ClNO$: C, 66.8; H, 9.0; N, 5.2. Found: C, 67.0; H, 8.6; N, 5.1.

(*S*)-3-(Dipropylamino)chroman [(*S*)-1]. Compound (*S*)-**1** was prepared from (*S*)-**4** (1.29 g, 8.65 mmol) using the same procedure as for the synthesis of (*R*)-**1** to give 1.49 g (74%) of (*S*)-**1**. The amine was converted into the hydrochloride salt, (*S*)-**1**·HCl, which was recrystallized from MeOH/ether. (*S*)-**1**·HCl: mp 133−134 °C; $[\alpha]_D$ −4.2° (*c* 0.5, MeOH). Anal. Calcd for $C_{15}H_{24}ClNO$: C, 66.8; H, 9.0; N, 5.2. Found: C, 66.8; H, 8.9; N, 5.2.

***Endo*- and *exo*-[η^6-3-(Dipropylamino)chroman]$Cr(CO)_3$ (*endo*-5 and *exo*-5).** A mixture of **1** (4.0 g, 0.017 mol) and $Cr(CO)_6$ (10 g, 0.045 mol) in THF/Bu_2O (1:9) (50 mL) was heated at 120 °C under N_2 for 48 h. The reaction mixture was filtered through Celite, and the volatiles were evaporated. The oily residue was chromatographed [SiO_2; EtOAc/*n*-hexane (1:9)] to give 2.8 g (44%) of *endo*-**5** and 2.0 g (32%) of *exo*-**5**.

Endo-**5**: IR (film) 1963, 1983 cm^{-1}. Anal. Calcd for $C_{18}H_{23}CrNO_4$: C, 58.5; H, 6.3; N, 3.8. Found: C, 58.7; H, 6.1; N, 3.9.

Exo-**3**: IR (film) 1963, 1984 cm^{-1}. Anal. Calcd for $C_{18}H_{23}CrNO_4$: C, 58.5; H, 6.3; N, 3.8. Found: C, 58.2; H, 6.1; N, 3.8.

***Endo*- and *exo*-(3*R*)-[η^6-3-(Dipropylamino)chroman]Cr(CO)$_3$ [*endo*-(3*R*)-5 and *exo*-(3*R*)-5].** A mixture of (*R*)-**1** (2.12 g, 0.009 mol) and $Cr(CO)_6$ (3.99 g, 0.018 mol) in THF/Bu_2O (1:10) (50 mL) was heated at 120 °C under N_2 for 48 h. The reaction mixture was filtered through Celite, and the volatiles were evaporated. The oily residue was chromatographed [SiO_2; EtOAc/*n*-hexane (1:9)] to give 1.37 g (41%) of *endo*-(3*R*)-**5** and 1.42 g (42%) of *exo*-(3*R*)-**5**. A small sample of each isomer was converted into the corresponding hydrochloride salts, *endo*-(3*R*)-**5**·HCl and *exo*-(3*R*)-**5**·HCl, respectively.

endo-(3*R*)-**5**·HCl: mp 138−139 °C; $[\alpha]_D$ −26.8° (*c* 0.5, MeOH).

endo-(3*R*)-**5**: ^{1}H NMR ($CDCl_3$, 270 MHz) δ 5.37−5.30 (m, 3H), 5.10−4.91 (m, 1H), 4.23 (ddd, J = 10.5, 4, 2 Hz, 1H), 3.77 (dd, J = 11, 10.5 Hz, 1H), 3.09 (dddd, J = 11, 11, 6.5, 4 Hz, 1H), 2.76 (dd, J = 16, 11 Hz, 1H), 2.65 (ddd, J = 16, 6.5, 2 Hz, 1H), 2.47−2.42 (m, 4H), 1.48−1.36 (m, 4H), 0.92−0.82 (m, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 233.7, 138.0, 94.7, 93.3, 92.0, 87.0, 83.7, 68.4, 52.7, 52.6, 26.7, 22.1, 11.7. Anal. Calcd for $C_{18}H_{24}ClCrNO_4$: C, 53.3; H, 6.0; N, 3.5. Found: C, 53.0; H, 5.7; N, 3.3.

exo-(3*R*)-**5**·HCl: mp 145−147 °C; $[\alpha]_D$ +19.6° (*c* 0.5, MeOH).

exo-(3*R*)-**5**: ^{1}H NMR ($CDCl_3$, 270 MHz) δ 5.41 (app d, 1H), 5.38 (app t, 1H), 5.13 (app d, 1H), 4.85 (app t, 1H), 4.19 (ddd, J = 10.5, 4, 2 Hz, 1H), 3.77 (dd, J = 10.5, 10.5 Hz, 1H), 3.30 (dddd, J = 11.5, 10.5, 6, 4 Hz, 1H), 2.71 (dd, J = 17.5, 11.5 Hz, 1H), 2.61 (ddd, J = 17.5, 6, 2 Hz, 1H), 2.56−2.34 (m, 4H) 1.55−1.38 (m, 4H), 0.85 (t, J = 7 Hz, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 233.9, 138.9, 95.8, 94.3, 94.0, 86.4, 80.6, 69.1, 52.7, 52.5, 27.7, 21.7, 11.8. Anal. Calcd for $C_{18}H_{24}ClCrNO_4$: C, 53.3; H, 6.0; N, 3.5. Found: C, 53.1; H, 5.7; N, 3.3.

***Endo*- and *exo*-(3*S*)-[η^6-3-(Dipropylamino)chroman]Cr(CO)$_3$ [*endo*-(3*S*)-5 and *exo*-(3*S*)-5].** *endo*-(3*S*)-**5** and *exo*-(3*S*)-**5** were prepared from (*S*)-**1** (0.68 g, 2.91 mmol), using the same procedure as for the preparation of *endo*-(3*R*)-**5** and *exo*-(3*R*)-**5**, to give 0.44 g (41%) of *endo*-(3*S*)-**5** and 0.51 g (47%) *exo*-(3*S*)-**5**. A small sample of each isomer was converted into the corresponding hydrochloride salts, *endo*-(3*S*)-**5**·HCl and *exo*-(3*S*)-**5**·HCl, respectively.

endo-(3*S*)-**5**·HCl: mp 124−125 °C; $[\alpha]_D$ +24.3° (*c* 0.4, MeOH). Anal. Calcd for $C_{18}H_{24}ClCrNO_4 \cdot 0.25H_2O$: C, 52.7; H, 6.0; N, 3.4. Found: C, 52.7; H, 5.8; N, 3.4.

exo-(3*S*)-**5**·HCl: mp 145−147 °C; $[\alpha]_D$ −20.5° (*c* 0.5, MeOH). Anal. Calcd for $C_{18}H_{24}ClCrNO_4$: C, 53.3; H, 6.0; N, 3.5. Found: C, 53.2; H, 5.8; N, 3.5.

Alkylation Reactions of *endo*- and *exo*-[η^6-3-(Dipropylamino)chroman]Cr(CO)$_3$ Complexes Using KN(SiMe$_3$)$_2$. The following methylation reaction is representative: $KN(SiMe_3)_2$ (1.37 g, 6.87 mmol) was added to a stirred solution of *endo*-(3*R*)-**5** (0.25 g, 0.68 mmol) in THF (35 mL) under N_2 at room temperature. After 1 h, the reaction mixture was cooled to 0 °C, and methyl iodide (0.96 g, 0.42 mL, 6.77 mmol) was added droppwise. The stirring was continued for 15 min at room temperature. The reaction was quenched with NH_4Cl (0.36 g, 6.73 mmol) and partitioned between H_2O and ether. The combined organic phases was dried (K_2CO_3), filtered, and concentrated. The residue was chromatographed [SiO_2; isohexane followed by EtOAc/isohexane (1:10)] to give 0.21 g (81%) of ***endo*-(3*R*,4*S*)-[η^6-4-methyl-3-(dipropylamino)chroman]Cr(CO)$_3$ [*endo*-(3*R*,4*S*)-6]**. A small sample was converted into the corresponding hydrochloride salt, *endo*-(3*R*,4*S*)-**6**·HCl.

endo-(3*R*,4*S*)-**6**·HCl: mp 98−99 °C; $[\alpha]_D$ −199° (*c* 1.0, MeOH); IR (NaCl, $CHCl_3$) 1964, 1890, 1875 cm^{-1}.

endo-(3*R*,4*S*)-**6**: ^{1}H NMR ($CDCl_3$, 270 MHz) δ 5.46 (dd, J = 6.5, 1 Hz, 1H), 5.30 (dd, J = 7.5, 1.5 Hz, 1H), 5.31 (ddd, J = 7.5, 6.5, 1 Hz, 1H), 5.04 (ddd, J = 6.5, 6.5, 1.5 Hz, 1H), 4.24 (dd, J = 10.5, 3.5 Hz, 1H), 3.77 (dd, J = 10.5, 10.5 Hz, 1H), 2.73 (dq, J = 10.5, 6.5 Hz, 1H), 2.60−2.39 (m, 1H), 2.46 (t, J = 7.5 Hz, 4H), 1.31 (d, J = 6.5 Hz, 3H), 1.54−1.27 (m, 4H), 0.87 (t, J = 7 Hz, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 233.7, 137.3, 98.9, 93.1, 92.6, 87.5, 84.9, 65.7, 59.8, 52.4, 32.2, 22.5, 19.3, 11.7. Anal. Calcd for $C_{19}H_{26}ClCrNO_4$: C, 54.3; H, 6.2; N, 3.3. Found: C, 53.9; H, 6.4; N, 3.2.

Alkylation of *endo*-(3*S*)-**5** (0.34 g, 0.92 mmol) with methyl iodide gave 0.27 g (77%) of ***endo*-(3*S*,4*R*)-[η^6-4-methyl-3-(dipropylamino)chroman]Cr(CO)$_3$ [*endo*-(3*S*,4*R*)-6]**. A small sample was converted into the corresponding hydrochloride salt, *endo*-(3*S*,4*R*)-**6**·HCl.

endo-(3*S*,4*R*)-**6**·HCl: mp 96−97 °C; $[\alpha]_D$ +201° (*c* 1.0, MeOH). Anal. Calcd for $C_{19}H_{26}ClCrNO_4$: C, 54.3; H, 6.2; N, 3.3. Found: C, 54.6; H, 6.2; N, 3.4.

In the methylation reaction of *exo*-(3*R*)-**5** (0.28 g, 0.76 mmol), two products were formed, ***exo*-(3*R*,4*S*)-[η^6-4-methyl-3-(dipropylamino)chroman]Cr(CO)$_3$ [*exo*-(3*R*,4*S*)-6]** (0.13 g, 45%) and ***exo*-(3*R*,4*R*)-[η^6-4-methyl-3-(dipropylamino)chroman]Cr(CO)$_3$ [*exo*-(3*R*,4*R*)-7]** (0.076 g, 26%). A small sample of each isomer was converted into the corresponding hydrochloride salt, *exo*-(3*R*,4*S*)-**6**·HCl and *exo*-(3*R*,4*R*)-**7**·HCl.

exo-(3*R*,4*S*)-**6**·HCl: mp 142−144 °C; $[\alpha]_D$ +239° (*c* 1.0, MeOH); IR (NaCl, $CHCl_3$) 1971, 1891 cm^{-1}.

exo-(3*R*,4*S*)-**6**: ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.61 (app d, 1H), 5.54 (app t, 1H), 4.95 (app d, 1H), 4.74 (app t, 1H), 4.22 (dd, J = 11, 3 Hz, 1H), 3.88 (dd, J = 11, 9.5 Hz, 1H), 2.83 (ddd, J = 10.5, 9.5, 3 Hz, 1H), 2.80 (dq, J = 10.5, 6.5 Hz, 1H), 2.56−2.38 (m, 4H), 1.56−1.34 (m, 4H), 1.43 (d, J = 6.5 Hz, 3H), 0.87 (t, J = 7.5 Hz, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 234.1, 141.1, 101.3, 95.6, 95.2, 83.7, 77.5, 65.9, 58.0, 52.4, 32.0, 22.2, 18.9, 11.8. Anal. Calcd for $C_{19}H_{26}ClCrNO_4$: C, 54.3; H, 6.2; N, 3.3. Found: C, 54.5; H, 6.1; N, 3.1.

exo-(3*R*,4*R*)-**7**·HCl: mp 150−152 °C; $[\alpha]_D$ +162° (*c* 0.8, MeOH); IR (NaCl, $CHCl_3$) 1964, 1888 cm^{-1}.

exo-(3*R*,4*R*)-**7**: ^{1}H NMR ($CDCl_3$, 400 MHz) δ 5.48 (app d, 1H), 5.46−5.41 (m, 1H), 5.16 (app d, 1H), 4.88 (app t, 1H), 4.23 (ddd, J = 10.5, 4, 1.5 Hz, 1H), 3.94 (dd, J = 10.5, 10.5 Hz, 1H), 3.30 (ddd, J = 10.5, 4, 4 Hz, 1H), 2.85 (ddq, J = 7, 4, 1.5 Hz, 1H), 2.52 (t, J = 7 Hz, 4H), 1.54−1.40 (m, 4H), 1.27 (d, J = 7 Hz, 3H,), 0.89 (t, J = 7 Hz, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 233.7, 138.1, 99.5, 95.2, 94.2, 85.9, 80.1, 65.1, 55.4, 52.3, 32.8, 20.1, 18.1, 11.8. Anal. Calcd for $C_{19}H_{26}ClCrNO_4$: C, 54.3; H, 6.2; N, 3.3. Found: C, 54.7; H, 6.1; N, 3.4.

Alkylation of *exo*-(3*S*)-**5** (0.21 g, 0.57 mmol) with methyl iodide gave 0.11 g (50%) of ***exo*-(3*S*,4*R*)-[η^6-4-methyl-3-(dipropylamino)chroman]Cr(CO)$_3$ [*exo*-(3*S*,4*R*)-6]** and 0.058 g (27%) of ***exo*-(3*S*,4*S*)-[η^6-4-methyl-3-(dipropylamino)chroman]Cr(CO)$_3$ [*exo*-(3*S*,4*S*)-7]**. A small sample of each isomer was converted into the corresponding hydrochloride salts, *exo*-(3*S*,4*R*)-**6**·HCl and *exo*-(3*S*,4*S*)-**7**·HCl, respectively.

exo-(3*S*,4*R*)-**6**·HCl: mp 141−142 °C; $[\alpha]_D$ +239° (*c* 1.0, MeOH). Anal. Calcd for $C_{19}H_{26}ClCrNO_4$: C, 54.3; H, 6.2; N, 3.3. Found: C, 54.1; H, 6.2; N, 3.3.

exo-(3*S*,4*S*)-**7**·HCl: mp 148−149 °C; $[\alpha]_D$ +163° (*c* 0.9, MeOH). Anal. Calcd for $C_{19}H_{26}ClCrNO_4$: C, 54.3; H, 6.2; N, 3.3. Found: C, 54.2; H, 6.2; N, 3.3.

Alkylation of *endo*-**5** (0.21 g, 0.57 mmol) with benzyl bromide gave 0.15 g (57%) of ***endo-trans*-[η^6-4-benzyl-3-(dipropylamino)chroman]Cr(CO)$_3$ (*endo*-10)**. A small sample was converted into the corresponding hydrochloride salt, *endo*-**10**·HCl.

endo-**10**·HCl: IR (NaCl, $CHCl_3$) 1964, 1889 cm^{-1}.

endo-**10**: mp 100−102 °C; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 7.35−7.13 (m, 5H), 5.37 (app d, 1H), 5.26 (app t, 1H), 5.01 (app d, 1H), 4.86 (app t, 1H), 4.28 (dd, J = 10.5, 4 Hz, 1H), 3.83 (dd, J = 11, 10.5 Hz, 1H), 3.52 (dd, J = 14, 2.5 Hz, 1H), 3.09 (ddd, J = 10, 8.5, 2.5 Hz, 1H), 2.69 (dd, J = 14, 8.5 Hz, 1H), 2.73 (ddd, J = 11, 10, 4 Hz, 1H), 2.63−2.48 (m, 4H), 1.58−1.36 (m, 4H), 0.93 (t, J = 7.5 Hz, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 233.7, 139.9, 137.6, 129.4 (2C), 128.9 (2C), 126.8, 98.4, 93.1, 92.1, 87.5, 85.9, 66.1, 58.6, 52.8, 40.4, 38.2, 22.7, 12.0. Anal. Calcd for $C_{25}H_{30}ClCrNO_4 \cdot 0.5H_2O$: C, 59.5; H, 6.2; N, 2.8. Found: C, 59.4; H, 6.3; N, 3.1.

Alkylation of *endo*-**5** (0.21 g, 0.57 mmol) with allyl bromide gave 0.17 g (73%) of ***endo-trans*-4-allyl-[η^6-3-(dipropylamino)chroman]Cr(CO)$_3$ (*endo*-11)**. A small sample was converted into the corresponding hydrochloride salt, *endo*-**11**·HCl.

endo-**11**·HCl: mp 49−50 °C; IR (NaCl, $CHCl_3$) 1964, 1889, 1875 cm^{-1}.

endo-**11**: ^1H NMR ($CDCl_3$, 270 MHz) δ 5.63 (dddd, J = 17.5, 10, 7, 7 Hz, 1H), 5.55 (dd, J = 6.5, 1 Hz, 1H), 5.38 (dd, J = 7, 1 Hz, 1H), 5.31 (app dt, 1H), 5.17−5.07 (m, 2H), 5.07−5.02 (m, 1H), 4.27 (dd, J = 11, 4 Hz, 1H), 3.79 (dd, J = 11, 11 Hz, 1H), 2.88 (ddd, J = 10.5, 4.5, 4.5 Hz, 1H), 2.76 (ddd, J = 11, 10.5, 4 Hz, 1H), 2.69−2.61 (m, 2H), 2.54−2.45 (m, 4H), 1.56−1.28 (m, 4H), 0.94−0.81 (m, 6H); ^{13}C NMR ($CDCl_3$, 270 MHz) δ 233.5, 137.7, 134.4, 118.4, 97.1, 92.8, 92.2, 87.5, 85.3, 65.6, 56.0, 52.4, 36.1, 35.6, 22.5, 11.7. Anal. Calcd for $C_{21}H_{28}ClCrNO_4 \cdot 0.5H_2O$: C, 55.4; H, 6.4; N, 3.1. Found: C, 55.3; H, 6.6; N, 3.1.

Alkylation of *exo*-**5** (0.22 g, 0.58 mmol) with benzyl bromide gave 0.20 g (73%) of ***exo-trans*-4-benzyl-[η^6-3-(dipropylamino)chroman]Cr(CO)$_3$ (*exo*-10)**. A small sample was converted into the corresponding hydrochloride salt, *exo*-**10**·HCl.

exo-**10**·HCl: mp 153−155 °C; IR (NaCl, $CHCl_3$) 1968, 1891 cm^{-1}.

exo-**10**: ^1H NMR ($CDCl_3$, 400 MHz) δ 7.39−7.18 (m, 5H), 5.56 (app d, 1H), 5.53 (app t, 1H), 5.02 (app d, 1H), 4.72 (app t, 1H), 4.23 (dd, J = 11, 2.5 Hz, 1H), 4.15 (dd, J = 11, 5.5 Hz, 1H), 3.19 (dd, J = 14.5, 7.5 Hz, 1H), 3.07 (dd, J = 14.5, 6 Hz, 1H), 3.00 (ddd, J = 7.5, 6, 5 Hz, 1H), 2.81 (ddd, J = 5.5, 5, 2.5 Hz, 1H), 2.44−2.24 (m, 4H), 1.37−1.12 (m, 4H), 0.74 (t, J = 7.5 Hz, 6H); ^{13}C NMR ($CDCl_3$, 400 MHz) δ 233.9, 140.7, 140.0, 128.8 (4C), 126.5, 99.9, 96.1, 95.8, 83.9, 78.3, 65.5, 54.6, 52.0, 43.0, 37.2, 21.2, 11.7. Anal. Calcd for $C_{25}H_{30}ClCrNO_4 \cdot 0.5H_2O$: C, 59.5; H, 6.2; N, 2.8. Found: C, 59.8; H, 6.1; N, 2.8.

Alkylation of *exo*-**5** (0.26 g, 0.71 mmol) with allyl bromide gave 0.19 g (66%) of ***exo-trans*-4-allyl-[η^6-3-(dipropylamino)chroman]Cr(CO)$_3$ (*exo*-11)**. A small sample was converted into the corresponding hydrochloride salt, *exo*-**11**·HCl.

exo-**11**·HCl: mp 139−140 °C; IR (NaCl, $CHCl_3$) 1970, 1891 cm^{-1}.

exo-**11**: ^1H NMR ($CDCl_3$, 270 MHz) δ 6.02−5.85 (m, 1H), 5.77 (dd, J = 6.5, 1 Hz, 1H), 5.53 (ddd, J = 6.5, 6.5, 1 Hz, 1H), 5.32−5.13 (m, 2H), 5.00 (dd, J = 6.5, 1 Hz, 1H), 4.76 (ddd, J = 6.5, 6.5, 1 Hz, 1H), 4.15 (dd, J = 12, 3.5 Hz, 1H), 4.09 (dd, J = 12, 6 Hz, 1H), 2.86 (ddd, J = 6, 5.5, 3.5 Hz, 1H), 2.80−2.63 (m, 2H), 2.57−2.50 (m, 1H), 2.50−2.40 (m, 4H), 1.49−1.32 (m, 4H), 0.84 (t, J = 7.5 Hz, 6H); ^{13}C NMR ($CDCl_3$, 270 MHz) δ 233.8, 140.7, 137.3, 117.3, 100.2, 96.0, 95.7, 83.9, 78.2, 65.2, 55.2, 52.2, 40.7, 35.7, 21.4, 11.6. Anal. Calcd for $C_{21}H_{28}ClCrNO_4$: C, 56.6; H, 6.3; N, 3.1. Found: C, 56.2; H, 6.3; N, 3.1.

Decomplexation Reaction Using Light. The following reaction is representative: A solution of *endo*-(3*R*,4*S*)-**6** (45 mg, 0.12 mmol) in MeCN (25 mL) was stirred under light (300 W bulb) for 24 h. The reaction mixture was filtered through Celite and evaporated. The residue was chromatographed [SiO_2; isohexane followed by EtOAc/isohexane (1:30)] to give 27 mg (93%) of **(3*R*,4*S*)-4-methyl-3-(dipropylamino)chroman [(3*R*,4*S*)-8]**. A small sample was converted into the hydrochloride salt, (3*R*,4*S*)-**8**·HCl.

(3*R*,4*S*)-**8**·HCl: mp 140−141 °C; $[\alpha]_D$ +78.0° (*c* 0.9, MeOH); ^1H NMR (CD_3OD, 400 MHz) δ 7.28 (dd, J = 7.5, 1.5 Hz, 1H), 7.18 (ddd, J = 8, 7.5, 1.5 Hz, 1H), 7.01 (ddd, J = 7.5, 7.5, 1.5 Hz, 1H), 6.88 (dd, J = 8, 1.5 Hz, 1H), 4.66 (app br d, 1H), 4.26 (dd, J = 14, 2.5 Hz, 1H), 3.65−3.59 (m, 1H), 3.35 (app q, 1H), 3.29−3.12 (m, 4H), 1.84−1.70 (m, 4H), 1.50 (d, J = 7.5 Hz, 3H), 0.97 (t, J = 7 Hz, 6H); ^{13}C NMR (CD_3OD, 400 MHz) δ 154.2, 130.5, 128.9, 124.9, 123.0, 117.7, 62.7, 61.0, 53.9, 30.8, 24.8, 18.6, 10.8. Anal. Calcd for $C_{16}H_{26}ClNO$: C, 67.7; H, 9.2; N, 4.9. Found: C, 67.6; H, 9.0; N, 4.8.

Decomplexation of *exo*-(3*R*,4*S*)-**6** (40 mg, 0.10 mmol) gave 23 mg (89%) of (3*R*,4*S*)-**8**.

Decomplexation of *endo*-(3*S*,4*R*)-**6** (83 mg, 0.22 mmol) gave 51 mg (95%) of **(3*S*,4*R*)-4-methyl-3-(dipropylamino)chroman [(3*S*,4*R*)-8]**. A small sample was converted into the corresponding hydrochloride salt, (3*S*,4*R*)-**8**·HCl.

(3*S*,4*R*)-**8**·HCl: mp 138−139 °C; $[\alpha]_D$ −77.0° (*c* 1.0, MeOH). Anal. Calcd for $C_{16}H_{26}ClNO$: C, 67.7; H, 9.2; N, 4.9. Found: C, 67.5; H, 9.0; N, 4.8.

Decomplexation of *exo*-(3*S*,4*R*)-**6** (45 mg, 0.12 mmol) gave 27 mg (93%) of (3*S*,4*R*)-**8**.

Decomplexation of *exo*-(3*R*,4*R*)-**7** (15 mg, 0.039 mmol) gave 8.8 mg (91%) of **(3*R*,4*R*)-4-methyl-3-(dipropylamino)chroman [(3*R*,4*R*)-9]**. A small sample was converted into the corresponding hydrochloride salt, (3*R*,4*R*)-**9**·HCl.

(3*R*,4*R*)-**9**·HCl: mp 144−145 °C; $[\alpha]_D$ −71.4° (*c* 0.4, MeOH); ^1H NMR (CD_3OD, 400 MHz) δ 7.22 (app d, 1H), 7.16 (app t, 1H), 6.96 (app t, 1H), 6.83 (app d, 1H), 4.56 (ddd, J = 11.5, 3, 1.5 Hz, 1H), 4.35 (dd, J = 11.5, 11 Hz, 1H), 4.02−3.87 (m, 1H), 3.63−3.50 (m, 1H), 3.45−3.18 (m, 4H), 1.92−1.68 (m, 4H), 1.43 (d, J = 7 Hz, 3H), 1.15−0.94 (m, 6H); ^{13}C NMR (CD_3OD, 400 MHz) δ 153.9, 130.2, 129.6, 125.9, 122.8, 117.6, 61.1, 60.6, 53.7, 32.5, 18.7, 17.9, 11.1. Anal. Calcd for $C_{16}H_{26}ClNO$: C, 67.7; H, 9.2; N, 4.9. Found: C, 67.4; H, 9.6; N, 4.9.

Decomplexation of *exo*-(3*S*,4*S*)-**7** (30 mg, 0.078 mmol) gave 18 mg (93%) of **(3*S*,4*S*)-4-methyl-3-(dipropylamino)chroman [(3*S*,4*S*)-9]**. A small sample was converted into the corresponding hydrochloride salt, (3*S*,4*S*)-**9**·HCl.

(3*S*,4*S*)-**9**·HCl: mp 143−144 °C; $[\alpha]_D$ +71.4° (*c* 0.4, MeOH). Anal. Calcd for $C_{16}H_{26}ClNO$: C, 67.7; H, 9.2; N, 4.9. Found: C, 67.5; H, 9.2; N, 4.9.

Decomplexation of *endo*-**10** (46 mg, 0.11 mmol) gave 32 mg (99%) of ***trans*-4-benzyl-3-(dipropylamino)chroman (12)**. Decomplexation of *exo*-**10** (0.17 g, 0.37 mmol) gave 93 mg (78%) of **12**. A small sample was converted into the corresponding hydrochloride salt, **12**·HCl.

12·HCl: mp 209−210 °C.

12: ^1H NMR ($CDCl_3$, 270 MHz) δ 7.32−7.02 (m, 7H), 6.86−6.76 (m, 2H), 4.21 (dd, J = 11.5, 3.5 Hz, 1H), 4.05 (dd, J = 11.5, 6.5 Hz, 1H), 3.20−3.04 (m, 2H), 3.02−2.88 (m, 1H), 2.82 (ddd, J = 6.5, 5.5, 3.5 Hz, 1H), 2.50−2.30 (m, 4H), 1.44−1.13 (m, 4H), 0.77 (t, J = 7.5 Hz, 6H). **12**·HCl: ^{13}C NMR (CD_3OD, 270 MHz) δ 154.9, 139.1, 131.5, 131.1, 130.3, 129.9, 128.6, 123.8, 123.6, 118.3, 62.3, 59.3, 54.1, 45.6, 38.1, 18.8, 11.3. Anal. Calcd for $C_{22}H_{29}ClNO$: C, 73.4; H, 8.4; N, 3.9. Found: C, 73.2; H, 8.3; N, 3.9.

Decomplexation of *endo*-**11** (82 mg, 0.20 mmol) gave 48 mg (88%) of ***trans*-4-allyl-3-(dipropylamino)chroman (13)**.

Decomplexation of *exo*-**11** (78 mg, 0.19 mmol) gave 49 mg (94%) of **13**. A small sample was converted into the corresponding hydrochloride salt, **13**·HCl.

13·HCl: mp 127−129 °C.

13: ^1H NMR ($CDCl_3$, 400 MHz) δ 7.30−7.24 (m, 1H), 7.11−7.04 (m, 1H), 6.89 (app dt, 1H), 6.80 (dd, J = 8, 1 Hz, 1H), 5.63 (dddd, J = 17, 10, 7.5, 6 Hz, 1H), 5.10−5.06 (m, 2H), 4.25 (dd, J = 10.5, 3.5 Hz, 1H), 3.89 (dd, J = 10.5, 9 Hz, 1H), 3.02−2.95 (m, 1H), 2.89 (ddd, J = 9, 8.5, 3.5 Hz, 1H), 2.72−2.58 (m, 2H), 2.52−2.46 (m, 4H), 1.51−1.34 (m, 4H), 0.87 (t, J = 7 Hz, 6H). **13**·HCl: ^{13}C NMR (CD_3OD, 270 MHz) δ 155.0, 136.1, 131.3, 129.7, 123.7, 123.5, 120.4, 118.3, 61.9, 60.4, 54.3, 44.3, 35.8, 19.1, 11.3. Anal. Calcd for $C_{18}H_{27}ClNO$: C, 69.8; H, 9.1; N, 4.5. Found: C, 69.4; H, 9.0; N, 4.5.

Structure Determination. Single crystals of *exo*-(3*R*)-**5**·HCl and (3*R*,4*S*)-**8**·HCl was crystallized from MeOH/Et_2O. The authors have deposited the structures with the Cambridge Crystallographic Data Centre.

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Supporting Information Available: Detailed ^1H and ^{13}C NMR data. Experimental details, crystal data and selected details of the final structure refinement of *exo*-(3*R*)-**5**·HCl and (3*R*,4*S*)-**8**·HCl (10 pages). This material is contained in libraries on microfiche, immediately follows this article in the microfilm version of the journal, and can be ordered from the ACS; see any current masthead page for ordering information.

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