Synthesis and Structure Revision of Goupiolone A: A Benzotropolone Natural Product

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Dedicated to Prof. Dr. *Dieter Seebach* on the occasion of his 75th birthday

Goupiolone A, a benzotropolone natural product, has been synthesized by assembling a benzocyclobutene derivative and a silyl-substituted cyclopropane unit, followed by thermal ring enlargement. The synthetic sample did not correspond to the reported data. On the basis of biogenetic considerations, an alternative structure with a catechol moiety was proposed, and the synthesis established it as the correct structure.

Introduction. – Tropolones (=2-hydroxycyclohepta-2,4,6-trien-1-ones) constitute an intriguing class of compounds [1][2], and extensive research over decades has uncovered many interesting features of this unique π-conjugated system, leading to the non-benzenoid chemistry [3]. Recently, we became interested in benzotropolone as a structure motif shared by bioactive natural products, including theaflavin (**1**), aurantricholone (**2**), and purpurogallin (**3**; *Fig. 1*) [4]. However, little attention has been paid to the construction of substituted *benzo*tropolone structures, which stands in contrast to the well-explored synthesis for the *non-benzo* derivatives. In view of the potential relevance to various biological activities, *e.g.*, antibacterial, antiviral, antifungal, and antioxidant effects, it is unfortunate that general methods for constructing this molecular framework have been lacking [5], except for a biomimetic approach [2c][6][7].

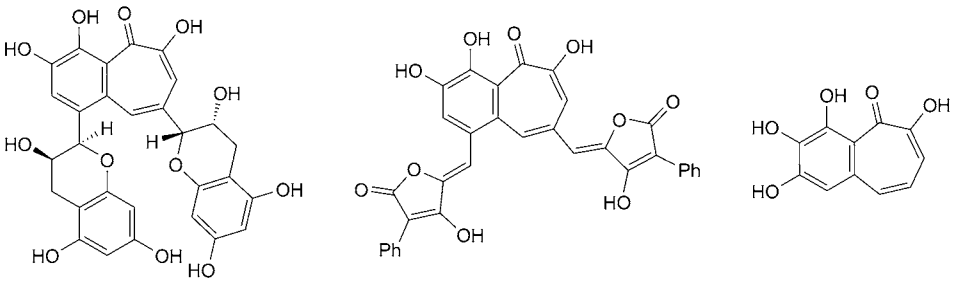
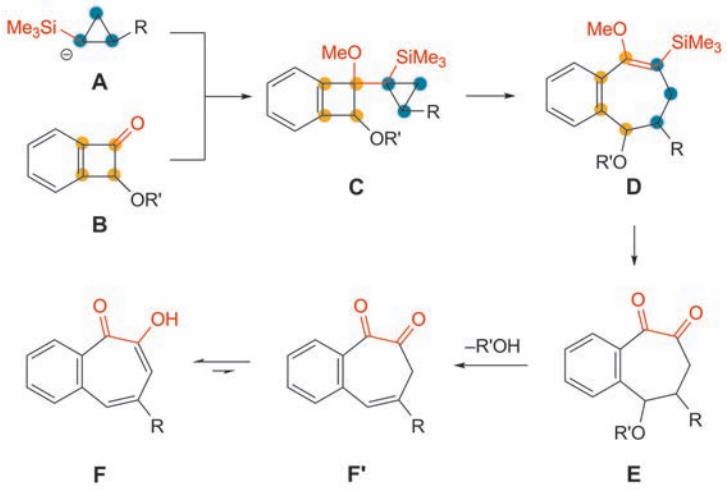


Fig. 1. *Natural benzotropolones*

We recently reported a facile route to benzocycloheptenes **D** with a high oxidation stage *via* the ring expansion of cyclopropyl-benzocyclobutenes **C** (*Scheme 1*) [8], where a Me_3Si group on the cyclopropyl moiety was the key for the efficient transformation. We became interested in applying this reaction in the context of benzotropolones, assuming that the methoxy-silyl-ene moiety in **D** would be a suitable precursor of the *diketo* function in **E**. Elimination of an alcohol (R′OH) from dione **E** would then give dione **F′**, a tautomer of benzotropolone **F**.

Scheme 1. *Ring-Expansion Route to Benzotropolones*



As the first target in our synthetic study on benzotropolone-containing natural products, we chose goupiolone A (**4**; *Fig. 2*), a natural genotoxin isolated from the extract of the *Kabukalli* tree (*Goupia grabra*) widely distributed in South America [9].

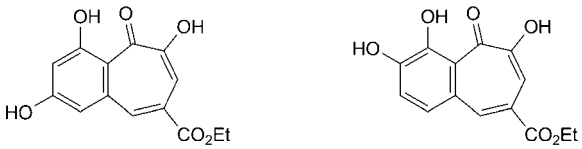
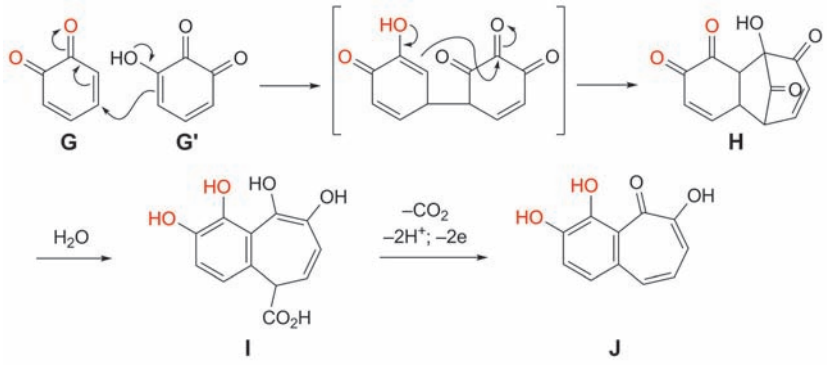


Fig. 2. *Structure of goupiolone A*

The proposed structure **4** seemed unlikely from a biogenetic viewpoint [10]. As the biosynthesis of such benzotropolones includes coupling of *ortho*-quinones (**G** + **G′** → **H**; *Scheme 2*), the vicinal dihydroxy pattern in **G** should be reflected to the catechol moiety in the downstream products along the biosynthetic pathway as **I** and **J**, while the reported structure **4** had a *meta*-dihydroxy pattern.

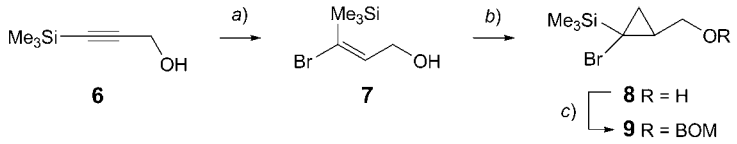
Scheme 2. *Biosynthetic Pathway of Benzotropolones*



Here, we describe the synthesis of the reported structure **4**, with the isomer **5** (*Fig. 2*), confirming our biosynthetic assumption that the correct structure should be as depicted for **5**.

Results and Discussion. – *Scheme 3* outlines preparation of bromocyclopropane **9**, the precursor to the corresponding lithio species. Propargyl alcohol **6** [11] was subjected to the hydroalumination, and the resulting alkenyl alane treated with Br_2 to give bromo alkene **7** [12]. *Simmons–Smith* reaction of **7** under *Shi*'s conditions [13] gave bromocyclopropane **8**, which was protected as a (benzyloxy)methyl (BOM) ether to give the desired cyclopropane **9**.

Scheme 3

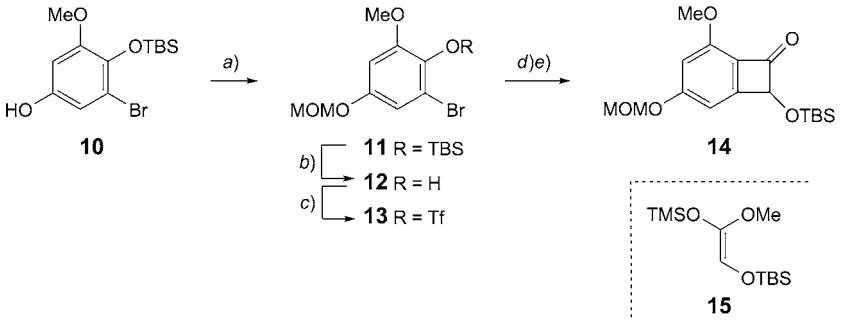


a) Diisobutylaluminum hydride (DIBAL-H, 2.3 equiv.), Et_2O, reflux, 24 h, then Br_2 (2.5 equiv.), pyridine, Et_2O, −78°, 3 h; 60%. *b*) Et_2Zn (5.0 equiv.), CH_2I_2 (5.0 equiv.), CF_3CO_2H (5 equiv.), CH_2Cl_2, 0°, 1 h; 74%. *c*) BOMCl ($BnOCH_2Cl$; 1.5 equiv.), $EtN(i\text{-}Pr)_2$ (2.5 equiv.), Bu_4NI (1.8 equiv.), CH_2Cl_2, r.t., 1 h; 91%.

Benzocyclobutenone **14**, the acceptor unit, was prepared from the known phenol **10** [14] (*Scheme 4*). Protection of **10** as methoxymethyl (MOM) ether, followed by desilylation, gave phenol **12** in 65% yield in two steps, which was converted to bromotriflate **13** in 74% yield. Upon treatment of **13** with BuLi in the presence of ketene silyl acetal **15** [15], the benzyne–olefin [2 + 2] cycloadduct was regioselectively obtained [16]. Hydrolysis with aqueous HF gave benzocyclobutenone **14** in 52% yield from **13**.

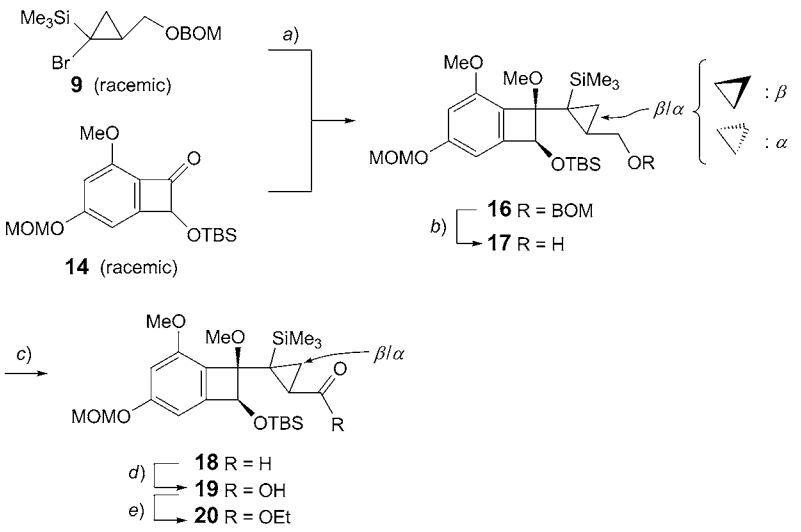
Scheme 5 shows union of the two fragments *en route* to ester **20**, the precursor for the key ring expansion. The cyclopropyllithium, generated by treating bromide **9** with *t*-

Scheme 4



a) MOMCl ($MeOCH_2Cl$; 2.5 equiv.), $EtN(i\text{-}Pr)_2$ (3.5 equiv.), CH_2Cl_2, r.t., 5 h. *b*) Bu_4NF (TBAF, 1.3 equiv.), THF, 0°, 0.5 h; 65%, 2 steps. *c*) Tf_2O (2.5 equiv.), $EtN(i\text{-}Pr)_2$ (3.5 equiv.), CH_2Cl_2, 0°, 3 h; 74%. *d*) **15** (1.4 equiv.), BuLi (1.4 equiv.), THF, −78°, 10 min. *e*) 46% aq. HF, MeCN, −10°, 15 min; 52%, 2 steps. TBS = (*t*-Butyl)(dimethyl)silyl, Tf = trifluoromethanesulfonyl, TMS = trimethylsilyl.

Scheme 5



a) 1. **9** (2.2 equiv.), *t*-BuLi (2.6 equiv.), Et_2O, −78°, 1 h; 2. **14** (1 equiv.), THF, −78°, 10 min; 3. MeOTf (3.0 equiv.), −78 to 0°, 1 h; 80%, β/α 9.2 : 1. *b*) H_2 (balloon), $Pd(OH)_2/C$, THF, r.t., 0.5 h; β-**17**: 61%, 2 steps from **14** and α-**17**: 10%, 2 steps from **14**. *c*) IBX (2-Iodoxybenzoic acid; 2.5 equiv.), DMSO, r.t., 5 h. *d*) $NaClO_2$ (3 equiv.), $NaH_2PO_4 \cdot 2\ H_2O$ (5 equiv.), 2-methylbut-2-ene (10 equiv.), acetone/H_2O 5 : 1, r.t., 2 h. *e*) EtI (2.5 equiv.), K_2CO_3 (10 equiv.), DMF, r.t., 2 h; 93% from β-**16**, 3 steps; 56% from α-**16**, 3 steps.

BuLi (Et_2O, −78°), was combined with benzocyclobutenone **14**, and *in situ* methylation afforded adduct **16** in 80% yield as an inseparable mixture of two diastereoisomers (9 : 1). Both the donor (the lithio species derived from **9**) and acceptor

14 were racemic mixtures, which were employed in a 2:1 molar ratio. By removing the BOM group in **16** by catalytic hydrogenolysis, the resulting alcohol **17** allowed separation of the diastereoisomers, which were assigned as α-**17** and β-**17** (α/β 1:6)[1]).

Despite little consequence with respect to the targeted benzotropolone without stereogenic centers, high stereoselectiviy in the step **9** + **14** → **16** is notable: out of eight isomers potentially formed (without counting the enantiomers), only two diastereoisomers were identified. Three relevant stereocontrolling factors are due.

1) The *cis*-relation of the MeO and siloxy groups on the cyclobutene ring is attributed to the steric effects; nucleophilic addition of the cyclopropyl anion from the less hindered side of the C=O group.

2) The cyclopropane geometry was retained during the Br/Li exchange and the following C–C bond formation [17]. This was not necessarily the case for the related experiments, where stereochemical integrity was lost by subtle change of the substrate structures and also the protective group.

3) The branching point to β-**16** and α-**16** is the high mutual chiral recognition between the cyclopropyllithium species and the benzocyclobutenone acceptor [18].

Alcohol **17** was converted to ester **20** by two-stage oxidation, *i.e.*, with 2-iodoxybenzoic acid (IBX) to aldehyde **18**, followed by *Pinnick* oxidation [19] to carboxylic acid **19** and esterification, ready for the key ring expansion reaction.

Having set the stage for the key ring enlargement, each of the isomeric substrates, β-**20** and α-**20**, were subjected to thermal conditions [8]. Upon heating β-**20** in refluxing *p*-xylene (3 h) in the presence of a catalytic amount of 2,6-di-(*tert*-butyl)-4-methylphenol (BHT), the planned ring enlargement smoothly proceeded to give benzocycloheptene **21** in 82% yield as a 1:1 separable mixture of two diastereoisomers,

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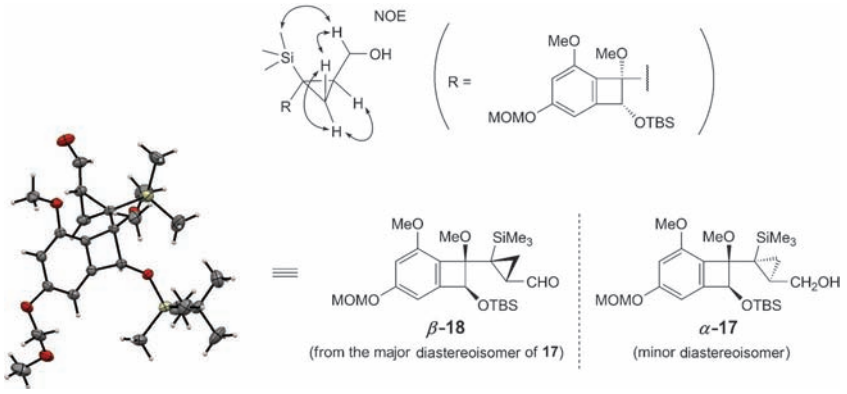
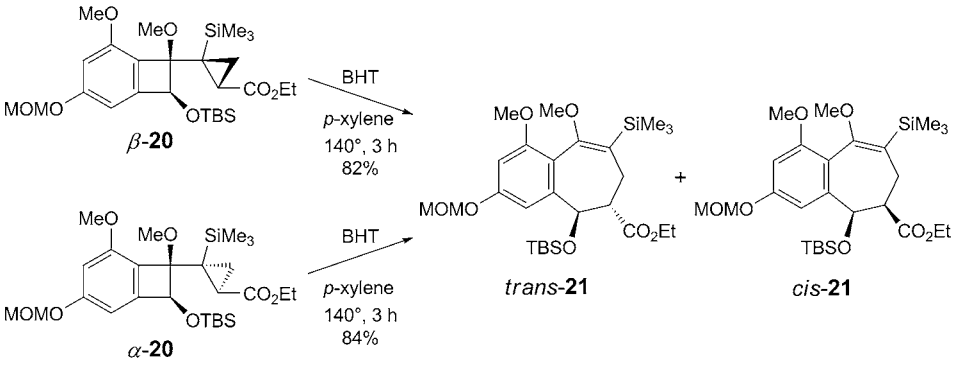
[1]) Geometry of the cyclopropane moiety was assigned by NOE study at the stage of **17**. Relative configuration of the major diastereoisomer, β-**17**, was confirmed by X-ray analysis after conversion to aldehyde **18**. CCDC-893856, -893857, -893858, -893859, and -893860 contain the supplementary crystallographic data of compounds β-**18**, *trans*-**21**, **23**, β-**30**, and *cis*-**33**, respectively, for this article. These data can be obtained free of charge from the *Cambridge Crystallographic Data Centre via* www.ccdc.cam.ac.uk/data_request/cif. On the other hand, the relative configuration of the minor diastereoisomer of **17** was determined as α by NOE experiment.



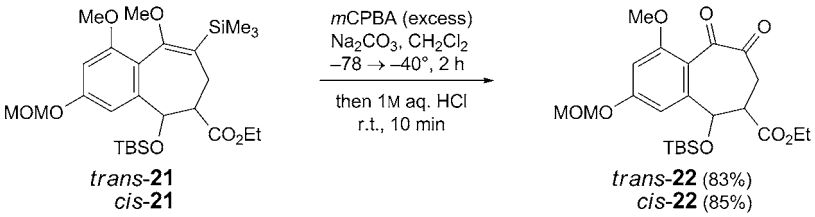
trans-**21** and *cis*-**21** (*Scheme 6*)[1][2]). The reactivity of the isomeric substrate, α-**20**, was essentially the same, also giving benzocycloheptene **21** as an isomer mixture (*trans*/*cis* 1:1) in 84% yield.

Scheme 6. *Ring Expansion to Construct Seven-Membered Ring* (BHT = 2,6-di(*tert*-butyl)-4-methylphenol)

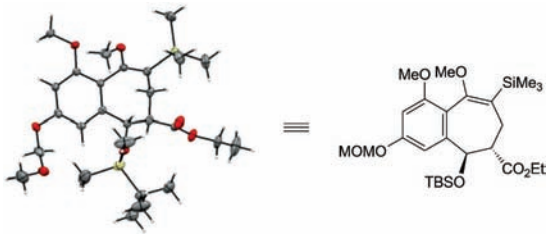


The next step was oxidation of the enol ether moiety in **21** to a dione, which was achieved in one pot (*Scheme 7*). When *trans*-**21** was treated with 3-chloroperoxybenzoic acid (*m*CPBA) in the presence of Na_2CO_3, the starting material was smoothly consumed (−78 to −40°, 2 h), and subsequent treatment with dilute HCl (1M) afforded dione *trans*-**22** in 83% yield. Under the same conditions, *cis*-**21** was transformed to *cis*-**22** in 85% yield.

Scheme 7. *Oxidation of Enol Ether* **21** *to Dione* **22**

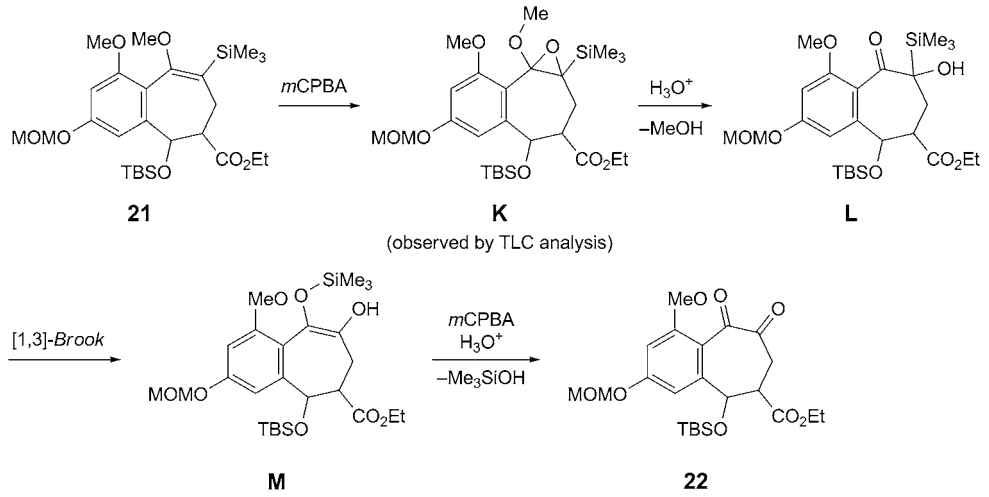


[2]) Stereochemical assignment relied on the X-ray single-crystal analysis. The less polar isomer of **21** (recrystallization, hexane/CH_2Cl_2) proved to be *trans*-**21**.



At the early stage of this one-pot transformation (before adding aq. HCl), TLC monitoring suggested an intermediate, which was identified as epoxide **K**[3]) by NMR analysis (*Scheme 8*). Thus, a mechanism can be reasonably postulated including two oxidative steps and a silyl migration[4]). After the first epoxidation, the acid treatment converts epoxy acetal **K** to silyl ketone **L**, which undergoes [1,3]-*Brook* rearrangement to give enol silyl ether **M**. The second epoxidation and hydrolysis yield dione **22**.

Scheme 8. *Mechanism of Oxidative Conversion*

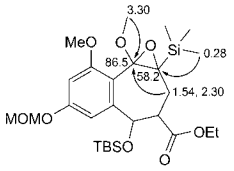


It should be noted here that non-silyl surrogate of **L** (H instead of Me_3Si) failed to give dione **22** by treatment with *m*CPBA. Thus, the silyl group played a dual role in the synthetic scheme, *i*) it facilitated the ring enlargement (*vide supra*; **20** → **21**) to form the seven-membered ring [8], and *ii*) it was essential for the dione-forming step.

Upon treatment with DBU, dione **22** underwent smooth elimination of a silanol to give benzotropolone **23**[1])[5]) in quantitative yield. The reactivity of the isomers, *trans*-**21** and *cis*-**21**, proved excellent (*Scheme 9*).

The remaining task was the removal of protecting groups. However, treatment of **23** with various *Lewis* acids (BBr_3, $AlCl_3$, $CeCl_3 \cdot 7\,H_2O$, *etc.*) gave only complex

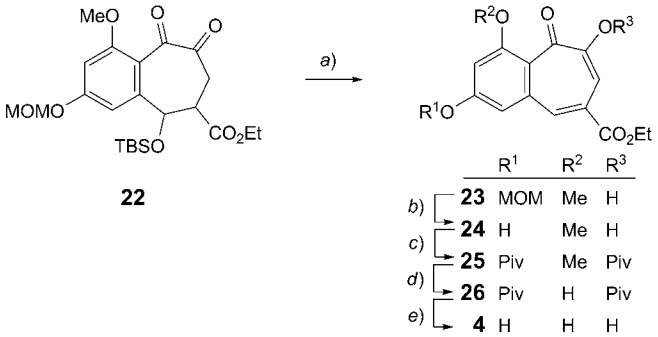
[3]) Structure was assigned by ^{1}H-NMR. The key HMBC correlations for intermediate **K** follow.



[4]) For double hydroxylation of enol silyl ethers, see [20].

[5]) The structure is confirmed by X-ray single-crystal analysis (recrystallization from hexane/CH_2Cl_2).

Scheme 9



a) DBU (1,8-Diazabicyclo[5.4.0]undec-7-ene; 2.5 equiv.), MeCN, r.t., 1 h (quantitative yields from each of *trans*-**22** and *cis*-**22**). *b*) 6M HCl, THF, r.t., 10 h; 80%. *c*) PivCl (Pivaloyl chloride; 4.8 equiv.), Et_3N (9.0 equiv.), CH_2Cl_2, r.t., 1 h; 70%, 2 steps. *d*) BBr_3 (excess), CH_2Cl_2, $-78°$, 3 h; 76%. *e*) EtONa (2.5 equiv.), EtOH, r.t., 6 h; 55%.

mixtures of unidentified products. After considerable experimentation, an indirect deprotection protocol was established. The MOM ether in **23** was detached by aqueous HCl (6M) to give phenol **24**, which was protected as the pivalate **25**. Note that the OH group at the tropolone ring was also pivalated. Upon treatment of **25** with BBr_3 ($-78°$, 3 h), demethylation smoothly occurred to give phenol **26** in 76% yield. The final step was the solvolytic removal of the pivaloyl groups (EtONa, EtOH) to give the target compound **4** as orange solid.

Along the same lines, the biosynthetically more plausible isomer **5** was synthesized (*Scheme 10*). Benzocyclobutenone **27**, with a vicinal dihydroxylation pattern, was prepared from sesamol. Halogen/Li exchange reaction of bromocyclopropane **9** to generate the corresponding lithio species, followed by addition of ketone **27**, gave adduct **28** in 87% yield as a mixture of diastereoisomers. After removal of the BOM group in **28**, the resulting primary alcohol **29**[6]) was oxidized to carboxylic acid **31** *via* aldehyde **30**[1])[7]), which was converted to ester **32** in high yield. Thermolysis of **32** under

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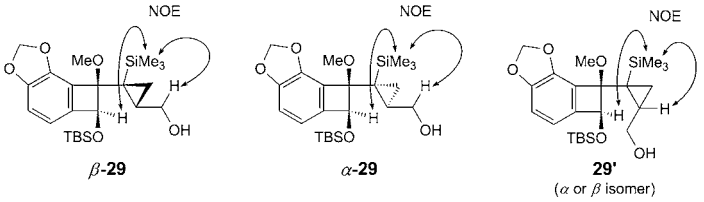
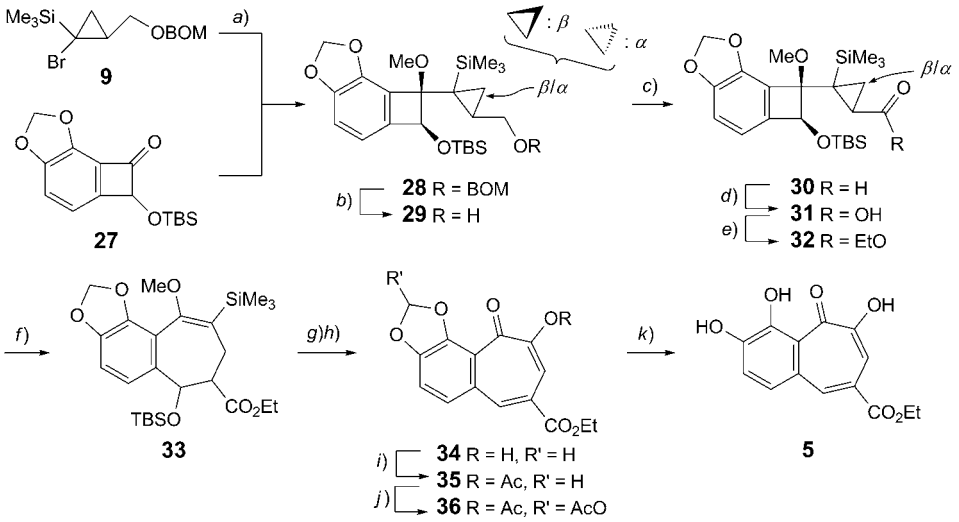
[6]) Stereostructures of **29** and by-product **29′** were assigned by NOE study.



[7]) Structure of β-**30** was assigned by the X-ray single-crystal analysis (recrystallization, hexane).

Scheme 10



a) 1) **9** (2.2 equiv.), *t*-BuLi (2.6 equiv.), Et_2O, −78°, 1 h; 2) **27** (1 equiv.), THF, −78°, 10 min; 3) MeOTf (3.0 equiv.), −78 to 0°, 1 h. *b*) H_2 (balloon), $Pd(OH)_2$/C (26 mol-%), THF, r.t., 0.5 h; 64% of *β*-**29** in 2 steps and 16% of *α*-**29** in 2 steps. *c*) IBX (2.5 equiv.), DMSO, r.t., 5 h. *d*) $NaClO_2$ (3.0 equiv.), $NaH_2PO_4 \cdot 2\,H_2O$ (5.0 equiv.), 2-methylbut-2-ene (10 equiv.), acetone, H_2O (5:1), r.t., 2 h. *e*) EtI (2.5 equiv.), K_2CO_3 (10 equiv.), DMF, r.t., 2 h; 70% of *β*-**32** in 3 steps. f) BHT, *p*-Xylene, reflux, 4 h; 82%, dr = 1:1. *g*) *m*CPBA (5.0 equiv.), Na_2CO_3 (10 equiv.), CH_2Cl_2, −78 to 0°, 0.5 h, then aq. HCl (2M), r.t., 10 min. *h*) DBU (2.5 equiv.), MeCN, r.t., 1.5 h. *i*) AcCl (2.5 equiv.), Et_3N (5.0 equiv.), CH_2Cl_2, 0°, 0.5 h; 77% from *cis*-**33**, 65% from *trans*-**33**. *j*) $Pb(OAc)_4$ (5.0 equiv.), benzene, reflux, 10 h; 63%. *k*) conc. HCl, CH_2Cl_2, EtOH, reflux, 1 h; 90%.

refluxing xylene afforded benzocycloheptene **33** in 82% yield[1])[8]). Oxidation of **33** with *m*CPBA, followed by acid hydrolysis, gave benzotroporone **34**. Removal of the methylene acetal in **34** proved unfruitful by employing *Brønsted* or *Lewis* acid (*e.g.*, aq. H_2SO_4, aq. HI, BBr_3). Thus, the protecting group was detached through a two-step operation. *O*-Acetylation of alcohol **34**, followed by the oxidation with $Pb(OAc)_4$ [14b][21], gave acetoxy acetal **36**. Subsequent acid hydrolysis yielded the desired product **5** as orange solid.

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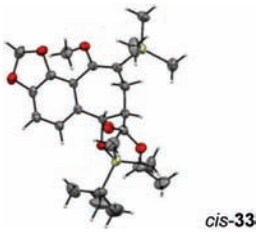
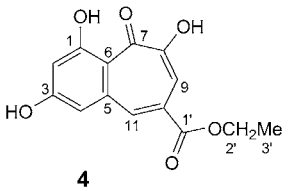
[8]) Structure of *cis*-**33** was assigned by the X-ray single-crystal analysis (recrystallization, hexane).



cis-**33**

These benzotropolone isomers **4** and **5**, thus obtained, were compared (*Fig. 3*). It turned out that the ^{1}H- and ^{13}C-NMR spectra of 1,3-dihydroxy isomer **4** (left column in the table) were *not* consistent with the reported data for goupiolone A (right column). On the other hand, the ^{1}H- and ^{13}C-NMR spectra of 1,2-dihydroxy isomer **5** (center column) were identical with the reported data (right column). It should be noted that the synthetic material **4** was orange solid that was sparingly soluble in $CHCl_3$, and the NMR spectra were recorded in (D_8)THF. Thus, for the indirect comparison of the data, the recordings for the isomer **5** were performed both in $CDCl_3$ and (D_8)THF. Other physical properties of **5** (IR, elemental analysis) also agreed with those reported for the natural product [9].



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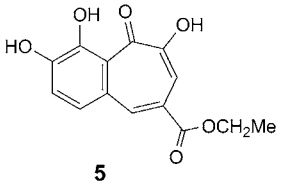

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Position	**4**		**5**				Reported data	
	Orange solid Insoluble in $CHCl_3$		Orange solid Soluble in $CHCl_3$				Yellow oil Soluble in $CHCl_3$	
	δ(H)	δ(C)	δ(H)	δ(C)	δ(H)	δ(C)	δ(H)	δ(C)
	(D_8)THF		(D_8)THF		$CDCl_3$		$CDCl_3$	
1	14.67 (OH)	169.2	14.76 (OH)	152.2	14.65 (OH)	149.9	14.65 (OH)	150.0
2	6.65	107.4	8.37 (OH)	150.2	6.56 (OH)	147.5	7.53	120.9
3	9.16 (OH)	164.4	7.43	122.6	7.52	120.9	6.56 (OH)	147.6
4	6.86	113.4	7.54	129.3	7.54	128.5	7.53	128.5
5	–	141.0	–	130.4	–	130.0	–	130.1
6	–	115.6	–	121.1	–	119.8	–	119.9
7	–	184.2	–	185.8	–	183.8	–	184.0
8	9.75 (OH)	156.3	9.21 (OH)	154.6	8.18 (OH)	152.7	8.18 (OH)	152.8
9	7.58	113.0	7.82	116.5	8.00	116.4	7.99	116.4
10	–	128.6	–	124.6	–	124.2	–	124.3
11	8.16	138.1	8.99	140.0	8.44	140.0	8.42	140.0
1'	–	166.7	–	166.8	–	166.3	–	165.4
2'	4.36	62.7	4.36	62.5	4.42	62.2	4.42	62.2
3'	1.39	14.6	1.39	14.6	1.43	14.4	1.43	14.3

Fig. 3. *Comparison with the reported data*

Conclusions. – The ring-expansion reaction of cyclopropyl-benzocyclobutene was exploited for the synthesis of benzotropolones, revealing that the original structure assignment of the natural product, goupiolone A, was wrong. The correct structure is that of the catechol derivative **5**, but not of the resorcinol derivative **4** that was originally reported.

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Experimental Part

General. All reactions utilizing air- or moisture-sensitive reagents were performed in dried glassware under Ar or N_2. Ethereal solvents (anh.; *Kanto Chemical Co., Inc.*) were used as received. DMF, Me_3SiCl, toluene, and *p*-xylene were distilled from CaH_2. EtOH was distilled from Na. CH_2Cl_2 was distilled successively from P_2O_5 and CaH_2, and stored over 4-Å molecular sieves. Other reagents were used without further purification as received from commercial source. TLC: *Merck* pre-coated silica-gel plates (SiO_2; *60 F_{254}*, *Art 5715*, 0.25 mm) and visualized by fluorescence quenching under UV light or by staining with phosphomolybdic acid. Prep. TLC (PTLC): SiO_2 plates prepared from *Merck Kieselgel 60 PF_{254}* (*Art 7747*). Column chromatography (CC): SiO_2 *60N* (*Spherical*, neutral, 23–210 μm; *Kanto Chemical Co., Inc.*). M.p.: *Yanaco MP-500* instrument or *Mettler Toledo* M*P70*; uncorrected. UV Spectra: *JASCO V-670* spectrophotometer; λ_{max} (log ε) in nm. IR Spectra: *Perkin-Elmer Spectrum 100* FT-IR spectrometer; $\tilde{\nu}$ in cm^{-1}. Attenuated total reflectance *Fourier* transform infrared (ATR-FT-IR) spectra: *Perkin-Elmer 100* FT-IR spectrometer equipped with a universal ATR sampling accessory. ^{1}H- and ^{13}C-NMR spectra: *JEOL JNM AL-300*, *JEOL JNM AL-400*, *JEOL JNM lambda-400*, *JEOL JNM ECX-400*, *JEOL JNM ECX-500*, or *Bruker DRX-500* spectrometer; δ in ppm rel. to Me_4Si as internal standard, *J* in Hz. LR-MS: *Shimadzu MALDI TOF Mass AXIMA® Confidence*, *Shimadzu GCMS-QP 5050A*, or *JEOL JMS-700* spectrometer; in *m*/*z* (rel. %). HR-MS: *JEOL JMS-700* spectrometer; in *m*/*z*.

rac-*[(1*R*,2*S*)-2-Bromo-2-(trimethylsilyl)cyclopropyl]methanol* (**8**). [13] To a soln. of Et_2Zn (10.0 ml, 98.3 mmol) in CH_2Cl_2 (120 ml) was added CF_3CO_2H (8.0 ml, 94.7 mmol) at 0°. After stirring for 30 min, to the resulting white suspension was added a soln. of CH_2I_2 (7.7 ml, 96 mmol) in CH_2Cl_2 (50 ml). After stirring for 20 min, to the resulting white soln. was added a soln. of **7** [12] (4.03 g, 19.3 mmol) in CH_2Cl_2 (30 ml). After stirring for further 1 h, the reaction was stopped by pouring the mixture into ice-chilled HCl (1M). The products were extracted with CH_2Cl_2 (3×), and the combined org. extracts were washed with 10% aq. $Na_2S_2O_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by distillation to afford **8** (3.20 g, 74%). Colorless oil. R_f (hexane/AcOEt 9:1) 0.15. B.p. 88–92°/4 mmHg. IR (neat): 3333, 2955, 2898, 1409, 1251, 1111, 1045, 1027, 842, 754. ^{1}H-NMR (500 MHz, $CDCl_3$) 0.19 (*s*, 9 H); 0.97 (*t*, *J* = 6.9, 1 H); 1.34 (*dd*, *J* = 9.8, 6.9, 1 H); 1.92 (*dddd*, *J* = 11.5, 9.8, 9.7, 6.9, 1 H); 3.46 (*dd*, *J* = 11.5, 8.0, 1 H); 3.65 (*dd*, *J* = 9.7, 8.0, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −1.0, 19.0, 26.0, 31.4, 63.1. Anal. calc. for $C_7H_{15}BrOSi$: C 37.67, H 6.77; found: C 37.40, H 6.76.

rac-*[(1*R*,2*S*)-2-{[(Benzyloxy)methoxy]methyl}-1-bromocyclopropyl](trimethyl)silane* (**9**). To a soln. of **8** (11.3 g, 50.7 mmol), $EtN(i\text{-}Pr)_2$ (16.0 ml, 91.8 mmol), and Bu_4NI (13.1 g, 35.5 mmol) in CH_2Cl_2 (168 ml) was added $BnOCH_2Cl$ (9.5 ml, 70 mmol) at r.t. After stirring for 1 h, Et_2NH (10 ml) was added to quench the excess $BnOCH_2Cl$. After stirring for 1 h, sat. aq. $NaHCO_3$ was added. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by CC (SiO_2; hexane/AcOEt 100:0 to 96:4) to afford **9** (15.9 g, 91%). Colorless oil. R_f (hexane/AcOEt 4:1) 0.86. IR (neat): 3065, 3031, 2953, 2884, 1497, 1455, 1381, 1250, 1174, 1152, 1108, 1051, 1028, 913, 843, 736, 697, 620. ^{1}H-NMR (400 MHz, $CDCl_3$): 0.21 (*s*, 9 H); 0.86 (*t*, *J* = 6.6, 1 H); 1.37 (*dd*, *J* = 9.5, 6.6, 1 H); 1.98 (*dddd*, *J* = 9.5, 8.3, 7.6, 6.6, 1 H); 3.46 (*dd*, *J* = 11.0, 8.3, 1 H); 3.63 (*dd*, *J* = 11.0, 7.6, 1 H); 4.62 (*d*, *J* = 12.0, 1 H); 4.65 (*d*, *J* = 12.0, 1 H); 4.76 (*d*, *J* = 6.8, 1 H); 4.83 (*d*, *J* = 6.8, 1 H); 7.29–7.37 (*m*, 5 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −1.0; 19.1; 26.1; 28.8; 68.3; 69.6; 94.4; 127.7; 127.9; 128.4; 137.8. Anal. calc. for $C_{15}H_{23}BrO_2Si$: C 52.47, H 6.75; found: C 52.32, H 6.45.

*3-Bromo-4-{[(*tert*-butyl)(dimethyl)silyl]oxy}-5-methoxyphenol* (**10**). To a soln. of 3-bromo-4-hydroxy-5-methoxybenzaldehyde [14] (46.5 g, 0.201 mol) in DMF (660 ml) was added 1*H*-imidazole (27.3 g, 0.409 mol), followed by ^{t}BuMe$_2$SiCl (36.1 g, 0.241 mol). After stirring for 1 h, the mixture was poured into phosphate buffer (pH 7). The products were extracted with Et_2O (3×), and the combined org. layer was washed with H_2O (4×), brine, dried ($MgSO_4$), and concentrated *in vacuo* to afford the crude product of 3-bromo-4-{[(*tert*-butyl)(dimethyl)silyl]oxy}-5-methoxybenzaldehyde (80.1 g). The

crude material was dissolved in CH_2Cl_2 (1.0 l), to which *m*CPBA (>65%, 74 g, 0.28 mol) was added. After stirring for 2 h at 40°, followed by for 12 h at r.t., the reaction was stopped by adding 10% aq. $Na_2S_2O_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with 10% aq. $Na_2S_2O_3$ (3×), sat. aq. $NaHCO_3$ (2×), brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in MeOH (650 ml), to which K_2CO_3 (41.1 g, 0.297 mmol) was added. After stirring for 30 min, the reaction was stopped by adding 2M HCl. The products were extracted with AcOEt (3×), and the combined org. layer washed with brine, dried (Na_2SO_4), and concentrated *in vacuo* to give crude **10** (70.1 g), which was employed in the next experiment without further purification.

*[2-Bromo-6-methoxy-4-(methoxymethoxy)phenoxy](*tert*-butyl)dimethylsilane* (**11**). To a soln. of crude **10** (70.1 g) in CH_2Cl_2 (650 ml) was added EtN(i-Pr)$_2$ (122 ml, 0.699 mol), followed by $MeOCH_2Cl$ (45.5 ml, 0.599 mol) at 0°. After stirring for 5 h at r.t., Et_2NH (10 ml) was added to quench the excess $MeOCH_2Cl$, and the mixture was further stirred for 30 min. After adding sat. aq. $NaHCO_3$, the products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with 1M HCl (2×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford crude **11** (69.9 g), which was employed in the next experiment without further purification. R_f (hexane/AcOEt 4:1) 0.65. ^{1}H-NMR (400 MHz, $CDCl_3$): 0.19 (*s*, 6 H); 1.02 (*s*, 9 H); 3.48 (*s*, 3 H); 3.77 (*s*, 3 H); 5.09 (*s*, 2 H); 6.52 (*d*, *J* = 2.7, 1 H); 6.83 (*d*, *J* = 2.7, 1 H).

2-Bromo-6-methoxy-4-(methoxymethoxy)phenol (**12**). [22] To a soln. of crude **11** (34.2 g) in THF (430 ml) was added Bu_4NF (1.0M in THF, 110 ml, 110 mmol) at 0°. After stirring for 1 h at this temp., the mixture was neutralized by adding 1M HCl. The products were extracted with AcOEt (3×), and the combined org. layer washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was filtered through a short SiO_2 pad (hexane/AcOEt 9:1 to 6:4) to give **12** (15.7 g, 67%, 5 steps). Pale-yellow oil. R_f (hexane/AcOEt 7:3) 0.15. IR (neat): 3327, 3010, 2937, 2831, 1605, 1590, 1499, 1419, 1347, 1289, 1249, 1235, 1145, 1131, 1008, 939, 910, 832, 819. ^{1}H-NMR (400 MHz, $CDCl_3$): 3.45 (*s*, 3 H); 3.86 (*s*, 3 H); 5.10 (*s*, 2 H); 6.48 (*d*, *J* = 2.9, 1 H); 6.51 (*d*, *J* = 2.9, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 55.9; 60.4; 95.3; 100.8; 107.8; 111.7; 138.4; 147.4; 150.8. Anal. calc. for $C_9H_{11}BrO_4$: C 41.09, H 4.21; found: C 40.96, H 3.92.

2-Bromo-6-methoxy-4-(methoxymethoxy)phenyl Trifluoromethanesulfonate (**13**). To a soln. of **12** (15.8 g, 60.1 mol) in CH_2Cl_2 (300 ml) was added EtN(i-Pr)$_2$ (14.3 ml, 82.0 mmol), followed by Tf_2O (12.0 ml, 71.2 mmol) at −78°. After stirring for 1.5 h, the reaction was stopped by adding sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with 1M HCl (2×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by CC (SiO_2; hexane/AcOEt 95:5 to 90:10) to give **13** (17.4 g, 74%). Colorless oil. R_f (hexane/AcOEt 4:1) 0.75. IR (neat): 2950, 2909, 1594, 1479, 1468, 1456, 1422, 1214, 1171, 1154, 1136, 1041, 1008, 873, 613. ^{1}H-NMR (500 MHz, $CDCl_3$): 3.48 (*s*, 3 H); 3.88 (*s*, 3 H); 5.15 (*s*, 2 H); 6.65 (*d*, *J* = 2.3, 1 H); 6.91 (*d*, *J* = 2.3, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): 56.3; 94.7; 101.1; 111.9; 117.0; 118.5 (*q*, *J* = 320); 131.8; 153.0; 157.3. Anal. calc. for $C_{10}H_{10}BrF_3O_6S$: C 30.40, H 2.55, S 8.11; found: C 30.21, H 2.48, S 7.83.

*8-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-5-methoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-one* (**14**). To a soln. of **13** (6.42 g, 16.3 mmol) and **15** (7.32 g, 26.5 mmol) in Et_2O (350 ml) was added BuLi (1.61M in hexane, 12.0 ml, 19.3 mmol) at −78°. After stirring for 10 min, the reaction was stopped by adding H_2O. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in MeCN (250 ml), and 46% aq. HF (24.0 ml) was added. After stirring for 15 min at −10°, the reaction was stopped by adding sat. aq. $NaHCO_3$ soln. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by CC (SiO_2; hexane/Et_2O 4:1 to 7:3) to afford **14** (8.58 g, 52%, 2 steps). White wax. R_f (hexane/AcOEt 1:1) 0.80. IR (ATR): 2931, 2859, 1756, 1608, 1570, 1472, 1361, 1288, 1217, 1142, 1073, 1040, 999, 879, 837, 777. ^{1}H-NMR (500 MHz, $CDCl_3$): 0.19 (*s*, 3 H); 0.20 (*s*, 3 H); 0.95 (*s*, 9 H); 3.48 (*s*, 3 H); 4.10 (*s*, 3 H); 5.19 (*d*, *J* = 6.9, 1 H); 5.23 (*d*, *J* = 6.9, 1 H); 5.62 (*s*, 1 H); 6.55 (*d*, *J* = 1.7, 1 H); 6.83 (*d*, *J* = 1.7, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −4.8; −4.6; 18.3; 25.8; 56.3; 60.0; 84.4; 94.3; 102.6; 106.6; 125.7; 156.2; 158.7; 165.6; 184.6. Anal. calc. for $C_{17}H_{26}O_5Si$: C 60.32, H 7.74; found: C 60.32, H 7.72.

rac-*{(1*S*,2*S*)-2-{[(Benzyloxy)methoxy]methyl}-1-[(7*R*,8*S*)-8-{[(*tert*-butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-yl]cyclopropyl}(trimethyl)silane* (**16**). To

a soln. of **9** (1.59 g, 4.64 mmol) in Et_2O (12 ml) was added *t*-BuLi (1.61M in pentane, 3.4 ml, 5.47 mmol) slowly at $-78°$. After stirring for 1 h at this temp., a soln. of **14** (785 mg, 2.11 mmol) in THF (8.2 ml) was added, and then the mixture was stirred for 10 min. To the mixture was added TfOMe (950 µl, 8.23 mmol). After warming to 0°, $Me_2NCH_2CH_2NH_2$ (1 ml) was added to quench the excess TfOMe, and the mixture was further stirred for 10 min. After dilution of the mixture with H_2O, the products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by flash column chromatography (FC; on SiO_2; hexane/Et_2O 98:2 to 93:7, followed by hexane/AcOEt 9:1) to afford **16** (1.04 g, 80%) as a mixture of two diastereoisomers, α-**16**/β-**16**, (*ca.* 1:9). Colorless oil. R_f (hexane/AcOEt 9:1) 0.50. IR (neat): 2953, 2931, 2895, 2857, 1611, 1583, 1472, 1464, 1304, 1250, 1154, 1131, 1108, 1078, 1055, 1026, 837, 777. ^{1}H-NMR (500 MHz, $CDCl_3$, for the major isomer β-**16**): −0.14 (*dd*, *J* = 8.6, 4.6, 1 H); 0.00 (*s*, 3 H); 0.04 (*s*, 3 H); 0.17 (*s*, 9 H); 0.32 (*t*, *J* = 4.6, 1 H); 0.90 (*s*, 9 H); 1.85 (*dddd*, *J* = 10.3, 8.6, 6.3, 4.6, 1 H); 3.58 (*dd*, *J* = 10.3, 8.0, 1 H); 3.77 (*dd*, *J* = 8.0, 6.3, 1 H); 3.82 (*s*, 3 H); 4.75 (*d*, *J* = 6.3, 1 H); 4.81 (*d*, *J* = 6.3, 1 H); 5.00 (*s*, 1 H); 5.16 (*d*, *J* = 6.9, 1 H); 5.20 (*d*, *J* = 6.9, 1 H); 6.55 (*d*, *J* = 1.7, 1 H); 6.63 (*d*, *J* = 1.7, 1 H); 7.25–7.36 (*m*, 6 H). ^{13}C-NMR (125 MHz, $CDCl_3$, for the major isomer β-**16**): −3.9; −2.7; 1.72; 10.9; 18.7; 19.0; 22.5; 26.5; 55.0; 56.0; 56.2; 69.1; 69.8; 80.9; 94.7; 95.5; 97.0; 102.3; 103.5; 124.1; 128.3; 128.6; 129.2; 139.6; 150.3; 157.7; 161.5. Anal. calc. for $C_{33}H_{52}O_7Si_2$: C 64.25, H 8.50; found: C 64.10, H 8.35.

rac-*{2-[(7*R*,8*S*)-8-{[*tert*-Butyl(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]-octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropyl}methanol* (**17**). A flask, purged with Ar, was charged with 20% $Pd(OH)_2$/C (2.4 g), to which was added a soln. of **16** (5.62 g, 9.12 mmol) in AcOEt (30 ml). The atmosphere was changed from Ar to H_2 (1 atm), and the mixture was stirred for 1 h at r.t. After changing the atmosphere from H_2 to Ar, the mixture was filtered through a *Celite* pad (washed with AcOEt) and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 85:15 to 75:25) to give rac-*[(1*S*,2*S*)-2-[(7*R*,8*S*)-8-{[(*tert*-butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropyl]methanol* (α-**17**; 444 mg, 9.9%) and rac-*[(1*R*,2*R*)-2-[(7*R*,8*S*)-8-{[(*tert*-butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)-bicyclo[4.2.0]octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropyl]methanol* (β-**17**) (2.75 g, 61%).

Data of α-**17**. Colorless oil. R_f (hexane/AcOEt 4:1) 0.45. IR (neat): 3468, 2954, 2932, 2896, 2857, 1609, 1586, 1472, 1464, 1302, 1251, 1156, 1133, 1078, 1054, 1017, 838, 777. ^{1}H-NMR (500 MHz, $CDCl_3$): 0.10 (*s*, 3 H); 0.12 (*s*, 3 H); 0.17 (*s*, 9 H); 0.53 (*t*, *J* = 5.2, 1 H); 0.64 (*ddd*, *J* = 8.6, 6.9, 5.2, 1 H); 0.91 (*s*, 9 H); 1.47 (*dd*, *J* = 8.6, 5.2, 1 H); 3.26 (*s*, 3 H); 3.48 (*s*, 3 H); 3.48 (*dd*, *J* = 11.5, 8.6, 1 H); 3.59 (*dd*, *J* = 11.5, 6.9, 1 H); 3.76 (*s*, 3 H); 5.10 (*s*, 1 H); 5.13 (*d*, *J* = 6.9, 1 H); 5.15 (*d*, *J* = 6.9, 1 H); 6.42 (*d*, *J* = 1.7, 1 H); 6.56 (*d*, *J* = 1.7, 1 H). ^{1}H-NMR (500 MHz, (D_6)acetone): 0.06 (*s*, 3 H); 0.10 (*s*, 3 H); 0.18 (*s*, 9 H); 0.46 (*dd*, *J* = 5.1, 4.0, 1 H); 0.47–0.53 (*m*, 1 H); 0.92 (*s*, 9 H); 1.42 (*dd*, *J* = 8.1, 4.0, 1 H); 3.29 (*s*, 3 H); 3.36–3.39 (*m*, 1 H); 3.43 (*s*, 3 H); 3.52–3.55 (*m*, 1 H); 3.81 (*s*, 3 H); 3.85 (*dd*, *J* = 11.2, 6.8, 1 H); 4.96 (*s*, 1 H); 5.17 (*s*, 1 H); 5.18 (*d*, *J* = 2.9, 1 H); 5.19 (*d*, *J* = 2.9, 1 H); 6.52 (*s*, 1 H); 6.62 (*s*, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −4.4; −3.2; 1.7; 13.5; 18.2; 19.0; 24.0; 26.0; 54.6; 55.3; 56.1; 64.0; 79.8; 94.8; 95.5; 100.7; 102.9; 123.8; 149.6; 156.6; 160.4. ^{13}C-NMR (100 MHz, (D_6)acetone): −4.0; −2.7; 0.9; 2.0; 14.2; 19.0; 24.6; 26.5; 54.8; 55.9; 56.2; 80.5; 95.6; 96.8; 101.9; 103.8; 124.5; 150.6; 157.6; 161.5. Anal. calc. for $C_{25}H_{44}O_6Si_2$: C 60.44, H 8.93; found: C 60.47, H 9.18.

Data of β-**17**. Colorless oil. R_f (hexane/AcOEt 4:1) 0.40. IR (neat): 3414, 2954, 2932, 2857, 2829, 1611, 1584, 1472, 1465, 1304, 1251, 1131, 1056, 1018, 837. ^{1}H-NMR (400 MHz, $CDCl_3$): −0.09 (*dd*, *J* = 8.6, 5.1, 1 H); 0.03 (*s*, 3 H); 0.05 (*s*, 3 H); 0.16 (*s*, 9 H); 0.28 (*t*, *J* = 5.1, 1 H); 0.89 (*s*, 9 H); 1.69 (*dddd*, *J* = 8.6, 8.5, 6.8, 5.1, 1 H); 3.40 (*s*, 3 H); 3.47 (*s*, 3 H); 3.51 (*dd*, *J* = 11.2, 8.5, 1 H); 3.82 (*s*, 3 H); 3.85 (*dd*, *J* = 11.2, 6.8, 1 H); 4.96 (*s*, 1 H); 5.13 (*s*, 2 H); 6.45 (*s*, 1 H); 6.54 (*s*, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −4.4; −3.2; 1.4; 10.0; 18.2; 19.1; 24.6; 26.0; 54.7; 55.4; 56.0; 80.3; 94.7; 95.8; 101.1; 102.6; 123.4; 149.3; 156.7; 160.2. Anal. calc. for $C_{25}H_{44}O_6Si_2$: C 60.44, H 8.93; found: C 60.19, H 8.67.

rac-*(1*R*,2*R*)-2-[(7*R*,8*S*)-8-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropanecarbaldehyde* (β-**18**). To a soln. of β-**17** (2.57 g, 5.18 mol) in DMSO (50 ml) was added 2-iodoxybenzoic acid (IBX; 3.91 mg, 13.9 mmol). After stirring for 3 h, the reaction was stopped by adding 10% aq. $Na_2S_2O_3$ and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with H_2O (5×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford β-**18** (2.56 g, quant.). This material

was employed in the next experiment without further purification. An anal. sample was prepared by a smaller-scale reaction, followed by CC (SiO_2; hexane/AcOEt 9:1). White solid. R_f (hexane/AcOEt 6:4) 0.88. M.p. 96.6–97.4° (hexane/acetone, colorless prisms). IR (ATR): 2950, 2853, 1701, 1614, 1583, 1471, 1307, 1248, 1155, 1129, 1112, 1073, 1059, 996, 831, 775. ^{1}H-NMR (500 MHz, $CDCl_3$): 0.04 (*s*, 3 H); 0.05 (*s*, 3 H); 0.20 (*s*, 9 H); 0.45 (*dd*, *J* = 8.0, 3.7, 1 H); 0.89 (*s*, 9 H); 1.16 (*t*, *J* = 3.7, 1 H); 2.51 (*ddd*, *J* = 8.0, 6.9, 3.7, 1 H); 3.39 (*s*, 3 H); 3.47 (*s*, 3 H); 3.83 (*s*, 3 H); 4.97 (*s*, 1 H); 5.14 (*s*, 2 H); 6.45 (*s*, 1 H); 6.56 (*s*, 1 H); 9.21 (*d*, *J* = 6.9, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −4.4; −3.2; 1.1; 14.2; 18.2; 25.9; 27.2; 34.4; 55.0; 55.3; 56.0; 80.4; 94.7; 95.2; 101.1; 102.6; 122.4; 149.1; 156.7; 160.6; 201.6. Anal. calc. for $C_{25}H_{42}O_6Si_2$: C 60.69, H 8.56; found: C 60.73, H 8.53.

rac-*Ethyl (1*R,*2*R*)-2-[(7*R,*8*S*)-8-{[(*tert-*Butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropanecarboxylate* (*β*-**20**). To a soln. of *β*-**18** (2.56 g, 4.96 mmol), 2-methylbut-2-ene (11.0 ml, 104 mmol), $NaH_2PO_4 \cdot 2\ H_2O$ (7.81 g, 50.1 mmol) in acetone (22 ml) and H_2O (4 ml) was added $NaClO_2$ (2.21 g, 24.6 mmol) at r.t. After stirring for 1 h, the mixture was diluted with H_2O. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in DMF (0.6 ml), to which were added K_2CO_3 (3.08 g, 22.3 mmol) and EtI (0.87 ml, 11 mmol). After stirring for 1.5 h, the mixture was diluted with Et_2O. The products were extracted with Et_2O (3×), and the combined org. layer was washed with H_2O (3×), brine, dried ($MgSO_4$), and concentrated *in vacuo*. The residue was purified by CC (SiO_2; hexane/AcOEt 95:5 to 9:1) to give *β*-**20** (2.45 g, 93%, 3 steps). Colorless oil. R_f (hexane/AcOEt 7:3) 0.95. IR (neat): 2953, 2902, 2859, 1727, 1699, 1612, 1579, 1462, 1305, 1247, 1177, 1154, 1134, 1109, 1079, 1029, 1016, 835, 775. ^{1}H-NMR (400 MHz, $CDCl_3$): 0.01 (*s*, 3 H); 0.04 (*s*, 3 H); 0.16 (*s*, 9 H); 0.17 (*dd*, *J* = 7.1, 5.6, 1 H); 0.89 (*s*, 9 H); 0.98 (*t*, *J* = 5.6, 1 H); 1.28 (*t*, *J* = 7.1, 3 H); 2.35 (*dd*, *J* = 8.1, 5.9, 1 H); 3.44 (*s*, 3 H); 3.47 (*s*, 3 H); 3.84 (*s*, 3 H); 4.12 (*q*, *J* = 7.1, 2 H); 4.96 (*s*, 1 H); 5.14 (*s*, 2 H); 6.45 (*d*, *J* = 1.4, 1 H); 6.56 (*d*, *J* = 1.4, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −4.4; −3.1; 0.6; 13.3; 14.3; 18.3; 23.3; 25.1; 25.9; 54.8; 55.4; 56.0; 60.3; 80.1; 94.7; 95.9; 101.2; 102.8; 123.0; 149.3; 156.5; 160.3; 173.9. Anal. calc. for $C_{27}H_{46}O_7Si_2$: C 60.18, H 8.60; found: C 60.08, H 8.55.

rac-*(1*S,*2*S*)-2-[(7*R,*8*S*)-8-{[(*tert-*Butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropanecarbaldehyde* (*α*-**18**). To a soln. of *α*-**17** (100 mg, 0.202 mmol) in DMSO (1.5 ml) was added IBX (140 mg, 13.9 mmol). After stirring for 3 h, the reaction was stopped by adding 10% aq. $Na_2S_2O_3$ and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with H_2O (5×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified with PTLC (hexane/AcOEt 4:1) to give *α*-**18** (68.4 mg, 68%). Colorless oil. R_f (hexane/AcOEt 4:1) 0.45. IR (neat): 2954, 2931, 2898, 2857, 1702, 1610, 1586, 1464, 1303, 1252, 1154, 1135, 1078, 1014, 838, 777. ^{1}H-NMR (500 MHz, (D_6)benzene): 0.11 (*s*, 3 H); 0.16 (*s*, 3 H); 0.27 (*s*, 9 H); 1.00 (*s*, 9 H); 1.30 (*t*, *J* = 4.6, 1 H); 1.52 (*ddd*, *J* = 8.0, 6.9, 4.6, 1 H); 2.08 (*dd*, *J* = 8.0, 4.6, 1 H); 3.13 (*s*, 3 H); 3.14 (*s*, 3 H); 3.37 (*s*, 3 H); 4.85 (*s*, 1 H); 5.27 (*s*, 2 H); 6.41 (*d*, *J* = 1.8, 1 H); 6.80 (*d*, *J* = 1.8, 1 H); 9.19 (*d*, *J* = 6.9, 1 H). ^{13}C-NMR (125 MHz, (D_6)benzene): −4.3; −3.1; 1.6; 16.8; 18.4; 26.1; 26.5; 33.6; 54.7; 54.8; 55.7; 79.5; 94.8; 95.2; 101.2; 103.4; 123.1; 149.9; 156.6; 161.4; 200.1. Anal. calc. for $C_{25}H_{42}O_6Si_2$: C 60.69, H 8.56; found: C 60.41, H 8.28.

rac-*Ethyl (1*S,*2*S*)-2-[(7*R,*8*S*)-8-{[(*tert-*Butyl)(dimethyl)silyl]oxy}-5,7-dimethoxy-3-(methoxymethoxy)bicyclo[4.2.0]octa-1,3,5-trien-7-yl]-2-(trimethylsilyl)cyclopropanecarboxylate* (*α*-**20**). To a soln. of *α*-**18** (50.0 mg, 0.101 mmol), 2-methylbut-2-ene (106 µl, 1.00 mmol), $NaH_2PO_4 \cdot 2\ H_2O$ (78.3 mg, 0.500 mmol) in acetone (0.9 ml) and H_2O (0.1 ml) was added $NaClO_2$ (23.0 mg, 0.255 mmol) at r.t. After stirring for 1 h, the mixture was diluted with H_2O. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in DMF (0.3 ml), to which were added K_2CO_3 (69.0 mg, 0.500 mmol) and EtI (15 µl, 0.19 mmol). After stirring for 1.5 h, the mixture was diluted with Et_2O. The products were extracted with Et_2O (3×), and the combined org. layer was washed with H_2O (3×), brine, dried ($MgSO_4$), and concentrated *in vacuo*. The residue was purified by PTLC (hexane/AcOEt 85:15) to give *α*-**20** (43.1 mg, 80%, 2 steps). Colorless oil. R_f (hexane/AcOEt 7:3) 0.95. IR (neat): 2955, 2932, 2900, 2857, 1731, 1611, 1584, 1465, 1303, 1249, 1184, 1109, 1078, 1016, 839, 777. ^{1}H-NMR (500 MHz, (D_6)benzene): 0.17 (*s*, 3 H); 0.19 (*s*, 3 H); 0.48 (*s*, 9 H); 0.85 (*t*, *J* = 7.5, 3 H); 1.03 (*s*, 9 H); 1.48 (*dd*, *J* = 8.0, 5.8, 1 H); 1.57 (*dd*, *J* = 5.8, 4.1, 1 H); 2.01 (*dd*, *J* = 8.0, 4.1, 1 H); 3.13 (*s*, 3 H); 3.15 (*s*, 3 H); 3.44 (*s*, 3 H);

3.87 (*q*, *J* = 7.5, 2 H); 4.83 (*s*, 2 H); 5.50 (*s*, 1 H); 6.42 (*d*, *J* = 1.2, 1 H); 6.80 (*d*, *J* = 1.2, 1 H). ^{13}C-NMR (125 MHz, (D_6)benzene): −4.2; −3.0; 1.1; 14.1; 16.2; 18.4; 23.78; 24.6; 26.2; 54.76; 54.78; 55.6; 60.3; 80.0; 94.8; 95.9; 101.2; 103.4; 123.6; 150.1; 156.8; 161.2; 172.8. Anal. calc. for $C_{27}H_{46}O_7Si_2$: C 60.18, H 8.60; found: C 60.14, H 8.89.

rac-*Ethyl (5*R,*6*R*)-5-{[(*tert-*Butyl)(dimethyl)silyl]oxy}-6,7-dihydro-1,9-dimethoxy-3-(methoxymethoxy)-8-(trimethylsilyl)-5*H*-benzocycloheptene-6-carboxylate* (*cis*-**21**) *and* rac-*Ethyl (5*R,*6*S*)-5-{[*tert-*Butyl(dimethyl)silyl]oxy}-6,7-dihydro-1,9-dimethoxy-3-(methoxymethoxy)-8-(trimethylsilyl)-5*H*-*benzocycloheptene-6-carboxylate* (*trans*-**21**). To a soln. of *β*-**20** (1.20 g, 2.74 mmol) in *p*-xylene (70 ml) was added 2,6-di-(*tert*-butyl)-4-methylphenol (BHT; 1.7 mg, 7.7 μmol), and the mixture was heated for 3 h at 140° (reflux). After cooling, the mixture was concentrated *in vacuo*, and the residue was purified by FC (SiO_2; hexane/Et_2O 95 : 5 to 4 : 1) to give *trans*-**21** (496 mg, 41%) and *cis*-**21** (490 mg, 41%).

Data of trans-**21**. Colorless solid. R_f (hexane/CH_2Cl_2/Et_2O 75 : 15 : 10) 0.45. M.p. 106–108° (hexane and CH_2Cl_2, colorless prisms). IR (ATR): 2950, 2930, 2859, 1728, 1599, 1463, 1259, 1215, 1172, 1145, 1078, 1030, 1016, 830, 778, 753. ^{1}H-NMR (400 MHz, (D_6)acetone): −0.06 (*s*, 3 H); 0.13 (*s*, 3 H); 0.13 (*s*, 9 H); 0.91 (*s*, 9 H); 1.26 (*t*, *J* = 7.2, 3 H); 1.86 (*dd*, *J* = 14.4, 8.0, 1 H); 2.05 (*dd*, *J* = 14.4, 1.2, 1 H); 2.67 (*ddd*, *J* = 10.0, 8.0, 1.2, 1 H); 3.35 (*s*, 3 H); 3.46 (*s*, 3 H); 3.82 (*s*, 3 H); 4.11 (*dq*, *J* = 10.8, 7.1, 1 H); 4.18 (*dq*, *J* = 10.8, 7.1, 1 H); 5.15 (*d*, *J* = 10.0, 1 H); 5.21 (*d*, *J* = 6.8, 1 H); 5.25 (*d*, *J* = 6.8, 1 H); 6.62 (*d*, *J* = 2.4, 1 H); 7.01 (*d*, *J* = 2.4, 1 H). ^{13}C-NMR (100 MHz, (D_6)acetone): −4.9; −4.1; 14.8; 18.9; 26.4; 28.8; 56.1; 56.2; 56.6; 60.1; 60.8; 73.4; 95.0; 100.2; 104.9; 113.4; 115.0; 146.4; 158.0; 160.0; 160.5; 173.9; 205.9. Anal. calc. for $C_{27}H_{46}O_7Si_2$: C 60.18, H 8.60; found: C 60.38, H 8.86.

Data of cis-**21**. Amorphous. M.p. 70–73°. R_f (hexane/CH_2Cl_2/Et_2O 75 : 15 : 10) 0.40. IR (ATR): 2952, 2928, 2898, 1723, 1596, 1465, 1358, 1301, 1259, 1240, 1145, 1125, 1077, 1015, 848, 829, 780. ^{1}H-NMR (400 MHz, (D_6)acetone): 0.03 (*s*, 3 H); 0.07 (*s*, 3 H); 0.19 (*s*, 9 H); 0.93 (*s*, 9 H); 1.18 (*t*, *J* = 7.2, 1 H); 1.88 (*t*, *J* = 13.6, 3 H); 2.03 (*dd*, *J* = 13.6, 5.6, 1 H); 3.20 (*ddd*, *J* = 13.6, 7.6, 5.6, 1 H); 3.28 (*s*, 3 H); 3.45 (*s*, 3 H); 3.83 (*s*, 3 H); 3.95–4.06 (*m*, 2 H); 4.87 (*d*, *J* = 7.6, 1 H); 5.20 (*d*, *J* = 6.8, 1 H); 5.25 (*d*, *J* = 6.8, 1 H); 6.64 (*d*, *J* = 2.4, 1 H); 6.98 (*d*, *J* = 2.4, 1 H). ^{13}C-NMR (100 MHz, (D_6)acetone): −4.94; −4.86; 14.8; 19.1; 26.2; 26.4; 56.1; 56.2; 56.5; 59.2; 60.3; 73.0; 95.1; 99.8; 107.0; 113.7; 114.2; 145.3; 157.8; 159.4; 161.0; 172.2; 205.9. Anal. calc. for $C_{27}H_{46}O_7Si_2$: C 60.18, H 8.60; found: C 60.39, H 8.86.

Ring-Enlargement Reaction of α-**20**. To a soln. of *α*-**20** (37.8 mg, 0.0703 mmol) in *p*-xylene (4.2 ml) was added BHT (cat. amount). After stirring for 3 h at 140° (reflux), the mixture was concentrated *in vacuo*. The residue was purified by PTLC (hexane/CH_2Cl_2/Et_2O 7 : 2 : 1) to give *trans*-**21** (15.8 mg, 42%) and *cis*-**21** (15.8 mg, 42%).

Detection of Intermediate **K**. To a soln. of *cis*-**21** (29.9 mg, 0.0561 mmol) in CH_2Cl_2 (0.5 ml) was added Na_2CO_3 (49.1 mg, 0.54 mmol), followed by *m*CPBA (74.9 mg, 0.274 mmol) at −78°. After warming up to −40°, the reaction was stopped by adding sat. aq. $Na_2S_2O_3$ and sat. aq, $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford **K** (29.2 mg, single diastereoisomer), containing a trace amount of impurity (assessed by ^{1}H-NMR). This material was employed in the structural analysis without further purification. Pale-yellow oil. R_f (hexane/AcOEt 93 : 7) 0.60. ^{1}H-NMR (500 MHz, (D_6)benzene): 0.15 (*s*, 3 H); 0.24 (*s*, 3 H); 0.28 (*s*, 9 H); 1.01 (*t*, *J* = 7.5, 3 H); 1.07 (*s*, 9 H); 1.55 (*t*, *J* = 13.8, 1 H); 3.00 (*dd*, *J* = 13.8, 5.2, 1 H); 3.20 (*s*, 3 H); 3.30 (*s*, 3 H); 3.39 (*ddd*, *J* = 13.8, 6.9, 5.2, 1 H); 3.89–4.03 (*m*, 2 H); 4.93 (*d*, *J* = 6.9, 1 H); 5.07 (*d*, *J* = 6.9, 1 H); 5.72 (*d*, *J* = 6.9, 1 H); 6.41 (*d*, *J* = 2.3, 1 H); 6.60 (*d*, *J* = 2.3, 1 H). ^{13}C-NMR (125 MHz, (D_6)benzene): −4.8; −4.7; −1.5; 14.3; 18.5; 26.0; 34.2; 49.1; 53.1; 55.2; 55.6; 58.4; 60.2; 70.8; 86.5; 94.5; 100.4; 106.7; 113.8; 141.1; 159.2; 159.3; 171.2. LR-MS (FAB+, 3-nitrobenzyl alcohol (3-NBA)): 554 (M^+; $C_{27}H_{46}O_8Si_2^+$; calc. 554).

rac-*Ethyl (5*R,*6*S*)-5-{[(*tert-*Butyl)(dimethyl)silyl]oxy}-6,7,8,9-tetrahydro-1-methoxy-3-(methoxymethoxy)-8,9-dioxo-5*H*-*benzocycloheptene-6-carboxylate* (*trans*-**22**). To a soln. of *trans*-**21** (120 mg, 0.223 mmol), in CH_2Cl_2 (2.0 ml) was added Na_2CO_3 (98.1 mg, 2.23 mmol) followed by *m*CPBA (295 mg, 1.08 mmol) at −78°. After warming up to −40°, the mixture was stirred for 2 h at this temp. To the mixture was added 1M HCl (2.0 ml), and the stirring was continued for 10 min at r.t. The reaction was stopped by adding sat. aq. $Na_2S_2O_3$ and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by PTLC (hexane/acetone 7 : 3) to afford *trans*-**22** (84.8 mg, 83%). Pale-yellow

oil. R_f (hexane/acetone 7:3) 0.45. IR (ATR): 2931, 2857, 1732, 1692, 1902, 1583, 1464, 1252, 1189, 1149, 1075, 1048, 1003, 976, 924, 837, 778. ^{1}H-NMR (400 MHz, $CDCl_3$): −0.14 (*s*, 3 H); 0.02 (*s*, 3 H); 0.75 (*s*, 9 H); 1.28 (*t*, *J* = 7.3, 3 H); 2.85 (*dd*, *J* = 12.8, 7.3, 1 H); 3.05 (*dd*, *J* = 12.8, 11.0, 1 H); 3.28 (*ddd*, *J* = 11.0, 7.3, 2.9, 1 H); 3.47 (*s*, 3 H); 3.82 (*s*, 3 H); 4.10–4.23 (*m*, 2 H); 5.17 (*d*, *J* = 7.3, 1 H); 5.19 (*d*, *J* = 7.3, 1 H); 5.22 (*d*, *J* = 2.8, 1 H); 6.41 (*d*, *J* = 2.3, 1 H); 6.60 (*d*, *J* = 2.3, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −5.6; −5.5; 14.1; 18.0; 25.4; 37.6; 50.2; 56.1; 56.3; 61.5; 76.2; 94.3; 100.2; 106.2; 117.6; 144.1; 160.9; 161.3; 170.0; 184.5; 191.2. Anal. calc. for $C_{28}H_{34}O_8Si$: C 59.20, H 7.34; found: C 59.11, H 7.07.

rac-*Ethyl (5*R,*6*R*)-5-[[(*tert-*Butyl(dimethyl)silyl]oxy]-6,7,8,9-tetrahydro-1-methoxy-3-(methoxymethoxy)-8,9-dioxo-5*H*-benzocycloheptene-6-carboxylate* (*cis*-**22**). To a soln. of *cis*-**21** (31.3 mg, 0.0582 mmol) in CH_2Cl_2 (0.5 ml) was added Na_2CO_3 (50.0 mg, 0.595 mmol), followed by *m*CPBA (18.8 mg, 0.286 mmol) at −78°. After warming up to −40°, the mixture was stirred for 2 h at this temp. To the mixture was added 1M HCl (1.0 ml), which was stirred for 10 min at r.t. The reaction was stopped by adding sat. aq. $Na_2S_2O_3$ and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified with PTLC (hexane/AcOEt 55:45) to give *cis*-**22** (23.1 mg, 85%). Yellow solid. R_f (hexane/AcOEt 1:1) 0.23. M.p. 118–120° (hexane/$CHCl_3$, yellow prisms). IR (ATR): 2093, 2858, 1733, 1717, 1697, 1598, 1574, 1465, 1329, 1249, 1151, 1114, 1105, 1082, 1015, 831, 784, 668. ^{1}H-NMR (500 MHz, $CDCl_3$): −0.32 (*s*, 3 H); 0.00 (*s*, 3 H); 0.71 (*s*, 9 H); 1.33 (*t*, *J* = 7.5, 3 H); 2.77 (*dd*, *J* = 13.5, 9.1, 1 H); 3.14 (*ddd*, *J* = 13.5, 9.1, 2.9, 1 H); 3.28 (*d*, *J* = 13.5, 1 H); 3.51 (*s*, 3 H); 3.82 (*s*, 3 H); 4.16 (*dq*, *J* = 10.9, 7.5, 1 H); 4.26 (*dq*, *J* = 10.9, 7.5, 1 H); 5.24 (*s*, 2 H); 5.32 (*d*, *J* = 2.9, 1 H); 6.60 (*d*, *J* = 2.5, 1 H); 6.62 (*d*, *J* = 2.5, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −5.9; −5.3; 14.1; 17.9; 25.3; 36.3; 49.1; 56.2; 56.4; 61.7; 76.1; 94.4; 100.4; 105.3; 117.9; 146.0; 161.2; 161.5; 170.4; 184.8; 190.7. Anal. calc. for $C_{28}H_{34}O_8Si$: C 59.20, H 7.34; found: C 59.40, H 7.31.

*Ethyl 6-Hydroxy-4-methoxy-2-(methoxymethoxy)-5-oxo-5*H*-benzocycloheptene-8-carboxylate* (**23**). To a soln. of *cis*-**22** (166 mg, 0.223 mmol) in MeCN (3.0 ml) was added DBU (132 µl, 0.868 mmol) at r.t. After stirring for 1 h, the mixture was diluted with H_2O. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford **23** (131 mg), which contained a trace amount of impurity (assessed by ^{1}H-NMR). This material was employed in the next experiment without further purification. According to the procedure described for the reaction of *cis*-**22**, *trans*-**22** (25.0 mg, 0.0536 mmol) gave **23** (21.8 mg, including a small amount of impurities). A small potion was triturated with hexane/Et_2O to give an anal. pure sample. Pale-orange solid. R_f (hexane/AcOEt 1:1) 0.74. M.p. 171–172° (hexane and CH_2Cl_2, yellow plates). UV (MeOH): 276 (4.1), 378 (3.7). IR (ATR): 3311, 2937, 1711, 1599, 1575, 1541, 1378, 1349, 1277, 1246, 1212, 1195, 1147, 1120, 1084, 1033, 980, 932, 919, 89, 845, 834. ^{1}H-NMR (400 MHz, $CDCl_3$): 1.42 (*t*, *J* = 7.1, 3 H); 3.53 (*s*, 3 H); 3.99 (*s*, 3 H); 4.40 (*q*, *J* = 7.1, 2 H); 5.32 (*s*, 2 H); 5.32 (*d*, *J* = 2.9, 1 H); 6.92 (*d*, *J* = 2.2, 1 H); 7.08 (*d*, *J* = 2.2, 1 H); 6.52 (*d*, *J* = 1.5, 1 H); 8.12 (*d*, *J* = 1.5, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 14.3; 56.5; 56.9; 62.1; 94.3; 103.8; 108.3; 111.5; 119.8; 128.3; 135.7; 139.8; 156.8; 160.3; 164.0; 166.6; 180.1. Anal. calc. for $C_{17}H_{18}O_7$: C 61.07, H 5.43; found: C 60.95, H 5.49.

*Ethyl 2,6-Dihydroxy-4-methoxy-5-oxo-5*H*-benzocycloheptene-8-carboxylate* (**24**). To a soln. of **23** (115 mg, 0.340 mmol) in THF (5.0 ml) was added 6M HCl (5.0 ml) at r.t. After stirring for 10 h, the mixture was diluted with H_2O. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford **24** (100 mg), which contained a trace amount of impurity (assessed by ^{1}H-NMR). This material was employed in the next experiment without further purification. A small potion was triturated with $CHCl_3$ to give an anal. pure sample of **24**. Yellow solid. R_f (hexane/AcOEt 1:1) 0.15. M.p. 240–243° (dec.). UV (MeOH): 225 (4.1), 278 (4.1), 300 (4.1), 382 (3.7). IR (ATR): 3220 (br.), 3009, 2967, 2410, 1705, 1589, 1546, 1458, 1372, 1357, 1290, 1250, 1210, 1188, 1175, 1131, 1118, 1017, 979, 840, 763. ^{1}H-NMR (400 MHz, (D_6)DMSO): 1.30 (*t*, *J* = 7.2, 3 H); 3.77 (*s*, 3 H); 4.26 (*q*, *J* = 7.2, 2 H); 6.72 (*d*, *J* = 2.4, 1 H); 6.78 (*d*, *J* = 2.4, 1 H); 6.80 (*d*, *J* = 1.2, 1 H); 7.76 (*d*, *J* = 1.2, 1 H); 10.15 (*s*, 1 H); 10.68 (*s*, 1 H). ^{13}C-NMR (125 MHz, (D_6)DMSO): 14.2; 56.3; 61.8; 103.0; 104.8; 109.2; 118.7; 127.0; 133.0; 137.0; 157.1; 160.6; 161.4; 166.6; 182.7. Anal. calc. for $C_{15}H_{14}O_6$: C 62.07, H 4.86; found: C 62.03, H 4.67.

*Ethyl 2,6-Bis[(2,2-dimethylpropanoyl)oxy]-4-methoxy-5-oxo-5*H*-benzocycloheptene-8-carboxylate* (**25**). To a soln. of **24** (22.5 mg, 0.0813 mmol) and Et_3N (100 µl, 0.732 mmol) in CH_2Cl_2 (0.8 ml) was

added pivaloyl chloride (48 µl, 0.39 mmol) at r.t. After stirring for 1 h, the reaction was quenched by adding sat. aq. $NaHCO_3$. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by PTLC (hexane/AcOEt 4:1) to afford **25** (25.8 mg, 70%). Colorless oil. R_f (hexane/AcOEt 4:1) 0.80. UV (EtOH): 212 (4.5), 258 (4.2), 262 (4.1), 295 (3.9). IR (neat): 2976, 2936, 1757, 1716, 1667, 1594, 1263, 1236, 1149, 1102. ^{1}H-NMR (400 MHz, $CDCl_3$): 1.36 (*s*, 9 H); 1.38 (*s*, 9 H); 1.30 (*t*, *J* = 7.2, 3 H); 3.93 (*s*, 3 H); 4.37 (*q*, *J* = 7.2, 1 H); 6.95 (*d*, *J* = 2.0, 1 H); 7.04 (*d*, *J* = 2.0, 1 H); 7.27 (*d*, *J* = 1.2, 1 H); 8.13 (*d*, *J* = 1.2, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 14.3; 27.0; 27.1; 57.3; 32.1; 109.0; 116.7; 117.5; 125.3; 125.8; 135.3; 139.3; 149.4; 153.2; 160.7; 165.9; 175.5; 176.3; 182.5. LR-EI-MS: 458 (M^+). Anal. calc. for $C_{25}H_{30}O_8$: C 65.49, H 6.60; found: C 65.32, H 6.90.

*Ethyl 2,6-Bis[(2,2-dimethylpropanoyl)oxy]-4-hydroxy-5-oxo-5*H-*benzocycloheptene-8-carboxylate* (**26**). To a soln. of **25** (7.7 mg, 0.017 mmol) in CH_2Cl_2 (0.15 ml) was added BBr_3 (195 µl, 1.32 mmol) at −78°. After stirring for 3 h, the reaction was quenched by adding H_2O. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by PTLC (hexane/AcOEt 75:25) to afford the starting material (1.7 mg) and **26** (5.7 mg, 76%). Yellow solid. R_f (hexane/AcOEt 4:1) 0.80. M.p. 185–187°. UV (MeOH): 258 (4.5), 300 (4.2), 378 (4.1). IR (ATR): 2975, 2933, 1756, 1716, 1606, 1552, 1479, 1272, 1246, 1149, 1097, 1035. ^{1}H-NMR (500 MHz, $CDCl_3$): 1.39 (*s*, 9 H); 1.41 (*s*, 9 H); 1.43 (*t*, *J* = 7.2, 3 H); 4.41 (*q*, *J* = 7.2, 1 H); 7.05 (*d*, *J* = 2.4, 1 H); 7.14 (*d*, *J* = 2.4, 1 H); 7.74 (*d*, *J* = 1.3, 1 H); 8.33 (*d*, *J* = 1.3, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): 14.3; 27.0; 27.2; 39.1; 39.4; 62.5; 114.6; 119.6; 120.1; 125.1; 126.5; 137.3; 144.0; 150.1; 155.4; 165.3; 167.3; 175.9; 176.6; 184.5. LR-EI-MS: 444 (M^+). Anal. calc. for $C_{24}H_{28}O_8$: C 64.85, H 6.35; found: C 64.65, H 6.65.

*Ethyl 2,4,6-Trihydroxy-5-oxo-5*H-*benzocycloheptene-8-carboxylate* (the reported structure of *goupiolone A* (**4**)). To a soln. of **26** (10.2 mg, 0.0230 mmol) in EtOH (0.3 ml) was added EtONa (*ca.* 2M in EtOH, prepared from Na and EtOH, 0.11 ml, 0.22 mmol) at 0°. After stirring for 6 h at r.t., the mixture was poured into ice-chilled 2M HCl. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was suspended in CH_2Cl_2 and centrifuged to afford **4** (3.5 mg, 55%). Orange powder. R_f (hexane/AcOEt 1:1) 0.55. M.p. 238–240°. IR (ATR): 3351, 3288, 1697, 1601, 1462, 1308, 1229, 1176, 1035. ^{1}H-NMR (500 MHz, (D_6)DMSO): 1.35 (*t*, *J* = 6.7, 3 H); 4.33 (*q*, *J* = 6.7, 1 H); 6.68 (*d*, *J* = 2.0, 1 H); 6.95 (*d*, *J* = 2.0, 1 H); 7.39 (*s*, 1 H); 8.07 (*s*, 1 H); 9.87 (br. *s*, 1 H); 11.14 (br. *s*, 1 H); 14.92 (*s*, 1 H). ^{1}H-NMR (500 MHz, (D_8)THF): 1.39 (*t*, *J* = 7.1, 3 H); 4.36 (*q*, *J* = 7.1, 1 H); 6.65 (*d*, *J* = 2.5, 1 H); 6.86 (*d*, *J* = 2.5, 1 H); 7.58 (*d*, *J* = 1.5, 1 H); 8.16 (br. *s*, 1 H); 9.16 (br. *s*, 1 H); 9.75 (br. *s*, 1 H); 14.67 (*s*, 1 H). ^{13}C-NMR (125 MHz, (D_8)THF): 14.6, 62.7, 107.4, 113.0, 113.9, 115.6, 128.6, 138.1, 141.0, 156.3, 164.4, 166.7, 169.2, 184.2. LR-EI-MS: 276 (M^+). Anal. calc. for $C_{14}H_{12}O_6$: C 60.87, H 4.38; found: C 60.69, H 4.67.

5-(Methoxymethoxy)-1,3-benzodioxole [23]. To a suspension of NaH (14.4 g, 0.378 mol) in a mixture of DMF (72 ml) and THF (180 ml) was added a soln. of sesamol (50.0 g, 0.368 mol) in THF (110 ml) at 0°. After stirring for 50 min, $MeOCH_2Cl$ (30.0 ml, 0.398 mol) was added, and the mixture was stirred further 1 h at r.t., before quenching the reaction by adding H_2O. The products were extracted with hexane (3×), and the combined org. layer was washed with H_2O and brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by distillation to afford *5-(methoxymethoxy)-1,3-benzodioxole* (64.3 g, 96%). Colorless oil. R_f (hexane/AcOEt 4:1) 0.65. B.p. 76–81°/0.2 mmHg. IR (neat): 2955, 2898, 2846, 2826, 1986, 1849, 1630, 1611, 1501, 1490, 1451, 1404, 1245, 1213, 1178, 1152, 1069, 1038, 1005, 937, 922, 843, 815. ^{1}H-NMR (400 MHz, $CDCl_3$): 3.47 (*s*, 3 H); 5.07 (*s*, 2 H); 5.91 (*s*, 2 H); 6.48 (*dd*, *J* = 8.5, 2.4, 1 H); 6.62 (*d*, *J* = 2.4, 1 H); 6.69 (*d*, *J* = 8.5, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 55.8; 95.5; 99.7; 101.2; 95.5; 99.7; 101.1; 107.9; 108.4; 142.5; 148.1; 152.5. Anal. calc. for $C_9H_{10}O_4$: C 59.34, H 5.53; found: C 59.39, H 5.56.

4-Iodo-5-(methoxymethoxy)-1,3-benzodioxole. To a soln. of 5-(methoxymethoxy)-1,3-benzodioxole (5.34 g, 29.3 mmol) in THF (95 ml) was added BuLi (2.23M in hexane, 15.8 ml, 35.2 mmol) at 0°. After stirring for 0.5 h at r.t., I_2 (10.1 g, 39.9 mmol) was added, and the mixture was stirred further 4 h at r.t. before quenching the reaction by adding 10% aq. $Na_2S_2O_3$. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by CC (SiO_2; hexane/AcOEt 95:5) to give *4-iodo-5-(methoxymethoxy)-1,3-*

benzodioxole (4.78 g, 53%). Off-white solid. R_f (hexane/AcOEt 9:1) 0.63. M.p. 58–59° (hexane, colorless prisms). IR (ATR): 2990, 2957, 2909, 2833, 1799, 1609, 1495, 1454, 1437, 1403, 1242, 1203, 1152, 1081, 1039, 1021, 934, 915, 792. ^{1}H-NMR (400 MHz, $CDCl_3$): 3.52 (*s*, 3 H); 5.15 (*s*, 2 H); 6.00 (*s*, 2 H); 6.54 (*d*, *J* = 8.6, 1 H); 6.67 (*d*, *J* = 8.6, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 56.4; 66.8; 96.1; 100.9; 107.5; 107.6; 141.6; 150.3; 151.4. Anal. calc. for $C_9H_9IO_4$: C 35.09, H 2.94; found: C 35.32, H 3.06.

4-Iodo-1,3-benzodioxole. To a soln. of 4-iodo-5-(methoxymethoxy)-1,3-benzodioxole (4.80 g, 15.6 mmol) in a mixture of THF (10 ml) and MeOH (10 ml) was added 2M HCl (10 ml). After stirring for 3.5 h at 45°, the mixture was concentrated *in vacuo*. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with H_2O and brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by recrystallization (AcOEt/hexane) to give *4-iodo-1,3-benzodioxole* (2.80 g, 69%). Pale-red solid. R_f (hexane/AcOEt 4:1) 0.70. M.p. 123–125° (hexane and AcOEt, colorless prisms). IR (ATR): 3160, 2912, 1619, 1496, 1451, 1408, 1384, 1319, 1225, 1038, 974, 929, 875, 785, 773. ^{1}H-NMR (300 MHz, $CDCl_3$): 4.93 (*s*, 1 H); 6.00 (*s*, 2 H); 6.45 (*d*, *J* = 8.6, 1 H); 6.66 (*d*, *J* = 8.6, 1 H). ^{1}H-NMR (500 MHz, (D_6)acetone): 5.98 (*s*, 2 H); 6.39 (*d*, *J* = 8.0, 1 H); 6.64 (*d*, *J* = 8.0, 1 H); 8.66 (*s*, 1 H). ^{13}C-NMR (125 MHz, (D_6)acetone): 64.6, 101.8, 106.7, 108.8, 140.6, 151.4, 152.8. Anal. calc. for $C_7H_5IO_3$: C 31.84, H 1.91; found: C 32.06, H 1.75.

4-Iodo-1,3-benzodioxol-5-yl Trifluoromethanesulfonate. To a soln. of 4-iodo-1,3-benzodioxole (2.75 g, 10.4 mmol) in CH_2Cl_2 (50 ml) was added EtN(i-Pr)$_2$ (2.4 ml, 14 mmol), followed by Tf_2O (2.1 ml, 13 mmol) at −78°. After stirring for 1.5 h, the reaction was stopped by adding sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with 1M HCl (2×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 4:1) to give *4-iodo-1,3-benzodioxol-5-yl trifluoromethanesulfonate* (4.30 g, quant.). White solid. R_f (hexane/AcOEt 4:1) 0.93. M.p. 78–79° (hexane and AcOEt, colorless prisms). IR (ATR): 3098, 2907, 2789, 1859, 1594, 1494, 1445, 1427, 1249, 1208, 1136, 1120, 1039, 958, 930, 883, 829, 815, 735, 711. ^{1}H-NMR (400 MHz, $CDCl_3$): 6.12 (*s*, 2 H); 6.76 (*d*, *J* = 8.6, 1 H); 6.81 (*d*, *J* = 8.6, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 68.4, 102.0, 107.8, 114.9, 118.5 (*q*, *J* = 319); 144.3, 145.6, 151.3. Anal. calc. for $C_8H_4F_3IO_5S$: C 24.26, H 1.02, S 8.10; found: C 24.45, H 0.80, S 7.84.

*6-{[(*tert*-Butyl)(dimethyl)silyl]oxy}cyclobuta[e][1,3]benzodioxol-7(6*H*)-one* (**27**). To a soln. of 4-iodo-1,3-benzodioxol-5-yl trifluoromethanesulfonate (4.00 g, 10.1 mmol) and **15** (3.70 g, 13.4 mmol) in THF (50 ml) was added BuLi (1.63M in hexane, 8.9 ml, 14.5 mmol) at −78°. After stirring for 10 min, the reaction was stopped by adding H_2O. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in MeCN (250 ml) and 46% aq. HF (24.0 ml) was added. After stirring for 15 min at −10°, the reaction was stopped by adding sat. aq. $NaHCO_3$. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 95:5 to 90:10) to afford **27** (866 mg, 30%, 2 steps). Pale-yellow solid. R_f (hexane/AcOEt 9:1) 0.42. M.p. 95–98°. IR (ATR): 2951, 2929, 2894, 2857, 1760, 1607, 1510, 1471, 1340, 1258, 1216, 1143, 1104, 1044, 1023, 984, 914, 870, 837, 826 807, 778, 724. ^{1}H-NMR (400 MHz, $CDCl_3$): 0.16 (*s*, 3 H); 0.18 (*s*, 3 H); 0.92 (*s*, 9 H); 5.64 (*s*, 1 H); 6.06 (*d*, *J* = 1.2, 1 H); 6.07 (*d*, *J* = 1.2, 1 H); 6.99 (*d*, *J* = 13.6, 1 H); 7.04 (*d*, *J* = 13.6, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −4.7; −4.5; 18.2; 25.7; 60.3; 85.8; 102.6; 115.7; 127.5; 138.1; 148.8; 150.0; 185.9. Anal. calc. for $C_{15}H_{20}O_4Si$: C 61.61, H 6.89; found: C 61.60, H 6.79.

rac-*(2-{[(Benzyloxy)methoxy]methyl}-1-[(6*S*,7*R*)-6-{[(*tert*-butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]cyclopropyl)(trimethyl)silane* (**28**). To a soln. of **9** (1.68 g, 4.90 mmol) in Et_2O (17 ml) was added *t*-BuLi (1.61M in pentane, 3.5 ml, 5.6 mmol) slowly at −78°. After stirring for 1 h at this temp., a soln. of **27** (643 mg, 2.20 mmol) in THF (10 ml) was added, and the mixture was stirred for 10 min. To the mixture was added TfOMe (1.0 µl, 8.7 mmol). After warming to 0°, $Me_2NCH_2CH_2NH_2$ (1 ml) was added for quenching the excess TfOMe, and the mixture was further stirred for 10 min. After diluting the mixture with H_2O, the products extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 98:2 to 96:4)to give **28** (1.09 g, 87%), which was composed of three diastereoisomers (dr = 75:19:6). Colorless oil. R_f (hexane/AcOEt 9:1) 0.56. IR (neat): 2952, 2929, 2892, 2857, 1486, 1456, 1378, 1252, 1214, 1171, 1112, 1048, 929, 836, 776. ^{1}H-NMR (500 MHz, $CDCl_3$):

– 0.07 (*s*, 3 H); – 0.02 (*s*, 3 H); 0.06 (*s*, 3 H, minor); 0.09 (*s*, 3 H, minor); 0.18 (*s*, 9 H); 0.20 (*s*, 9 H, minor); 0.38 (*t*, *J* = 5.2, 1 H); 0.55 – 0.62 (*m*, 1 H, minor); 0.69 (*t*, *J* = 5.2, 1 H, minor); 0.90 (*s*, 9 H); 0.93 (*s*, 9 H); 1.20 (*dd*, *J* = 8.6, 5.2, 1 H, minor); 1.27 (*dd*, *J* = 14.3, 5.2, 1 H); 1.56 (*dddd*, *J* = 14.3, 9.2, 6.3, 5.2, 1 H); 3.33 (*s*, 3 H, minor); 3.47 (*s*, 3 H); 3.52 (*dd*, *J* = 10.3, 8.6, 1 H, minor); 3.58 (*dd*, *J* = 10.3, 9.2, 1 H); 3.57 – 3.60 (*m*, 1 H, minor); 3.90 (*dd*, *J* = 10.3, 6.3, 1 H); 4.54 (*s*, 2 H, minor); 4.61 (*d*, *J* = 11.5, 1 H); 4.64 (*d*, *J* = 11.5, 1 H); 4.69 (*d*, *J* = 6.3, 1 H, minor); 4.72 (*d*, *J* = 6.3, 1 H, minor); 4.80 (*d*, *J* = 6.9, 1 H); 4.83 (*d*, *J* = 6.9, 1 H); 5.03 (*s*, 1 H); 5.17 (*s*, 1 H, minor); 6.72 (*d*, *J* = 7.5, 1 H); 6.74 (*d*, *J* = 7.5, 1 H, minor); 6.79 (*d*, *J* = 7.5, 1 H); 6.80 (*d*, *J* = 7.5, 1 H, minor); 7.27 – 7.37 (*m*, 7 H + 7 H (minor)). ^{13}C-NMR (125 MHz, $CDCl_3$): – 4.2 (minor); – 4.0; – 3.1 (minor); – 3.0; 1.0; 1.4 (minor); 10.0; 14.2 (minor); 16.8; 18.3; 20.0 (minor); 22.0; 22.6 (minor); 25.9; 26.0 (minor); 31.6 (minor); 54.1; 54.3 (minor); 68.7 (minor); 68.8; 69.3 (minor); 69.4; 79.6 (minor); 79.9; 94.37; 94.43 (minor); 95.2 (minor); 95.5; 100.9; 101.0 (minor); 110.4; 110.7 (minor); 116.3; 116.5 (minor); 122.2; 122.3 (minor); 127.6 (minor); 127.76; 127.82 (minor); 128.4; 137.87 (minor); 137.94; 141.3 (minor); 141.45; 141.50; 141.7 (minor); 147.76; 147.77 (minor). Anal. calc. for $C_{31}H_{46}O_6Si_2$: C 65.22, H 8.12; found: C 64.96, H 7.90.

rac-*{2-[(6*S*,7*R*)-6-{[*tert*-Butyl(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropyl}methanol* (**29**). A flask, purged with Ar, was charged with 20% $Pd(OH)_2$/C (350 mg), to which was added a soln. of **28** (1.08 g, 1.89 mmol) in AcOEt (18 ml). The atmosphere was changed from Ar to H_2 (1 atm), and the mixture was stirred for 45 min at r.t. After changing the atmosphere from H_2 to Ar, the mixture was filtered through a *Celite* pad (washed with AcOEt) and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 9 : 1 to 4 : 1) to give rac-*[(1*R*,2*R*)-2-[(6*S*,7*R*)-6-{[(*tert*-butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropyl]methanol* (*β*-**29**; 652 mg, 64%), and a mixture of rac-*[(1*S*,2*S*)-2-[(6*S*,7*R*)-6-{[(*tert*-butyl)(dimethyl)silyl]oxy}-7-methoxy-6,7-dihydrocyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropyl]methanol* (*α*-**29**) and rac-*[(1*R*,2*S*)-2-[(6*S*,7*R*)-6-{[(*tert*-butyl)(dimethyl)silyl]oxy}-7-methoxy-6,7-dihydrocyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)-cyclopropyl]methanol* (**29′**; 204 mg, 20%) as a colorless oil. Anal. samples of *α*-**29** and **29′** were prepared by separation of the mixture by PTLC (hexane/acetone 4 : 1) to afford pure *α*-**29** and **29′** as colorless oils.

Data of β-**29**. R_f (hexane/AcOEt 4 : 1) 0.25. IR (neat): 3363, 2953, 2934, 2895, 2857, 1457, 1404, 1376, 1251, 1208, 1169, 1114, 1047, 837. ^{1}H-NMR (400 MHz, $CDCl_3$): – 0.09 (*dd*, *J* = 8.6, 4.6, 1 H); – 0.05 (*s*, 3 H); – 0.01 (*s*, 3 H); 0.17 (*s*, 9 H); 0.32 (*t*, *J* = 4.6, 1 H); 0.89 (*s*, 9 H); 1.26 (*s*, 1 H); 1.49 (*dddd*, *J* = 8.6, 8.4, 6.6, 4.6, 1 H); 3.44 (*s*, 3 H); 3.58 (*dd*, *J* = 11.2, 8.4, 1 H); 3.87 (*dd*, *J* = 11.2, 6.6, 1 H); 5.02 (*s*, 1 H); 5.93 (*d*, *J* = 1.2, 1 H); 6.00 (*d*, *J* = 1.2, 1 H); 6.71 (*d*, *J* = 7.8, 1 H); 6.80 (*d*, *J* = 7.8, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): – 4.1; – 3.0; 1.1; 9.7; 14.1; 17.4; 18.3; 22.6; 25.0; 25.9; 31.6; 54.3; 63.8; 80.0; 95.4; 101.0; 110.5; 116.3; 122.2; 141.4; 141.6; 147.8. HR-MS (FAB +, 3-NBA): 451.2334 ($[M+H]^+$, $C_{23}H_{39}O_5Si_2^+$; calc. 451.2336).

Data of α-**29**. R_f (hexane/AcOEt 4 : 1) 0.22. IR (neat): 3388, 2952, 2929, 2895, 2857, 1457, 1252, 1214, 1167, 1113, 1048, 1031, 932, 836, 776. ^{1}H-NMR (500 MHz, $CDCl_3$): 0.05 (*s*, 3 H); 0.07 (*s*, 3 H); 0.18 (*s*, 9 H); 0.57 (*dddd*, *J* = 8.6, 8.0, 6.8, 4.6, 1 H); 0.63 (*t*, *J* = 4.6, 1 H); 0.90 (*s*, 9 H); 1.15 (*dd*, *J* = 8.6, 4.6, 1 H); 1.64 (*s*, 1 H); 3.31 (*s*, 3 H); 3.50 (*dd*, *J* = 10.9, 8.0, 1 H); 3.57 (*dd*, *J* = 10.9, 6.8, 1 H); 5.13 (*s*, 1 H); 5.89 (*d*, *J* = 1.2, 1 H); 5.95 (*d*, *J* = 1.2, 1 H); 6.73 (*d*, *J* = 7.8, 1 H); 6.79 (*d*, *J* = 7.8, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): – 4.3; – 3.2; 1.4; 13.6; 17.3; 18.1; 23.2; 25.8; 54.3; 63.5; 79.6; 95.1; 101.0; 110.4; 116.5; 122.4; 141.2; 141.5; 147.7. HR-MS (FAB +, 3-NBA): 450.2268 (M^+, $C_{23}H_{38}O_5Si_2^+$; calc. 450.2258).

Data of **29′**. R_f (hexane/AcOEt 4 : 1) 0.22. IR (neat): 3428, 2953, 2930, 2896, 2858, 1501, 1455, 1378, 1251, 1208, 1141, 1044, 932, 877, 836, 777. ^{1}H-NMR (500 MHz, $CDCl_3$): – 0.03 (*s*, 9 H); 0.12 (*s*, 3 H); 0.15 (*s*, 3 H); 0.66 (*dd*, *J* = 9.8, 4.6, 1 H); 0.69 (*t*, *J* = 4.6, 1 H); 0.90 (*s*, 1 H); 0.92 (*s*, 9 H); 1.35 (*dddd*, *J* = 9.8, 9.5, 5.8, 4.6, 1 H); 3.29 (*s*, 3 H); 3.89 (*dd*, *J* = 12.1, 9.5, 1 H); 3.95 (*dd*, *J* = 12.1, 5.8, 1 H); 5.37 (*s*, 1 H); 5.95 (*d*, *J* = 1.2, 1 H); 5.96 (*d*, *J* = 1.2, 1 H); 6.76 (*d*, *J* = 8.0, 1 H); 6.87 (*d*, *J* = 8.0, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): – 4.4; – 3.2; – 1.0; 13.2; 17.8; 18.1; 24.1; 25.8; 55.1; 62.3; 79.9; 92.1; 101.0; 110.9; 116.6; 124.6; 140.8; 141.5; 148.2. HR-MS (FAB +, 3-NBA): 492.2353 (M^+, $C_{23}H_{38}O_5Si_2^+$; calc. 492.2363).

rac-*(1*R*,2*R*)-2-[(6*S*,7*R*)-6-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropanecarbaldehyde* (*β*-**30**). To a soln. of *β*-**29** (470 mg, 1.04 mmol) in DMSO (10 ml) was added IBX (730 mg, 2.61 mmol). After stirring for 11 h, the reaction was stopped by adding 10% aq. $Na_2S_2O_3$ and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2

(3×), and the combined org. layer was washed with H_2O (5×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford *β*-**30** (449 mg, 96%). This material was employed in the next experiment without further purification. White solid. R_f (hexane/AcOEt 4:1) 0.93. M.p. 116–118° (hexane, colorless plates). IR (ATR): 2956, 2930, 2859, 1685, 1456, 1253, 1211, 1166, 1112, 1026, 924, 831, 792, 782, 761. ^{1}H-NMR (500 MHz, $CDCl_3$): −0.01 (*s*, 3 H); 0.00 (*s*, 3 H); 0.22 (*s*, 9 H); 0.46 (*dd*, *J* = 8.0, 5.2, 1 H); 0.89 (*s*, 9 H); 1.21 (*t*, *J* = 5.2, 1 H); 2.19 (*ddd*, *J* = 8.0, 6.9, 5.2, 1 H); 3.42 (*s*, 3 H); 5.04 (*s*, 1 H); 5.96 (*d*, *J* = 1.2, 1 H); 6.02 (*t*, *J* = 1.2, 1 H); 6.74 (*d*, *J* = 7.5, 1 H); 6.83 (*d*, *J* = 7.5, 1 H); 9.23 (*d*, *J* = 6.9, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −4.1; −3.1; 0.8; 13.8; 18.3; 25.90; 25.92; 34.7; 54.8; 80.3; 94.6; 101.3; 111.0; 116.6; 121.1; 140.8; 141.6; 148.1; 200.9. HRMS (FAB+, 3-NBA): 449.2170 ($[M+H]^+$, $C_{23}H_{37}O_5Si_2^+$; calc. 449.2180). Anal. calc. for $C_{23}H_{36}O_5Si_2$: C 61.57, H 8.09; found: C 61.36, H 8.14.

rac-*Ethyl (1*R,2R*)-2-[(6*S,7R*)-6-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropanecarboxylate* (*β*-**32**). To a soln. of *β*-**30** (435 mg, 0.97 mmol), 2-methylbut-2-ene (2.0 ml, 19 mmol), and $NaH_2PO_4 \cdot 2\,H_2O$ (760 mg, 4.97 mmol) in acetone (8.0 ml) and H_2O (2.0 ml) was added $NaClO_2$ (320 mg, 3.56 mmol) at r.t. After stirring for 4 h, the mixture was diluted with H_2O. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in DMF (10 ml), to which were added K_2CO_3 (400 mg, 2.89 mmol) and EtI (140 µl, 1.76 mmol). After stirring for 1.5 h, the mixture was diluted with H_2O. The products were extracted with Et_2O (3×), and the combined org. layer was washed with H_2O (3×), brine, dried ($MgSO_4$), and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 95:5) to give *β*-**32** (356 mg, 70%, 3 steps). R_f (hexane/AcOEt 4:1) 0.87. M.p. 148–151° (hexane, colorless plates). IR (ATR): 2952, 2928, 2895, 2857, 1716, 1495, 1463, 1409, 1265, 1244, 1194, 1166, 1117, 1044, 1034, 939, 919, 832, 776. ^{1}H-NMR (500 MHz, $CDCl_3$): −0.05 (*s*, 3 H); −0.02 (*s*, 3 H); 0.16 (*dd*, *J* = 8.1, 6.9, 1 H); 0.17 (*s*, 9 H); 0.89 (*s*, 9 H); 1.04 (*t*, *J* = 5.2, 1 H); 1.30 (*t*, *J* = 6.9, 1 H); 2.03 (*dd*, *J* = 8.1, 6.9, 1 H); 3.49 (*s*, 3 H); 4.11–4.21 (*m*, 2 H); 5.03 (*s*, 1 H); 5.96 (*d*, *J* = 1.1, 1 H); 6.01 (*d*, *J* = 1.1, 1 H); 6.73 (*d*, *J* = 8.0, 1 H); 6.82 (*d*, *J* = 8.0, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −4.0; −3.0; 0.3; 12.8; 14.4; 18.3; 23.7; 24.3; 25.9; 54.4; 60.6; 79.9; 95.3; 101.1; 110.7; 116.6; 121.7; 141.1; 141.4; 147.9; 173.3. Anal. calc. for $C_{25}H_{40}O_6Si_2$: C 60.94, H 8.18; found: C 60.73, H 8.29.

rac-*(1*S,2S*)-2-[(6*S,7R*)-6-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]-benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropanecarbaldehyde* (*α*-**30**) *and* rac-*(1*S,2R*)-2-[(6*S,7R*)-6-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropanecarbaldehyde* (**30′**). To a soln. of a mixture *α*-**29**/**29′** (14.0 mg, 0.0311 mmol, dr = 2.8:1) in DMSO (10 ml) was added IBX (24.0 mg, 0.0857 mmol). After stirring for 11 h, the reaction was stopped by adding 10% aq. $Na_2S_2O_3$ and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with H_2O (5×), sat. aq. $NaHCO_3$, brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford *α*-**30**/**30′** (9.3 mg, 75%, dr = 3.2:1). This material was employed in the next experiment without further purification. R_f (hexane/AcOEt 4:1) 0.87. IR (neat): 2954, 2930, 2896, 2857, 1704, 1459, 1253, 1206, 1168, 1114, 1042, 971, 927, 885, 838, 777. ^{1}H-NMR (500 MHz, $CDCl_3$): −0.10 (*s*, 3 H); 0.09 (*s*, 9 H, minor); 0.10 (*s*, 3 H); 0.11 (*s*, 3 H, minor); 0.24 (*s*, 3 H (minor) + 9 H); 0.90 (*s*, 9 H, minor); 0.92 (*s*, 9 H); 1.14 (*dd*, *J* = 8.0, 4.6, 1 H, minor); 1.21 (*ddd*, *J* = 8.1, 7.1, 5.1, 1 H); 1.52 (*t*, *J* = 5.1, 1 H); 1.67 (*dd*, *J* = 8.1, 5.1, 1 H); 1.81 (*ddd*, *J* = 8.0, 7.1, 4.6, 1 H, minor); 1.92 (*t*, *J* = 4.6, 1 H, minor); 3.29 (*s*, 3 H, minor); 3.33 (*s*, 3 H); 5.14 (*s*, 1 H); 5.21 (*s*, 1 H, minor); 5.93 (*d*, *J* = 1.1, 1 H); 5.95 (*d*, *J* = 1.1, 1 H); 5.96 (*d*, *J* = 1.1, 1 H, minor); 5.97 (*d*, *J* = 1.1, 1 H, minor); 6.75 (*d*, *J* = 7.8, 1 H + 1 H (minor)); 6.82 (*d*, *J* = 7.8, 1 H); 6.89 (*d*, *J* = 7.8, 1 H, minor); 9.12 (*d*, *J* = 7.1, 1 H); 9.42 (*d*, *J* = 7.1, 1 H, minor). HR-MS (FAB+, 3-NBA): 449.2177 ($[M+H]^+$, $C_{23}H_{37}O_5Si_2^+$; calc. 449.2180).

rac-*Ethyl (1*S,2S*)-2-[(6*S,7R*)-6-{[(*tert*-Butyl)(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropanecarboxylate* (*α*-**32**) *and* rac-*Ethyl (1*S,2R*)-2-[(6*S,7R*)-6-{[*tert*-Butyl(dimethyl)silyl]oxy}-6,7-dihydro-7-methoxycyclobuta[e][1,3]benzodioxol-7-yl]-2-(trimethylsilyl)cyclopropanecarboxylate* (**32′**). To a soln. of *β*-**30** (42.5 mg, 0.0949 mmol), 2-methylbut-2-ene (150 µl, 1.41 mmol), and $NaH_2PO_4 \cdot 2\,H_2O$ (150 mg, 0.961 mmol) in acetone (1.6 ml), and H_2O (0.4 ml) was added $NaClO_2$ (40.0 mg, 0.442 mmol) at r.t. After stirring for 2 h, the mixture was diluted by H_2O. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was dissolved in DMF (10 ml), and to the soln. were added K_2CO_3 (400 mg, 2.89 mmol) and EtI (140 µl, 1.76 mmol). After stirring for 1.5 h, the

mixture was diluted with H_2O. The products were extracted with Et_2O (3 ×), and the combined org. layer was washed with H_2O (3 ×), brine, dried ($MgSO_4$), and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 85:15) to give ester α-**32** (20.6 mg, 47%) and **32′** (8.9 mg, 20%).

Data of α-**32**. Colorless oil. R_f (hexane/AcOEt 4:1) 0.50. IR (neat): 2954, 2930, 2897, 2858, 1731, 1458, 1403, 1378, 1250, 1185, 1139, 1112, 1036, 979, 931, 835, 795, 777. ^{1}H-NMR (500 MHz, $CDCl_3$): 0.08 (*s*, 3 H); 0.11 (*s*, 3 H); 0.17 (*s*, 9 H); 0.92 (*s*, 9 H); 1.04 (*dd*, *J* = 8.6, 5.2, 1 H); 1.22 (*t*, *J* = 6.9, 1 H); 1.34 (*dd*, *J* = 8.6, 5.2, 1 H); 1.36 (*t*, *J* = 5.2, 1 H); 3.33 (*s*, 3 H); 4.01 – 4.09 (*m*, 2 H); 5.21 (*s*, 1 H); 5.92 (*d*, *J* = 1.1, 1 H); 5.95 (*d*, *J* = 1.1, 1 H); 6.77 (*d*, *J* = 8.0, 1 H); 6.83 (*d*, *J* = 8.0, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): − 4.4; − 3.2; 0.5; 14.2; 15.5; 18.1; 22.9; 25.9; 54.5; 60.5; 79.3; 94.9; 101.1; 110.7; 116.8; 121.8; 141.2; 141.5; 147.9; 172.9. HR-MS (FAB +, 3-NBA): 492.2353 (M^+, $C_{25}H_{40}O_6Si_2^+$; calc. 492.2363).

Data of **32′**. Colorless amorphous solid. R_f (hexane/AcOEt 4:1) 0.55. M.p. 98 – 101°. IR (neat): 2951, 2929, 2897, 2857, 1730, 1470, 1450, 1402, 1383, 1247, 1211, 1182, 1130, 1107, 1050, 1048, 936, 922, 885, 876, 849, 832, 820, 785, 720. ^{1}H-NMR (500 MHz, $CDCl_3$): 0.07 (*s*, 9 H); 0.15 (*s*, 3 H); 0.17 (*s*, 3 H); 0.93 (*s*, 9 H); 0.96 (*dd*, *J* = 7.5, 5.2, 1 H); 1.06 (*t*, *J* = 6.9, 1 H); 1.54 (*t*, *J* = 5.2, 1 H); 1.70 (*dd*, *J* = 7.5, 5.2, 1 H); 3.22 (*s*, 3 H); 3.34 (*dq*, *J* = 10.9, 6.9, 1 H); 3.62 (*dq*, *J* = 10.9, 6.9, 1 H); 5.21 (*s*, 1 H); 5.93 (*d*, *J* = 1.8, 1 H); 5.97 (*d*, *J* = 1.8, 1 H); 6.64 (*d*, *J* = 7.5, 1 H); 6.79 (*d*, *J* = 7.5, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): − 4.5; − 4.2; − 1.2; 14.0; 14.5; 18.1; 23.0; 25.4; 25.8; 54.7; 60.4; 90.1; 101.0; 110.7; 115.1; 123.3; 141.2; 142.7; 148.1; 170.9. HR-MS (FAB +, 3-NBA): 492.2374 (M^+, $C_{25}H_{40}O_6Si_2^+$; calc. 492.2363).

Ring-Enlargement Reaction of β-**32**. To a soln. of β-**32** (323 mg, 0.657 mmol) in *p*-xylene (30 ml) was added cat. BHT. After stirring for 4 h at 140° (reflux), the mixture was concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 99:1 to 9:1) to give rac-*ethyl (6*R,7S*)-6-[[(*tert-*butyl)(dimethyl)silyl]oxy}-7,8-dihydro-10-methoxy-9-(trimethylsilyl)-6*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]-dioxole-7-carboxylate* (*trans*-**33**; 123 mg, 38%) and rac-*ethyl (6*R,7R*)-6-[[(*tert-*butyl)(dimethyl)silyl]-oxy}-7,8-dihydro-10-methoxy-9-(trimethylsilyl)-6*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]dioxole-7-carboxylate* (*cis*-**33**; 141 mg, 44%).

Data of trans-**33**. Colorless oil. R_f (hexane/Et_2O 4:1) 0.70. IR (neat): 2954, 2930, 2896, 2858, 1733, 1608, 1583, 1459, 1446, 1271, 1245, 1173, 1103, 1052, 950, 868, 838, 779. ^{1}H-NMR (500 MHz, (D_6)benzene): 0.05 (*s*, 3 H); 0.21 (*s*, 3 H); 0.39 (*s*, 9 H); 1.03 (*s*, 9 H); 1.04 (*t*, *J* = 6.9, 3 H); 2.06 (br. *dd*, *J* = 13.8, 7.5, 1 H); 2.20 (*dd*, *J* = 13.8, 1.2, 1 H); 3.00 (br. *t*, *J* = 7.5, 1 H); 3.36 (*s*, 3 H); 3.99 (*dq*, *J* = 10.9, 6.9, 1 H); 4.09 (*dq*, *J* = 10.9, 6.9, 1 H); 5.27 (*d*, *J* = 1.2, 1 H); 5.33 (*d*, *J* = 1.2, 1 H); 5.40 (*d*, *J* = 9.2, 1 H); 6.62 (*d*, *J* = 8.6, 1 H); 7.28 (br. *d*, *J* = 8.6, 1 H). ^{13}C-NMR (125 MHz, (D_6)benzene): − 5.1; − 4.1; − 0.2; 14.4; 18.5; 26.2; 28.5; 57.1; 60.3; 73.2; 101.3; 108.16; 108.17; 114.7; 118.4; 118.6; 136.7; 143.6; 147.4; 158.0; 173.6. Anal. calc. for $C_{25}H_{40}O_6Si_2$: C 60.94, H 8.18; found: C 61.01, H 8.34.

Data of cis-**33**: Colorless solid. M.p. 105 – 106° (hexane, colorless plates). R_f (hexane/Et_2O 4:1) 0.65. IR (ATR): 2929, 2857, 1724, 1609, 1586, 1462, 1447, 1346, 1272, 1254, 1226, 1171, 1115, 1099, 1043, 1010, 926, 885, 870, 829, 776. ^{1}H-NMR (500 MHz, (D_6)benzene): 0.07 (*s*, 3 H); 0.12 (*s*, 3 H); 0.27 (*s*, 9 H); 0.99 (*s*, 9 H); 1.03 (*t*, *J* = 7.5, 1 H); 2.21 (*dd*, *J* = 13.2, 5.8, 3 H); 2.37 (*t*, *J* = 13.2, 1 H); 3.26 (*s*, 3 H); 3.50 (*ddd*, *J* = 13.2, 6.9, 5.8, 1 H); 3.97 – 4.07 (*m*, 2 H); 5.06 (*d*, *J* = 6.9, 1 H); 5.23 (*d*, *J* = 1.1, 1 H); 5.35 (*d*, *J* = 1.1, 1 H); 6.76 (*d*, *J* = 8.0, 1 H); 7.35 (br. *d*, *J* = 8.0, 1 H). ^{13}C-NMR (125 MHz, (D_6)benzene): − 5.2; − 5.0; − 0.1; 14.4; 18.7; 26.0; 29.1; 56.9; 58.7; 59.9; 72.6; 101.3; 108.5; 114.3; 117.5; 120.2; 135.1; 143.4; 147.4; 158.5; 171.7. Anal. calc. for $C_{25}H_{40}O_6Si_2$: C 60.94, H 8.18; found: C 61.04, H 8.38.

Ring-Enlargment Reaction of α-**32**. To a soln. of α-**32** (17.1 mg, 0.0348 mmol) in *p*-xylene (2 ml) was added cat. BHT. After stirring for 4 h at 140° (reflux), the mixture was concentrated *in vacuo*. The residue was purified by PTLC (hexane/Et_2O 4:1) to give *trans*-**33** (9.2 mg, 54%) as a colorless oil and *cis*-**33** (6.1 mg, 36%) as a white solid.

Ring-Enlargment Reaction of **32′**. To a soln. of **32′** (8.3 mg, 0.0348 mmol) in *p*-xylene (2 ml) was added cat. BHT. After stirring for 4 h at 140° (reflux), the mixture was concentrated *in vacuo*. The residue was purified by PTLC (hexane/Et_2O 4:1) to give *trans*-**33** (9.2 mg, 54%) as a colorless oil and *cis*-**33** (6.1 mg, 36%) as a white solid.

rac-*Ethyl (6*R,7S*)-6-[[(*tert-*Butyl)(dimethyl)silyl]oxy}-7,8,9,10-tetrahydro-9,10-dioxo-6*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]dioxole-7-carboxylate* (*trans*-**33′**). To a soln. of *trans*-**33** (90.2 mg, 0.183 mmol) in CH_2Cl_2 (2.0 ml) was added Na_2CO_3 (153 mg, 1.81 mmol), followed by *m*CPBA (251 mg, 0.923 mmol) at − 78°. After warming up to 0°, the mixture was stirred for 2 h at this temp. To the mixture was added 1M

HCl (2.0 ml), and the stirring was continued for 10 min at r.t. The reaction was stopped by adding sat. aq. Na_2SO_3 and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by PTLC (hexane/AcOEt 55:45) to afford *trans*-**33′** (50.0 mg, 65%). Yellow oil. R_f (hexane/AcOEt 55:45) 0.75. IR (neat): 2952, 2930, 2858, 1735, 1703, 1450, 1254, 1236, 1189, 1125, 1043, 856, 841, 779. ^{1}H-NMR (500 MHz, $CDCl_3$): −0.17 (*s*, 3 H); 0.02 (*s*, 3 H); 0.75 (*s*, 9 H); 1.27 (*t*, *J* = 7.5, 3 H); 2.92 (*dd*, *J* = 12.6, 7.4, 1 H); 3.06 (*dd*, *J* = 12.6, 10.0, 1 H); 3.35 (*ddd*, *J* = 10.0, 7.4, 2.3, 1 H); 4.09–4.23 (*m*, 2 H); 5.26 (*d*, *J* = 2.3, 1 H); 6.05 (*d*, *J* = 1.1, 1 H); 6.20 (*d*, *J* = 1.1, 1 H); 6.64 (*d*, *J* = 7.5, 1 H); 6.84 (*d*, *J* = 7.5, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): −5.6; −5.5; 14.2; 17.9; 25.3; 37.6; 50.5; 61.5; 76.0; 102.7; 110.9; 117.1; 120.0; 134.1; 149.1; 170.0; 185.1; 190.8. HR-MS (FAB+, 3-NBA): 421.1672 ([*M* + H]$^+$, $C_{21}H_{29}O_7Si^+$; calc. 421.1683).

rac-*Ethyl (6*R,7R*)-6-[[(*tert-*Butyl)(dimethyl)silyl]oxy]-7,8,9,10-tetrahydro-9,10-dioxo-6*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]dioxole-7-carboxylate* (*cis*-**33′**). To a soln. of *cis*-**33** (89.6 mg, 0.182 mmol) in CH_2Cl_2 (2.0 ml) was added Na_2CO_3 (152 mg, 1.80 mmol), followed by *m*CPBA (252 mg, 0.923 mmol) at −78°. After warming up to 0°, the mixture was stirred for 2 h at this temp. To the mixture was added 1M HCl (2.0 ml), which was stirred for 10 min at r.t. The reaction was stopped by adding sat. aq. Na_2SO_3 and sat. aq. $NaHCO_3$. The products were extracted with CH_2Cl_2 (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford *cis*-**33′** as a yellow solid. This material was used in the next reaction without purification. An anal. sample was prepared by purifying by PTLC (hexane/AcOEt 55:45) to afford *cis*-**33**. Yellow amorphous solid. R_f (hexane/AcOEt 55:45) 0.72. M.p. 95–98°. IR (ATR): 2952, 2930, 2858, 1743, 1703, 1630, 1462, 1450, 1288, 1241, 1191, 1139, 1043, 1001, 931, 845, 831, 809, 779. ^{1}H-NMR (400 MHz, $CDCl_3$): −0.36 (*s*, 3 H); −0.02 (*s*, 3 H); 0.69 (*s*, 9 H); 1.34 (*t*, *J* = 7.1, 3 H); 2.79 (*dd*, *J* = 12.9, 9.3, 1 H); 3.17 (*dd*, *J* = 9.3, 2.7, 1 H); 3.35 (*ddd*, *J* = 12.9, 2.7, 2.4, 1 H); 4.10–4.29 (*m*, 2 H); 5.39 (*d*, *J* = 2.4, 1 H); 6.05 (*d*, *J* = 1.1, 1 H); 6.21 (*d*, *J* = 1.1, 1 H); 6.82 (*d*, *J* = 7.5, 1 H); 6.90 (*d*, *J* = 7.5, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): −5.9; −5.2; 14.1; 17.9; 25.2; 36.2; 49.7; 61.7; 75.8; 102.8; 111.0; 117.3; 119.2; 135.9; 149.20; 149.23; 170.4; 185.0; 190.0. HR-MS (FAB+, 3-NBA): 421.1684 ([*M* + H]$^+$, $C_{21}H_{29}O_7Si^+$; calc. 421.1683).

*Ethyl 9-Hydroxy-10-oxo-10*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]dioxole-7-carboxylate* (**34**). To a soln. of *cis*-**33** (10.5 mg, 0.0250 mmol) in MeCN (1.0 ml) was added DBU (9 µl, 0.06 mmol) at r.t. After stirring for 1 h, the mixture was diluted with H_2O. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo* to afford **34** (131 mg), which contained a trace amount of impurity (assessed by ^{1}H-NMR). This material was used in the next reaction without purification. A small potion was triturated (hexane, CH_2Cl_2) to give an anal. pure sample. Yellow solid. R_f (hexane/AcOEt 6:4) 0.60. M.p. 204–205° (hexane, CH_2Cl_2, yellow needles). IR (ATR): 3257, 3079, 2992, 2910, 1704, 1644, 1608, 1568, 1454, 1473, 1434, 1395, 1367, 1297, 1255, 1226, 1204, 1085, 1045, 1026, 961, 850, 828. ^{1}H-NMR (400 MHz, $CDCl_3$): 1.43 (*t*, *J* = 6.1, 3 H); 4.35 (*q*, *J* = 6.1, 2 H); 6.35 (*s*, 2 H); 7.34 (*d*, *J* = 8.3, 1 H); 7.57 (*d*, *J* = 8.3, 1 H); 7.78 (*d*, *J* = 1.1, 1 H); 8.29 (*d*, *J* = 1.1, 1 H); 8.33 (br. *s*, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 14.3; 62.1; 103.2; 111.9; 114.0; 119.9; 124.7; 130.6; 131.7; 137.7; 149.9; 150.6; 153.9; 166.7; 179.5. HR-MS (FAB+, 3-NBA): 289.0715 ([*M* + H]$^+$, $C_{15}H_{13}O_6^+$; calc. 289.0712).

*Ethyl 9-(Acetyloxy)-10-oxo-10*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]dioxole-7-carboxylate* (**35**). To a soln. of **34** (35.5 mg, 0.123 mmol) and Et_3N (39 µl, 0.31 mmol) in CH_2Cl_2 (0.5 ml) was added AcCl (16 µl, 0.22 mmol) at 0°. After stirring for 10 min, the reaction was quenched by adding sat. aq. $NaHCO_3$. The products were extracted with AcOEt (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/acetone 7:3) to afford **35** (23.1 mg, 77%, 3 steps from *cis*-**33**). Yellow solid. R_f (hexane/AcOEt 1:1) 0.75. M.p. 87–90° (hexane, CH_2Cl_2, yellow prisms). IR (ATR): 2990, 2911, 1767, 1713, 1622, 1584, 1554, 1470, 1446, 1369, 1296, 1276, 1244, 1218, 1199, 1171, 1156, 1080, 1021, 966, 921, 842, 823, 787. ^{1}H-NMR (500 MHz, $CDCl_3$): 1.40 (*t*, *J* = 7.5, 3 H); 2.34 (*s*, 3 H); 4.37 (*q*, *J* = 7.5, 1 H); 6.76 (*s*, 2 H); 7.22 (*d*, *J* = 8.1, 1 H); 7.45 (*d*, *J* = 8.1, 1 H); 7.67 (*d*, *J* = 1.7, 1 H); 8.31 (*d*, *J* = 1.7, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): 14.3; 20.5; 62.1; 103.3; 112.8; 121.7; 122.1; 123.7; 128.4; 132.0; 143.3; 148.8; 149.9; 151.9; 165.9; 168.9; 178.8. HR-MS (FAB+, 3-NBA): 331.0825 ([*M* + H]$^+$, $C_{17}H_{15}O_7^+$; calc. 331.0818).

*Ethyl 2,9-Bis(Acetyloxy)-10-oxo-10*H*-cyclohepta[3,4]benzo[1,2-*d*][1,3]dioxole-7-carboxylate* (**36**). To a soln. of **35** (23.0 mg, 0.0697 mmol) in benzene (1.0 ml) was added $Pb(OAc)_4$ (95.0 mg, 0.214 mmol).

After stirring for 7 h under reflux conditions, the mixture was concentrated *in vacuo*. The residue was purified by FC (SiO_2; hexane/AcOEt 1:1) to afford the starting material (3.7 mg, 16%) and **37** (17.0 mg, 63%). Yellow oil. R_f (hexane/AcOEt 1:1) 0.75. IR (neat): 2987, 2957, 2935, 2857, 1768, 1714, 1635, 1447, 1369, 1276, 1248, 1213, 1167, 1101, 1011, 967. ^{1}H-NMR (500 MHz, $CDCl_3$): 1.42 (*t*, *J* = 6.9, 3 H); 2.13 (*s*, 3 H); 2.36 (*s*, 3 H); 4.40 (*q*, *J* = 6.9, 2 H); 7.40 (*d*, *J* = 8.1, 1 H); 7.60 (*d*, *J* = 8.1, 1 H); 7.73 (*d*, *J* = 1.8, 1 H); 7.98 (*s*, 1 H); 8.39 (*d*, *J* = 1.8, 1 H). ^{13}C-NMR (125 MHz, $CDCl_3$): 14.3; 20.5; 20.9; 62.3; 113.7; 114.0; 122.5; 122.8; 124.0; 129.2; 132.4; 142.9; 146.9; 148.6; 149.2; 165.8; 168.3; 168.9; 178.2. HR-MS (FAB$^+$, 3-NBA): 389.0866 ($[M+H]^+$, $C_{19}H_{17}O_9^+$; calc. 389.0873).

*Ethyl 3,4,6-Trihydroxy-5-oxo-5*H*-benzocycloheptene-8-carboxylate*; **5**). [24] To a soln. of **36** (15.0 mg, 0.0387 mmol) in a mixture of CH_2Cl_2 (0.5 ml) and EtOH (0.5 ml) was added conc. aq. HCl (0.5 ml). After stirring for 1 h under reflux conditions, to the mixture was added H_2O. The products were extracted with $CHCl_3$ (3×), and the combined org. layer was washed with brine, dried (Na_2SO_4), and concentrated *in vacuo*. The residue was purified by trituration (cold EtOH) to afford **5** (9.6 mg, 90%). Orange solid. M.p. 198–200° (EtOH). R_f (hexane/AcOEt 1:1) 0.50. UV (MeOH): 279 (4.5), 400 (4.2). IR (ATR): 3403, 3269, 2857, 1714. ^{1}H-NMR (500 MHz, $CDCl_3$): 1.44 (*t*, *J* = 6.7, 3 H); 4.42 (*q*, *J* = 6.7, 1 H); 6.54 (br. *s*, 1 H); 7.52 (*d*, *J* = 8.6, 1 H); 7.54 (*d*, *J* = 8.6, 1 H); 8.00 (*d*, *J* = 2.0, 1 H); 8.18 (*s*, 1 H); 8.44 (*d*, *J* = 2.0, 1 H); 14.66 (*s*, 1 H). ^{1}H-NMR (500 MHz, (D_8)THF): 1.39 (*t*, *J* = 7.1, 3 H); 4.36 (*q*, *J* = 7.1, 1 H); 7.43 (*d*, *J* = 8.6, 1 H); 7.54 (*d*, *J* = 8.6, 1 H); 7.82 (*d*, *J* = 1.0, 1 H); 8.37 (br. *s*, 1 H); 8.99 (br. *s*, 1 H); 9.21 (br. *s*, 1 H); 14.76 (*s*, 1 H). ^{13}C-NMR (100 MHz, $CDCl_3$): 14.4; 62.2; 116.4; 119.8; 120.9; 124.2; 128.5; 130.0; 140.0; 147.5; 149.9; 152.7; 166.3; 183.8. ^{13}C-NMR (125 MHz, (D_8)THF): 14.6; 62.5; 116.5; 121.1; 122.6; 124.6; 129.3; 130.4; 140.0; 150.2; 152.2; 154.6; 166.8; 185.8. Anal. calc. for $C_{14}H_{12}O_6$: C 60.87, H 4.38; found: C 60.66, H 4.57.

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