Synthesis of Novel Structurally Simplified Estrogen Analogues with Electron-Donating Groups in Ring A

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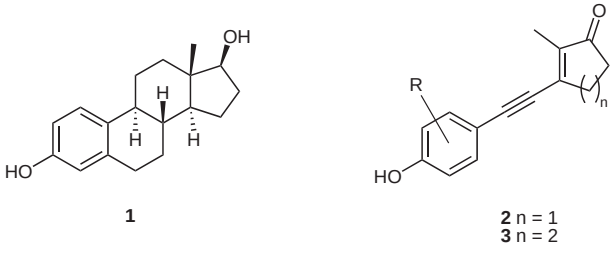
Abstract: A library of 25 novel estrogen analogues were prepared in five to eight steps from mostly commercially available substituted anisoles via bromination, formylation, Corey–Fuchs reaction, elimination, and Sonogashira reaction.

Key words: alkynes, estrogens, Corey–Fuchs reaction, Sonogashira reaction, steroids

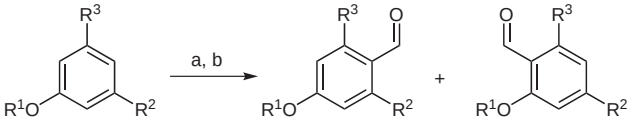
Recently, we have developed a new class of novel simplified estrogen analogues, which consist of a rigid alkyne moiety as surrogate for ring B and C connected to the aromatic ring A and a methylcyclopentenone or a methylcyclohexenone for ring D.[1] Some of these analogues **2** and **3** show biological activity close to that of estradiol (**1**) itself (Figure 1).[2] The development of simple SERMs (selective estrogen receptor modulators) with as few stereogenic centers as possible is an important task in drug development.[3] Thus, estradiol has a positive effect on blood vessels and the coronary heart system lowering the risk of arteriosclerotic diseases.[4,5] Although many elegant and efficient methods for the synthesis of estrogens[6] have been developed like the multiple palladium-catalyzed cyclization reaction, which was used by us for the synthesis of estradiol,[7] homo- and norestradiol, spiro-analogues and estrogen hybrids[8] as well as the contraceptive desogestrel,[9] there is still a great need to develop simplified analogues with high biological activity. For the successful synthesis of a library of estradiol analogues we used two palladium-catalyzed Sonogashira reactions.[1]



1 **2** n = 1 **3** n = 2

Figure 1 Estradiol **1** and simplified analogues **2** and **3**

However, by using this method there is some limitation in structural diversity since compounds of type **2** and **3** containing electron-donating groups cannot be obtained employing this procedure. Moreover, the necessary iodides have to be prepared via a diazonium salt, which is less appropriate, especially in industrial synthesis. Here we describe an alternative process towards **2** and **3** based on a Corey–Fuchs reaction of substituted aromatic aldehydes starting from the corresponding bromides obtained easily in most cases by direct bromination of anisoles **4**. The anisoles were either commercially available or prepared by different procedures.[10] Bromination of compounds **4** in the *para*-position to the OR^1 group was carried out by a very fast and efficient method published by Andersh et al.,[11] using *N*-bromosuccinimide (NBS) in the presence of catalytic amounts of concentrated HCl. Without purification, the crude products were directly treated with a slight excess of *n*-BuLi or *t*-BuLi in THF at –78 °C. Quenching with DMF and aqueous workup led to the desired aromatic aldehydes **6**. In a few cases – with increasing steric hindrance of the *para*-position to the OR^1 group – an unwanted *ortho*-bromination as side reaction took place leading finally to the formation of an inseparable mixture of the isomeric aldehydes **6** and **9** (Scheme 1).



4 **6** **9**

Scheme 1 Synthesis of the aldehydes **6**. *Reagents and conditions*: a) NBS, cat. concd HCl, acetone, r.t.; b) *n*-BuLi or *t*-BuLi, THF, –78 °C, then DMF, THF, –78 °C to r.t.

However, the procedure allowed us to prepare the aldehydes **6a**–**n** from the anisoles **4a**–**l** and **4n** via **5a**–**k** and **5n**. In the case of 2,6-dichloroanisole, the undesired *ortho*-bromination became dominant. Therefore, the 2,6-dichloro-substituted aldehyde **6l** was synthesized by an alternative three-step procedure published by Karl et al.[12] Aromatic aldehyde **6m** was prepared via a four-step synthetic sequence (Scheme 2).

Starting from 3-hydroxybenzaldehyde (**10**), bromination with Br_2 in AcOH led to bromophenol **11**, which could be isolated as single regioisomer after recrystallization from EtOH–toluene in 35% yield. Reduction of the aldehyde moiety with $NaBH_4$ in EtOH, TIPS-protection of both the phenolic and the benzylic hydroxy groups, halogen–metal exchange with *t*-BuLi in THF, and quenching with DMF

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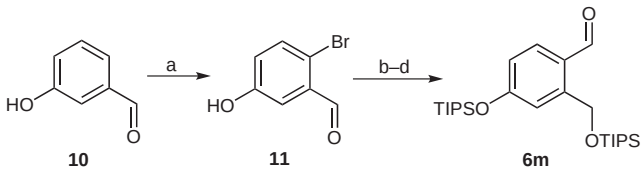


Scheme 2 Synthesis of aromatic aldehyde **6m**. *Reagents and conditions*: a) Br_2, AcOH, r.t., 2 h, 35%; b) $NaBH_4$, EtOH, r.t., 2 h; c) TIPSCl, imidazole, DMF, r.t., 39 h; d) *t*-BuLi, THF–*n*-pentane, –78 °C, 30 min; DMF, –78 °C to r.t., 3 h, 43% over three steps.

finally gave the desired aldehyde **6m** in 15% yield over four steps based on **10**.

The aldehydes **6** (pure or as mixtures with **9**) were treated with CBr_4, Zn powder, and Ph_3P to give the *gem*-dibromostyrene derivatives **7** in excellent yields.[13] At this stage we had to exchange the OMe group in the case of compounds **6a**–**l** for a THP group since the cleavage of a methyl ether moiety in the final product containing a triple bond led to severe problems. In contrast, the Corey–Fuchs products are rather stable and the methyl ether moiety in these compounds could easily be cleaved using BBr_3 in CH_2Cl_2, and the free phenol was then immediately converted into the corresponding THP-acetal **7** using dihydropyran (DHP) and catalytic amounts of pyridinium *p*-toluenesulfonate (PPTS) in CH_2Cl_2 with overall good yields in most cases (Table 1). The *gem*-dibromostyrenes **7m**,**n** were synthesized directly from the aldehydes without exchange of the protecting group (Table 1).

Finally, all dibromo compounds **7a**–**n** were converted into the corresponding arylacetylenes **8a**–**n** by treatment with *n*-BuLi in THF at –78 °C in good to excellent yields (Table 1).[13] The only exception is **8k**, which surprisingly turned out to be unstable under the reaction conditions. Thus, after an additional reprotection step with dihydropyran in the presence of PPTS only 10% of the desired compound **8k** was obtained. Due to the problems in the synthesis of **8k**, acetylenes **8j** and **8l** were prepared from **7j** and **7l**, respectively, using LDA for the elimination step. Although this procedure worked fine, it should be noted that in the case of **8l** the reaction had to be quenched with water at –78 °C since warming to room temperature led to decomposition.

The synthesis of the desired estrogen analogues **2** and **3** was accomplished employing a palladium-catalyzed Sonogashira coupling reaction of arylacetylenes **8** and the cyclic vinyl iodides **12** and **13** to give the protected estrogen analogues **14** and **15**. Due to the sensitivity of the iodides **12** and **13** under Sonogashira conditions[14] use of secondary amines like Et_2NH should be avoided. We therefore followed a procedure by Tamura et al.[15] using an excess of Et_3N in DMF at room temperature after initial heating to 60 °C.

Best yields were obtained using $Pd(PPh)_3Cl_2$ (1.0–2.5 mol%) and CuI (2.5–5.0 mol%) as catalyst system. The final step in the synthesis of **2** and **3**, respectively, was the removal of the protecting group under standard conditions. As procedures for the cleavage of the methyl ethers, BBr_3 in CH_2Cl_2 (alone and with addition of K_2CO_3 as acid scavenger),[12] $[NMe_4]^+[Al_2Cl_7]^-$ in CH_2Cl_2 under microwave irradiation[16] and $BF_3{\cdot}OEt_2$ in Me_2S[17] were employed leading in all cases to complex mixtures, which could not be separated. THP acetals were cleaved by stirring at room temperature in a solution of CH_2Cl_2 containing 10–30% of CF_3CO_2H to give the desired estrogen analogues **2a**–**f** and **3a**–**o** in high yields (Table 2). The TIPS protecting group was removed with *n*-$Bu_4NF{\cdot}3H_2O$ in THF to give the estrogen analogues **2g** and **3p** again in good yields (Table 2). The analogues **14a** and **15a** without a free oxygen functionality were synthesized by a Sonogashira coupling of the phenylacetylene **8n** and the cyclic vinyl iodides **12** and **13** (Table 2). A comparison of the used protecting groups revealed that the THP acetals showed by far the best properties concerning synthesis, stability, and removal.

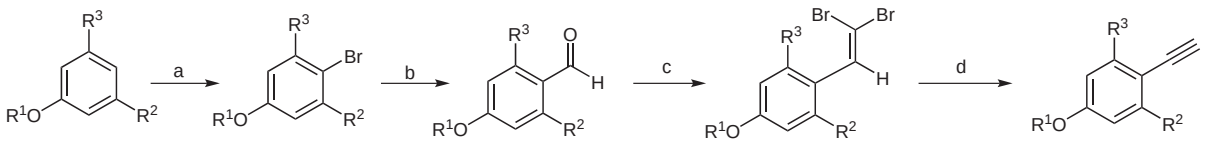
Summarizing, a library of 25 novel estrogen analogues with a large variety of substitution patterns were synthesized from arylacetylenes **8** and cyclic vinyl iodides **12** or **13** by palladium-catalyzed Sonogashira reaction. The necessary alkynes **8** were prepared via a Corey–Fuchs reaction of the corresponding aldehydes **6**. Different protecting groups for the phenolic hydroxy group were investigated revealing that the THP group is most suitable. Finally, two steroid analogues **14a** and **15a** without a free phenolic hydroxy group at the A-ring were prepared starting from commercially available materials in five to eight steps. The obtained estrogen analogues **2** and **3** are highly stable solids.

All reactions were performed under argon in flame-dried flasks. THF and Et_2O were dried and distilled prior to use by usual laboratory methods; all other solvents were used from commercial sources and stored over molecular sieves. All reagents obtained from commercial sources were used without further purification. TLC was performed on precoated silica gel SIL G/UV254 plates (Macherey-Nagel GmbH & Co. KG) and silica gel 60 (0.032–0.063 mm, Merck) was used for column chromatography. Phosphomolybdic acid in MeOH (PMA) or vanillin in methanolic H_2SO_4 was used as the staining reagent for TLC. UV spectra were taken in MeCN or MeOH with a PerkinElmer Lambda 2 spectrometer. IR spectra were recorded as KBr pellets or as films between NaCl plates with a Bruker IFS 25 spectrometer. ^1H and ^{13}C NMR spectra were recorded with Mercury-200, VXR-200, Unity-300, Inova-500, Unity Inova-600 (Varian), or AMX 300 (Bruker) spectrometer. Chemical shifts are reported in ppm with TMS as internal standard. Multiplicities of ^{13}C NMR peaks were determined with the APT pulse sequence. Mass spectra were measured with a Finnigan MAT 95, TSQ 7000, or LCQ instrument. Elemental analysis: Mikroanalytisches Labor, Institut für Organische und Biomolekulare Chemie, Georg-August-Universität Göttingen.

Anisoles 4 from Phenols; General Procedure

To a solution of the appropriate phenol (24.4–81.9 mmol) in dimethyl carbonate (1.2–1.5 mL/mmol) was added 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU) (1.00 equiv) and the mixture heated to 90 °C. After cooling to r.t., the mixture was diluted with H_2O (3.0 mL/mmol), acidified with concd HCl (0.50 mL/mmol) and extracted with Et_2O (3 × 2.0 mL/mmol). The combined organic extracts were washed with aq 2 N NaOH (2 × 1.0 mL/mmol), dried (Na_2SO_4), and the solvent evaporated under reduced pressure.

Table 1 Arylacetylenes **8a**–**n** Prepared[a]

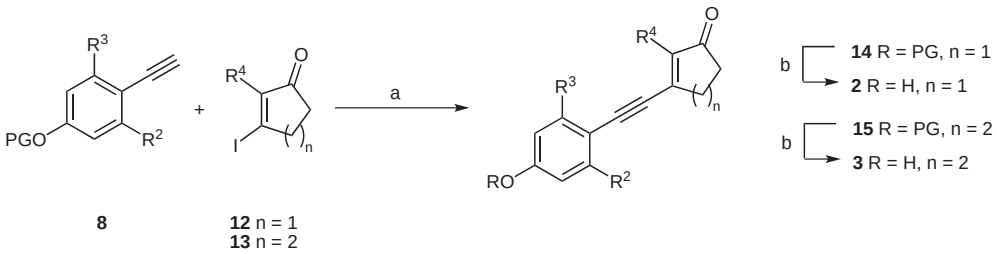


4 **5** **6** **7** **8**

R^1 for **7**, **8**	R^2	R^3	**4** (R^1 = Me)	**6** (R^1 = Me)		**7**	**8**
				Yield (%) (2 steps)	Ratio of **6**/**9**	Yield (%) (3 steps)	Yield (%)
THP[b]	Me	H	**a**	75	–	79	94
THP	Et	H	**b**	82	–	43	95
THP	*i*-Pr	H	**c**	60	11:1	69	92
THP	*t*-Bu	H	**d**	65	1:1	26	62
THP	*n*-Pr	H	**e**	78	–	62	73
THP	*n*-Bu	H	**f**	79	12:1	67	97
THP	*n*-C_9H_{19}	H	**g**	72	11:1	65	96
THP	Me	Me	**h**	63	–	59	95
THP	Ph	H	**i**	63	8:1	62[c]	92[d]
THP	CF_3	H	**j**	28[e]	–	55	78
THP	F	H	**k**	–[f]	–	17[g]	10 (2 steps)[h]
THP	Cl	Cl	**l**	86[i]	–	72	96[j]
TIPS[k]	CH_2OTIPS	H	**m**	43[l] (3 steps)	–	80[m]	quant
	R^2/*o*-H						
Me		H	**n**	81	–	84[m]	97

[a] Reagents and conditions: a) NBS, cat. concd HCl, acetone, r.t.; b) *n*-BuLi or *t*-BuLi, THF, –78 °C, then DMF, THF, –78 °C to r.t.; c) i. CBr_4, Zn powder, Ph_3P, CH_2Cl_2, r.t., ii. BBr_3, CH_2Cl_2, –78 °C to r.t., iii. DHP, PPTS, CH_2Cl_2, r.t.; d) *n*-BuLi or LDA, THF, –78 °C to r.t.
[b] Tetrahydropyranyl.
[c] The phenyl-substituted derivative **7i** could not be separated from its regioisomer derived from **9i**.
[d] Starting material and product contained 11% of the regioisomer derived from **9i**.
[e] After halogen–lithium exchange, the reaction was quenched with *N*-formylpiperidine instead of DMF.
[f] Yield was determined after Corey–Fuchs reaction (cf. **7k**).
[g] The yield was calculated over the five-step sequence starting from 3-fluoroanisole.
[h] The crude product was treated with DHP and PPTS in CH_2Cl_2 at r.t. to avoid loss of material.
[i] The aldehyde **6l** was synthesized from the corresponding benzyl alcohol by heating to 100 °C in toluene with activated MnO_2 (5.24 equiv).
[j] The reaction was quenched with H_2O at –78 °C.
[k] Triisopropylsilyl.
[l] For the synthesis of **6m**, see Scheme 2.
[m] Conditions in these two cases were: CBr_4, Zn powder, Ph_3P, CH_2Cl_2, r.t.

Table 2 Synthesis of the Estrogen Analogues **2** and **3**[a]



R^2	R^3	R^4	n	Product	Yield (%) (2 steps)
Me	H	Me	1	**2a**	45
Et	H	Me	1	**2b**	57
n-Pr	H	Me	1	**2c**	71
n-Bu	H	Me	1	**2d**	55
CF_3	H	Me	1	**2e**	76
Cl	Cl	Me	1	**2f**	82
CH_2OTIPS	H	Me	1	**2g**	60
R^2/*o*-H 	H	Me	1	**14a**	91
Me	H	Me	2	**3a**	50
Et	H	Me	2	**3b**	45
Et	H	Et	2	**3c**	42
i-Pr	H	Me	2	**3d**	59
t-Bu	H	Me	2	**3e**	41
n-Pr	H	Me	2	**3f**	56
n-Bu	H	Me	2	**3g**	57
n-C_9H_{19}	H	Me	2	**3h**	60
Ph	H	Me	2	**3i**	23
CF_3	H	Me	2	**3j**	82
CF_3	H	*i*-Pr	2	**3k**	42
Me	Me	Me	2	**3l**	46
F	H	Me	2	**3m**	40
Cl	Cl	**Me**	2	**3n**	51
Cl	Cl	**Et**	2	**3o**	64
CH_2OTIPS	H	Me	2	**3p**	45
R^2/*o*-H 	H	Me	2	**15a**	85

[a] Reagents and conditions: a) $PdCl_2(PPh_3)_2$, CuI, Et_3N, DMF, r.t.; b) CF_3CO_2H, CH_2Cl_2, r.t. for **2a**–**g** and **3a**–**l**; *n*-$Bu_4NF{\cdot}3H_2O$, THF, 0 °C to r.t. for **2g** and **3p**.

3-Ethylanisole (4b)
Yield: 96%.

IR (film): 2965, 2835, 1602, 1491, 1456, 1263, 1192, 1153, 1041, 877, 779, 695 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 1.25 (t, *J* = 7.6 Hz, 3 H, 3-CH_2CH_3), 2.64 (q, *J* = 7.6 Hz, 2 H, 3-CH_2CH_3), 3.81 (s, 3 H, 1-OCH_3), 6.70–6.86 (m, 3 H, 2-H, 4-H, 6-H), 7.16–7.27 (m, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 15.5 (3-CH_2CH_3), 28.9 (3-CH_2CH_3), 55.1 (1-OCH_3), 110.8, 113.6 (C-2, C-6), 120.3 (C-4), 129.2 (C-5), 145.9 (C-3), 159.6 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 136.1 (76, $[M]^+$), 121.0 (100, $[M - CH_3]^+$).

UV (MeCN): λ_{max} (log ε) = 196.0 (4.6516), 217.0 (3.8124), 272.0 (3.1935), 278.5 nm (3.1673).

3-Isopropylanisole (4c)
Yield: 98%.

IR (film): 2961, 2835, 1486, 1455, 1383, 1363, 1316, 1258, 1198, 1177, 1136, 1045, 920, 851, 778, 700 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 1.25 [d, *J* = 6.9 Hz, 6 H, 3-$CH(CH_3)_2$], 2.88 [sept, *J* = 6.9 Hz, 1 H, 3-$CH(CH_3)_2$], 3.80 (s, 3 H, 1-OCH_3), 6.69–6.86 (m, 3 H, 2-H, 4-H, 6-H), 7.17–7.26 (m, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 23.9 [3-$CH(CH_3)_2$], 34.2 [3-$CH(CH_3)_2$], 55.1 (1-OCH_3), 110.7 (C-2), 112.4 (C-6), 118.9 (C-4), 129.2 (C-5), 150.6 (C-3), 159.6 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 150.1 (50, $[M]^+$), 135.1 (100, $[M - CH_3]^+$), 77.0 $[C_6H_5]^+$.

UV (MeCN): λ_{max} (log ε) = 197 (4.5762), 216.5 (3.8381), 271.5 (3.2265), 278.0 nm (3.1931).

3-*tert*-Butylanisole (4d)
Yield: quant.

IR (film): 2963, 1583, 1487, 1364, 1318, 1276, 1231, 1054, 874, 777, 701 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 1.32 [s, 9 H, 3-$C(CH_3)_3$], 3.82 (s, 3 H, 1-OCH_3), 6.73 (ddd, *J* = 8.0,, 2.5, 0.9 Hz, 1 H, 6-H), 6.93–7.03 (m, 2 H, 2-H, 4-H), 7.24 (t, *J* = 8.0 Hz, 1 H, 5-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 31.3 [3-$C(CH_3)_3$], 34.7 [3-$C(CH_3)_3$], 55.1 (1-OCH_3), 109.9 (C-2), 112.0 (C-6), 117.8 (C-4), 128.9 (C-5), 152.9 (C-3), 159.3 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 164.2 (28, $[M]^+$), 149.2 (100, $[M - CH_3]^+$).

UV (MeCN): λ_{max} (log ε) = 196.0 (4.6443), 216.0 (3.8377), 271.5 (3.2260), 270.0 nm (3.1864).

3-*n*-Propylanisole (4e)
To a suspension of ethyltriphenylphosphonium bromide (12.0 g, 32.3 mmol, 1.10 equiv) in THF (100 mL) was added NaHMDS (1.00 M in THF, 32.3 mL, 32.3 mmol, 1.10 equiv) at r.t. and the mixture was stirred for 10 min. After cooling to –78 °C, a solution of 3-methoxybenzaldehyde (4.00 g, 3.57 mL, 29.4 mmol, 1.00 equiv) in THF (10 mL) was added dropwise. After stirring for 20 min at –78 °C, the mixture was allowed to reach r.t., stirred for 1 h, and H_2O (200 mL) was added. The aqueous layer was extracted with Et_2O (3 × 100 mL). The combined organic layers were washed with brine (50 mL), dried (Na_2SO_4), and the solvent was evaporated under reduced pressure. The crude product was dissolved in MeOH–EtOAc (1:1, 150 mL), Pd/C (10% Pd, 310 mg, 291 μmol, 0.990 mol%) was added, and the mixture was stirred for 46 h at r.t. in the presence of H_2. The resulting mixture was filtered over Celite and the solvent was evaporated under reduced pressure. The crude product was purified by column chromatography (*n*-pentane–EtOAc, 100:1); yield: 4.36 g (88%, over two steps).

IR (film): 2959, 1602, 1489, 1455, 1259, 1152, 1045, 873, 775, 695 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 0.95 (t, *J* = 7.5 Hz, 3 H, 3-$CH_2CH_2CH_3$), 1.65 (sext, *J* = 7.5 Hz, 2 H, 3-$CH_2CH_2CH_3$), 2.57 (t, *J* = 7.5 Hz, 2 H, 3-$CH_2CH_2CH_3$), 3.81 (s, 3 H, 1-OCH_3), 6.70–6.83 (m, 3 H, 2-H, 4-H, 6-H), 7.15–7.26 (m, 1 H, 5-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.8 (3-$CH_2CH_2CH_3$), 24.5 (3-$CH_2CH_2CH_3$), 38.1 (3-$CH_2CH_2CH_3$), 55.0 (1-OCH_3), 110.8, 114.2 (C-2, C-6), 120.9 (C-4), 129.1 (C-5), 144.3 (C-3), 159.5 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 150.1 (64, $[M]^+$), 135.1 (15, $[M - CH_3]^+$), 121.0 (100, $[M - C_2H_5]^+$).

UV (MeCN): λ_{max} (log ε) = 197.0 (4.6272), 217.0 (3.8337), 278.5 (3.2038), 272.0 nm (3.2329).

3-*n*-Butylanisole (4f)
To a suspension of *n*-propyltriphenylphosphonium bromide (12.5 g, 32.3 mmol, 1.10 equiv) in THF (100 mL) was added NaHMDS (1.00 M in THF, 32.3 mL, 32.3 mmol, 1.10 equiv) at r.t. and the mixture was stirred for 10 min. After cooling to –78 °C a solution of 3-methoxybenzaldehyde (4.00 g, 3.57 mL, 29.4 mmol, 1.00 equiv) in THF (10 mL) was added dropwise. After stirring for 20 min at –78 °C, the mixture was heated to r.t., stirred for 1 h, and diluted with H_2O (200 mL). The aqueous layer was extracted with Et_2O (3 × 100 mL) and the combined organic layers were washed with brine (50 mL) and dried (Na_2SO_4). The solvent was evaporated under reduced pressure and the residue was subjected to column chromatography (pentane). A solution of the resulting anisole (4.25 g, 26.2 mmol, 1.00 equiv) in MeOH–EtOAc (1:1, 130 mL) was stirred with Pd/C (10% Pd, 277 mg, 260 μmol, 0.993 mol%) in the presence of H_2 for 39 h at r.t. After filtration over Celite, the solvent was evaporated under reduced pressure. The residue was purified by column chromatography (*n*-pentane–EtOAc, 98:2); yield: 4.15 g (92%, over two steps).

^1H NMR (200 MHz, $CDCl_3$): δ = 0.95 (t, *J* = 7.2 Hz, 3 H, 4′-CH_3), 1.27–1.48 (m, 2 H, 3′-CH_2), 1.52–1.71 (m, 2 H, 2′-CH_2), 2.61 (t, *J* = 7.6 Hz, 2 H, 1′-CH_2), 3.81 (s, 3 H, 1-OCH_3), 6.70–6.84 (m, 3 H, 2-H, 4-H, 6-H), 7.16–7.27 (m, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 13.9 (C-4′), 22.4 (C-3′), 33.5 (C-2′), 35.7 (C-1′), 55.1 (1-OCH_3), 110.8 (C-6), 114.2 (C-2), 120.8 (C-4), 129.1 (C-5), 144.6 (C-3), 159.5 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 164.1 (37, $[M]^+$), 122.1 (100, $[M - C_3H_6]^+$).

EI-HRMS: *m*/*z* calcd for $C_{11}H_{16}O$ (164.244): 164.1201; found: 164.1201.

3-*n*-Nonylanisole (4g)
To a suspension of *n*-octyltriphenylphosphonium bromide (12.2 g, 24.2 mmol, 1.10 equiv) in THF (100 mL) NaHMDS (1.00 M in THF, 24.2 mL, 24.2 mmol, 1.10 equiv) was added at r.t. and the mixture was stirred for 10 min. After cooling to –78 °C, a solution of 3-methoxybenzaldehyde (3.00 g, 2.68 mL, 22.0 mmol, 1.00 equiv) in THF (10 mL) was added dropwise. After stirring for 20 min at –78 °C, the mixture was heated to r.t., stirred for 2 h, and diluted with H_2O (200 mL). The aqueous layer was extracted with

Et_2O (3 × 100 mL) and the combined organic layers were washed with brine (50 mL) and dried (Na_2SO_4). The solvent was evaporated under reduced pressure and the residue was subjected to column chromatography (*n*-pentane). A solution of the resulting anisole (3.83 g, 16.5 mmol, 1.00 equiv) in MeOH–EtOAc (1:1, 80 mL) was stirred with Pd/C (10% Pd, 179 mg, 168 μmol, 1.02 mol%) in the presence of H_2 for 23 h at r.t. After filtration over Celite, the solvent was evaporated under reduced pressure; yield: 3.93 g (79%, over two steps).

IR (film): 2926, 2854, 1602, 1489, 1466, 1261, 1152, 1047, 873, 775, 695 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 0.88 (t, *J* = 6.7 Hz, 3 H, 9′-CH_3), 1.11–1.43 (m, 12 H, 3′-CH_2, 4′-CH_2, 5′-CH_2, 6′-CH_2, 7′-CH_2, 8′-CH_2), 1.50–1.72 (m, 2 H, 2′-CH_2), 2.58 (t, *J* = 7.7 Hz, 2 H, 1′-CH_2), 3.80 (s, 3 H, 1-OCH_3), 6.69–6.82 (m, 3 H, 2-H, 4-H, 6-H), 7.14–7.25 (m, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 14.1 (C-9′), 22.7 (C-8′), 29.3, 29.5, 29.5 (C-4′, C-5′, C-6′, C-7′), 31.4 (C-3′), 31.9 (C-2′), 36.0 (C-1′), 55.1 (1-OCH_3), 110.8 (C-6), 114.2 (C-2), 120.8 (C-4), 129.1 (C-5), 144.6 (C-3), 159.5 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 234.2 (39, $[M]^+$).

EI-HRMS: *m*/*z* calcd for $C_{16}H_{26}O$ (234.377): 234.1984; found: 234.1984.

UV (MeCN): λ_{max} (log ε) = 197.0 (4.6603), 217.0 (3.8749), 272.0 (3.2691), 278.5 nm (3.2383).

3-Phenylanisole (4i)

To a solution of 3-bromoanisole (11.8 g, 63.2 mmol, 1.00 equiv) and phenylboronic acid (10.0 g, 81.9 mmol, 1.30 equiv) in THF (125 mL) was added aq K_2CO_3 (2.00 M, 125 mL, 250 mmol, 3.96 equiv) and the mixture was degassed. $Pd(PPh_3)_4$ (2.18 g, 1.88 mmol, 3.00 mol%) was added and the mixture was refluxed for 6.5 h. After cooling to r.t., H_2O (300 mL) was added and the aqueous layer was extracted with Et_2O (3 × 200 mL). The combined organic layers were washed with aq 2 M NaOH (200 mL) and brine (200 mL), dried (Na_2SO_4), and the solvent was evaporated under reduced pressure. The residue was purified by column chromatography (*n*-pentane–EtOAc, 100:1); yield: 8.77 g (75%).

^1H NMR (200 MHz, $CDCl_3$): δ = 3.88 (s, 3 H, 1-OCH_3), 6.91 (ddd, *J* = 8.2, 2.6, 1.0 Hz, 1 H, 6-H), 7.14 (t, *J* = 2.1 Hz, 1 H, 2-H), 7.16–7.23 (m, 1 H, 4-H), 7.30–7.50 (m, 4 H, 3′-H, 4′-H, 5-H, 5′-H), 7.56–7.64 (m, 2 H, 2′-H, 6′-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 55.2 (1-OCH_3), 112.6, 112.8 (C-2, C-6), 119.6 (C-4), 127.2 (C-2′, C-6′), 127.4 (C-4′), 128.7 (C-3′, C-5′), 129.7 (C-5), 141.1, 142.7 (C-1′, C-3), 159.9 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 184.2 (100, $[M]^+$), 154.2 (33, $[M - CH_2O]^+$), 141.1 (48, $[M - CH_3 - CO]^+$).

3,5-Dichloranisole (4l)

Yield: quant.

^1H NMR (200 MHz, $CDCl_3$): δ = 3.79 (s, 3 H, 1-OCH_3), 6.80 (d, *J* = 1.8 Hz, 2 H, 2-H, 6-H), 6.95 (t, *J* = 1.8 Hz, 1 H, 4-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 55.7 (1-OCH_3), 113.1 (C-2, C-6), 121.0 (C-4), 135.3 (C-3, C-5), 160.6 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 176.0/178.0 (100/61, $[M]^+$), 145.9/148.0 (59/45, $[M - CH_2O]^+$), 132.9/134.9 (27/26, $[M - CH_3 - CO]^+$).

Bromides 5 by Bromination of Anisoles 4; General Procedure

To a solution of the respective anisole (15.7–78.6 mmol) in acetone (2.0–3.3 mL/mmol) were added NBS (1.00 equiv) and a catalytic amount of HCl (10.0 μL/mmol) at r.t. After stirring at r.t. for 5 min, the solvent was evaporated under reduced pressure and the residue dissolved in *n*-pentane. The insoluble components were filtered off. The anisoles **5** were obtained by evaporation of the solvent under reduced pressure.

1-Bromo-4-methoxy-2-methylbenzene (5a)

Yield: quant.

^1H NMR (200 MHz, $CDCl_3$): δ = 2.37 (s, 3 H, 2-CH_3), 3.77 (s, 3 H, 4-OCH_3), 6.61 (dd, *J* = 8.8, 3.0 Hz, 1 H, 5-H), 6.79 (d, *J* = 3.0 Hz, 1 H, 3-H), 7.40 (d, *J* = 8.8 Hz, 1 H, 6-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 23.2 (2-CH_3), 55.4 (4-OCH_3), 112.9 (C-5), 115.4 (C-1), 116.5 (C-3), 132.8 (C-6), 138.8 (C-2), 158.8 (C-4).

MS (EI, 70 eV): *m*/*z* (%) = 202.1 (98), 200.1 (100, $[M]^+$), 187.1 (19), 185.1 (19, $[M - CH_3]^+$), 159.1 (20), 157.1 (22, $[M - CH_3 - CO]^+$), 121.1 (27, $[M - Br]^+$), 91.1 (25, $[C_7H_7]^+$), 78.1 (33, $[C_6H_6]^+$).

4-Bromo-3-ethylanisole (5b)

Yield: 95% (10:1 mixture with regioisomer).

IR (film): 2968, 2835, 1594, 1572, 1470, 1263, 1240, 1163, 1138, 1047, 1014, 870, 852, 800, 600 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 1.22 (t, *J* = 7.5 Hz, 3 H, 3-CH_2CH_3), 2.71 (q, *J* = 7.5 Hz, 2 H, 3-CH_2CH_3), 3.79 (s, 3 H, 1-OCH_3), 6.62 (dd, *J* = 8.7, 3.0 Hz, 1 H, 6-H), 6.79 (d, *J* = 3.0 Hz, 1 H, 2-H), 7.41 (d, *J* = 8.7 Hz, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 14.1 (3-CH_2CH_3), 29.5 (3-CH_2CH_3), 55.4 (1-OCH_3), 112.7, 115.3 (C-2, C-6), 114.7 (C-4), 133.1 (C-5), 144.3 (C-3), 159.0 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 214.0/216.0 (99/100, $[M]^+$), 199.0/201.0 (77/67, $[M - CH_3]^+$), 135.1 (52, $[M - Br]^+$).

UV (MeCN): λ_{max} (log ε) = 199.5 (4.5995), 227.5 (3.9754), 279.5 nm (3.2232).

4-Bromo-3-isopropylanisole (5c)

Yield: 96% (9.2:1 mixture with regioisomer).

IR (film): 2936, 2835, 1593, 1572, 1471, 1414, 1364, 1341, 1289, 1231, 1199, 1177, 1099, 1043, 1016, 924, 871, 800, 602 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 1.24 [d, *J* = 6.9 Hz, 6 H, 3-$CH(CH_3)_2$], 3.33 [sept, *J* = 6.9 Hz, 1 H, 3-$CH(CH_3)_2$], 3.80 (s, 3 H, 1-OCH_3), 6.62 (dd, *J* = 8.8, 3.0 Hz, 1 H, 6-H), 6.85 (d, *J* = 3.0 Hz, 1 H, 2-H), 7.43 (d, *J* = 8.8 Hz, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 22.7 [3-$CH(CH_3)_2$], 32.9 [3-$CH(CH_3)_2$], 55.4 (1-OCH_3), 112.3 (C-2), 113.0 (C-6), 114.7 (C-4), 133.2 (C-5), 148.4 (C-3), 159.2 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 228.0 (90, $[M]^+$), 213.0 (100, $[M - CH_3]^+$), 134.1 (72, $[M - Br - CH_3]^+$), 77.0 $[C_6H_5]^+$.

UV (MeCN): λ_{max} (log ε) = 199.5 (4.6189), 227.0 (3.9743), 279.5 nm (3.2371).

4-Bromo-3-*n*-propylanisole (5e)

Yield: 89% (8.8:1 mixture with regioisomer).

IR (film): 2960, 2870, 1572, 1471, 1288, 1241, 1162, 1138, 1052, 1014, 847, 800 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 0.98 (t, *J* = 7.4 Hz, 3 H, 3-$CH_2CH_2CH_3$), 1.54–1.74 (m, 2 H, 3-$CH_2CH_2CH_3$), 2.60–2.72 (m, 2 H, 3-$CH_2CH_2CH_3$), 3.78 (s, 3 H, 1-OCH_3), 6.62 (dd, *J* = 8.7, 3.1 Hz, 1 H, 6-H), 6.77 (d, *J* = 3.1 Hz, 1 H, 2-H), 7.40 (d, *J* = 8.7 Hz, 1 H, 5-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.8 (3-$CH_2CH_2CH_3$), 23.0 (3-$CH_2CH_2CH_3$), 38.3 (3-$CH_2CH_2CH_3$), 55.3 (1-OCH_3), 112.8 (C-6), 114.9 (C-4), 116.0 (C-2), 133.1 (C-5), 142.6 (C-3), 158.8 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 228.0/230.0 (100/87, $[M]^+$), 199.0/201.0 (83/90, $[M - C_2H_5]^+$), 149.1 (7, $[M - Br]^+$), 121.1 (72, $[M - Br - C_2H_4]^+$).

UV (MeCN): λ_{max} (log ε) = 200.0 (4.6164), 227.5 (3.9658), 280.0 nm (3.2228).

4-Bromo-3-*n*-butylanisole (5f)
Yield: 94% (6.1:1 mixture with regioisomer).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.95 (t, *J* = 7.3 Hz, 3 H, 4′-CH_3), 1.29–1.48 (m, 2 H, 3′-CH_2), 1.68–1.48 (m, 2 H, 2′-CH_2), 2.68 (t, *J* = 7.7 Hz, 2 H, 1′-CH_2), 3.78 (s, 3 H, 1-OCH_3), 6.61 (dd, *J* = 8.7, 3.0 Hz, 1 H, 6-H), 6.77 (d, *J* = 3.0 Hz, 1 H, 2-H), 7.40 (d, *J* = 8.7 Hz, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 13.9 (C-1′), 22.5 (C-2′), 32.0 (C-3′), 36.1 (C-4′), 55.4 (1-OCH_3), 112.8 (C-6), 114.9 (C-4), 116.0 (C-2), 133.1 (C-5), 143.1 (C-3), 158.8 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 242.1/244.2 (38/38, $[M]^+$), 199.0/201.0 (24/25, $[M - C_3H_7]^+$).

4-Bromo-3-*n*-nonylanisole (5g)
Yield: 95% (9.8:1 mixture with regioisomer).

IR (film): 2926, 2854, 1573, 1470, 1240, 1162, 1052, 1015, 798 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.88 (t, *J* = 6.7 Hz, 3 H, 9′-CH_3), 1.16–1.46 (m, 12 H, 3′-CH_2, 4′-CH_2, 5′-CH_2, 6′-CH_2, 7′-CH_2, 8′-CH_2), 1.50–1.69 (m, 2 H, 2′-CH_2), 2.67 (t, *J* = 7.7 Hz, 2 H, 1′-CH_2), 3.78 (s, 3 H, 1-OCH_3), 6.61 (dd, *J* = 8.7, 3.0 Hz, 1 H, 6-H), 6.76 (d, *J* = 3.0 Hz, 1 H, 2-H), 7.40 (d, *J* = 8.7 Hz, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 14.1 (C-9′), 22.7 (C-8′), 29.3 (C-7′), 29.4 (C-6′), 29.5 (C-5′), 29.5 (C-4′), 29.9 (C-3′), 31.9 (C-2′), 36.4 (C-1′), 55.4 (1-OCH_3), 112.8 (C-6), 114.9 (C-4), 115.9 (C-2), 133.1 (C-5), 143.1 (C-3), 158.8 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 312.1/314.1 (27/27, $[M]^+$), 121.1 (100, $[M - Br - C_8H_{16}]^+$).

UV (MeCN): λ_{max} (log ε) = 199.5 (4.6451), 227.0 (3.9597), 279.5 nm (3.2428).

2-Bromo-5-hydroxybenzaldehyde (11)
To a solution of 3-hydroxybenzaldehyde (**10**; 18.32 g, 150 mmol) in glacial AcOH (72 mL) was added Br_2 (7.80 mL, 152 mmol, 1.01 equiv) at 10 °C. After the addition of about 1 mL of Br_2 some of the substrate precipitated and was dissolved again by slight heating. The rest of the Br_2 was added over 40 min at r.t. with occasional cooling in an ice bath. The reaction mixture was stirred for 2 h at r.t., then diluted with *n*-hexane (72 mL). The solution was poured onto H_2O (350 mL) and extracted with Et_2O (3 × 200 mL). The combined organic layers were washed with aq sat. $NaHCO_3$ (100 mL), aq $Na_2S_2O_3$ (10%, 100 mL) and brine (100 mL), and dried ($MgSO_4$). The solvent was evaporated under reduced pressure. Remaining AcOH was removed by co-evaporation with toluene. Recrystallization from a mixture of EtOH and toluene gave the product (10.70 g, 53.2 mmol, 35%) as a light brown solid.

^{1}H NMR (200 MHz, acetone-d_6): δ = 7.09 (dd, *J* = 8.7, 3.2 Hz, 1 H, 4-H), 7.33 (d, *J* = 3.2 Hz, 1 H, 6-H), 7.57 (d, *J* = 8.7 Hz, 1 H, 3-H), 9.09 (s, 1 H, 5-OH), 10.23 (s, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, acetone-d_6): δ = 116.1 (C-2), 116.3 (C-6), 124.1 (C-4), 135.1 (C-1), 135.7 (C-3), 158.2 (C-5), 191.8 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 202.0 (99, $[M]^+$), 201.0 (89, $[M - H]^+$), 200.0 (100, $[M]^+$), 199.0 (69, $[M - H]^+$), 92.1 (33, $[M - Br - CO - H]^+$), 63.1 (56, $[C_5H_3]^+$).

1-Bromo-4-methoxynaphthalene (5n)
Yield: 96% (over two steps).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.99 (s, 3 H, 4-OCH_3), 6.68 (d, *J* = 8.3 Hz, 1 H, 3-H), 7.52 (ddd, *J* = 8.3, 7.0, 1.4 Hz, 1 H, 6-H), 7.61 (ddd, *J* = 8.3, 7.0, 1.4 Hz, 1 H, 7-H), 7.65 (d, *J* = 8.3 Hz, 1 H, 2-H), 8.16 (d, *J* = 8.3 Hz, 1 H, 5-H), 8.27 (d, *J* = 8.3 Hz, 1 H, 8-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 55.7 (4-OCH_3), 104.5 (C-3), 113.2 (C-1), 122.4 (C-5), 125.9 (C-6), 126.8 (C-4a), 126.8 (C-8), 127.7 (C-7), 129.4 (C-2), 132.4 (C-8a), 155.2 (C-4).

MS (EI, 70 eV): *m*/*z* (%) = 238.0 (100), 236.0 (91, $[M]^+$), 223.0 (42), 221.0 (35, $[M - CH_3]^+$), 195.0 (72), 193.0 (75, $[M - CH_3 - CO]^+$), 126.1 (26, $[M - CH_2O - HBr]^+$), 114.1 (96, $[M - CH_3 - CO - Br]^+$), 88.0 (30, $[C_7H_4]^+$), 63.0 (33, $[C_5H_3]^+$).

EI-HRMS: *m*/*z* calcd for $C_{11}H_9BrO$ (237.09): 235.9837; found: 235.9837.

Aldehydes 6 from Brominated Anisoles 5; General Procedure
To a solution of **5** (4.22–61.7 mmol) in THF (4.7–7.4 mL/mmol) was added *t*-BuLi (1.50–1.70 M in pentane, 1.09 equiv) at –78 °C and the resulting mixture stirred for 30 min at –78 °C. DMF (5.00 equiv) was then added, and after stirring for 15 min at –78 °C, the mixture was warmed up to r.t. Upon completion of the reaction, the mixture was diluted with H_2O (10 mL/mmol) and extracted with Et_2O (3 × 5 mL/mmol). The combined organic extracts were washed with brine (5 mL/mmol), dried (Na_2SO_4) and the solvent was evaporated under reduced pressure. The aldehydes **6** (pure or as mixtures with their corresponding regioisomer **9**) were isolated by column chromatography.

4-Methoxy-2-methylbenzaldehyde (6a)
Yield: 75% (over two steps).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.65 (s, 3 H, 2-CH_3), 3.87 (s, 3 H, 4-OCH_3), 6.75 (d, *J* = 2.4 Hz, 1 H, 3-H), 6.85 (dd, *J* = 8.6, 2.4 Hz, 1 H, 5-H), 7.76 (d, *J* = 8.6 Hz, 1 H, 6-H), 10.12 (s, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 19.9 (2-CH_3), 55.4 (4-OCH_3), 111.5 (C-5), 117.0 (C-3), 127.9 (C-1), 134.7 (C-6), 143.3 (C-2), 163.6 (C-4), 191.2 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 150.2 (71, $[M]^+$), 149.2 (100, $[M - H]^+$), 121.1 (13, $[M - CO - H]^+$), 91.1 (7, $[C_7H_7]^+$).

2-Ethyl-4-methoxybenzaldehyde (6b)
Yield: 82% (over two steps).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.27 (t, *J* = 7.5 Hz, 3 H, 2-CH_2CH_3), 3.05 (q, *J* = 7.5 Hz, 2 H, 2-CH_2CH_3), 3.88 (s, 3 H, 4-OCH_3), 6.77 (d, *J* = 2.6 Hz, 1 H, 3-H), 6.84 (dd, *J* = 8.5, 2.6 Hz, 1 H, 5-H), 7.79 (d, *J* = 8.5 Hz, 1 H, 6-H), 10.13 (s, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 15.9 (2-CH_2CH_3), 25.8 (2-CH_2CH_3), 55.3 (4-OCH_3), 111.3, 115.3 (C-3, C-5), 127.0 (C-1), 134.6 (C-6), 149.6 (C-2), 163.8 (C-4), 190.7 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 164.0 (86, $[M]^+$), 163.0 (100, $[M - H]^+$), 147.0 (34, $[M - H - CH_3]^+$).

2-Isopropyl-4-methoxybenzaldehyde (6c)
Yield: 60% (over two steps).

IR (film): 2966, 1686, 1602, 1565, 1493, 1462, 1290, 1241, 1202, 1175, 1114, 1070, 1030, 930, 867, 809 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.28 [d, *J* = 6.9 Hz, 6 H, 2-$CH(CH_3)_2$], 3.88 (s, 3 H, 4-OCH_3), 3.99 [sept, *J* = 6.9 Hz, 1 H, 2-$CH(CH_3)_2$], 6.83 (dd, *J* = 8.6, 2.5 Hz, 1 H, 5-H), 6.92 (d, *J* = 2.5 Hz, 1 H, 3-H), 7.80 (d, *J* = 8.6 Hz, 1 H, 6-H), 10.18 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 23.7 [2-$CH(CH_3)_2$], 27.7 [2-$CH(CH_3)_2$], 55.4 (4-OCH_3), 110.7 (C-3), 112.1 (C-5), 126.7 (C-1), 134.8 (C-6), 154.1 (C-2), 164.1 (C-4), 190.8 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 178.1 (100, $[M]^+$), 163.1 (32, $[M - CH_3]^+$), 91.0 $[C_7H_7]^+$, 77.0 $[C_6H_5]^+$.

UV (MeCN): λ_{max} (log ε) = 201.0 (4.1899), 222.5 (4.1299), 274.0 nm (4.1041).

2-*tert*-Butyl-4-methoxybenzaldehyde (6d)
Yield: 65% (over two steps).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 1.50 [s, 9 H, 2-C(CH_3)$_3$], 3.87 (s, 3 H, 4-OCH_3), 6.82 (dd, *J* = 8.7, 2.5 Hz, 5-H), 6.97 (d, *J* = 2.5 Hz, 1 H, 3-H), 8.00 (d, *J* = 8.7 Hz, 1 H, 6-H), 10.66 (s, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 32.5 [2-C(*C*H_3)$_3$], 35.5 [2-*C*(CH_3)$_3$], 55.2 (4-OCH_3), 110.0 (C-3), 113.6 (C-5), 128.6 (C-1), 133.8 (C-6), 155.0 (C-2), 161.9 (C-4), 191.3 (1-CHO).

2-*n*-Propyl-4-methoxybenzaldehyde (6e)
Yield: 78% (over two steps).

IR (film): 2961, 2871, 2726, 1688, 1600, 1496, 1463, 1258, 1128, 1029, 944, 852, 812 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.99 (t, *J* = 7.4 Hz, 3 H, 2-$CH_2CH_2CH_3$), 1.55–1.75 (m, 2 H, 2-$CH_2CH_2CH_3$), 2.92–3.03 (m, 2 H, 2-$CH_2CH_2CH_3$), 3.87 (s, 3 H, 4-OCH_3), 6.75 (d, *J* = 2.5 Hz, 1 H, 3-H), 6.84 (dd, *J* = 8.6, 2.5 Hz, 1 H, 5-H), 7.80 (d, *J* = 8.6 Hz, 1 H, 6-H), 10.13 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.9 (2-$CH_2CH_2CH_3$), 25.2 (2-$CH_2CH_2CH_3$), 34.6 (2-$CH_2CH_2CH_3$), 55.4 (4-OCH_3), 111.5, 116.1 (C-3, C-5), 127.4 (C-1), 134.2 (C-6), 148.1 (C-2), 163.7 (C-4), 190.7 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 178.1 (38, $[M]^+$), 163.1 (19, $[M - CH_3]^+$), 43.0 (100, $[C_3H_7]^+$).

UV (MeCN): λ_{max} (log ε) = 202.0 (4.1948), 223.5 (4.1526), 275.0 nm (4.1740).

2-*n*-Butyl-4-methoxybenzaldehyde (6f)
Yield: 79% (over two steps).

IR (film): 2958, 1686, 1601, 1496, 1463, 1253, 1207, 1128, 1031, 813 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.94 (t, *J* = 7.2 Hz, 3 H, 4′-CH_3), 1.30–1.50 (m, 2 H, 3′-CH_2), 1.50–1.69 (m, 2 H, 2′-CH_2), 3.00 (t, *J* = 7.7 Hz, 2 H, 1′-CH_2), 3.87 (s, 3 H, 4-OCH_3), 6.74 (d, *J* = 2.5 Hz, 1 H, 3-H), 6.84 (dd, *J* = 8.6, 2.5 Hz, 1 H, 5-H), 7.80 (d, *J* = 8.6 Hz, 1 H, 6-H), 10.13 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.9 (C-4′), 22.6 (C-3′), 32.4 (C-2′), 34.2 (C-1′), 55.4 (4-OCH_3), 111.5 (C-5), 116.0 (C-3), 127.3 (C-1), 134.1 (C-6), 148.4 (C-2), 163.7 (C-4), 190.7 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 192.1 (79, $[M]^+$), 163.1 (100, $[M - C_2H_5]^+$).

MS UV (MeCN): λ_{max} (log ε) = 201.0 (4.3432), 203.5 (4.3457), 223.5 (4.1348), 274.5 nm (4.1141).

4-Methoxy-2-*n*-nonylbenzaldehyde (6g)
Yield: 72% (over two steps).

IR (film): 2926, 2854, 1688, 1601, 1568, 1496, 1464, 1249, 1206, 1163, 1128, 1032, 875, 811, 722 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 0.88 (t, *J* = 6.6 Hz, 3 H, 9′-CH_3), 1.18–1.46 (m, 12 H, 3′-CH_2, 4′-CH_2, 5′-CH_2, 6′-CH_2, 7′-CH_2, 8′-CH_2), 1.51–1.71 (m, 2 H, 2′-CH_2), 2.99 (t, *J* = 7.7 Hz, 2 H, 1′-CH_2), 3.87 (s, 3 H, 4-OCH_3), 6.74 (d, *J* = 2.4 Hz, 1 H, 3-H), 6.84 (dd, *J* = 8.6, 2.4 Hz, 1 H, 5-H), 7.80 (d, *J* = 8.6 Hz, 1 H, 6-H), 10.13 (s, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 14.1 (C-9′), 22.6 (C-8′), 29.3 (C-7′), 29.5 (C-6′), 29.5 (C-5′), 29.5 (C-4′), 31.8 (C-3′), 32.2 (C-2′), 32.7 (C-1′), 55.4 (4-OCH_3), 111.5 (C-5), 116.0 (C-3), 127.3 (C-1), 134.1 (C-6), 148.5 (C-2), 163.7 (C-4), 190.6 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 262.2 (95, $[M]^+$), 163.1 (100, $[M - C_7H_{15}]^+$).

EI-HRMS: *m*/*z* calcd for $C_{17}H_{26}O_2$ (262.387): 262.1933; found: 262.1933.

UV (MeCN): λ_{max} (log ε) = 200.0 (4.2447), 223.5 (4.1786), 274.5 nm (4.1594).

4-Methoxy-2,6-dimethylbenzaldehyde (6h)
Yield: 63% (over two steps).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.61 (s, 6 H, 2-CH_3, 6-CH_3), 3.84 (s, 3 H, 4-OCH_3), 6.59 (s, 2 H, 3-H, 5-H), 10.47 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 21.1 (2-CH_3, 6-CH_3), 55.2 (4-OCH_3), 114.8 (C-3, C-5), 125.9 (C-1), 144.4 (C-2, C-6), 162.7 (C-4), 191.6 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 164.1 (32, $[M]^+$), 163.1 (100, $[M - H]^+$), 91.1 (23, $[C_7H_7]^+$), 71.1 (36, $[C_4H_7O]^+$), 57.0 (58, $[C_3H_5O]^+$).

4-Methoxy-2-phenylbenzaldehyde (6i)
Yield: 63% (over two steps).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.90 (s, 4-OCH_3), 6.88 (d, *J* = 2.5 Hz, 1 H, 3-H), 7.00 (ddd, *J* = 8.7, 2.5, 0.9 Hz, 1 H, 5-H), 7.33–7.51 (m, 5 H, 2′-H, 3′-H, 4′-H, 5′-H), 8.03 (d, *J* = 8.7 Hz, 1 H, 6-H), 9.84 (d, *J* = 0.9 Hz, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 55.6 (4-OCH_3), 113.9 (C-5), 115.1 (C-3), 127.3 (C-1), 128.1 (C-4′), 128.3 (C-2′, C-6′), 129.9 (C-3, C-3′, C-5′), 137.7 (C-1′), 148.5 (C-2), 163.5 (C-4), 191.0 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 211.1 (100, $[M - H]^+$).

2-Trifluoromethyl-4-methoxybenzaldehyde (6j)
After halogen–lithium exchange, the reaction was quenched with *N*-formylpiperidine instead of DMF; yield: 28% (over two steps).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.93 (s, 3 H, 4-OCH_3), 7.14 (dd, *J* = 8.8, 2.6 Hz, 1 H, 5-H), 7.25 (d, *J* = 2.6 Hz, 1 H, 3-H), 8.13 (d, *J* = 8.8 Hz, 1 H, 6-H), 10.26 (q, *J* = 2.1 Hz, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 55.9 (4-OCH_3), 112.3 (q, *J* = 6.0 Hz, C-3), 116.5 (C-5), 123.4 (q, *J* = 274 Hz, 2-CF_3), 126.6 (C-1), 131.7 (C-6), 133.0 (q, *J* = 33 Hz, C-2), 163.6 (C-4), 187.7 (q, *J* = 3.0 Hz, 1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 203.0 (100, $[M - H]^+$), 189.1 (19, $[M - CH_3]^+$).

2-Fluoro-4-methoxybenzaldehyde (6k)
Yield: the yield was calculated after the Corey–Fuchs reaction (cf. **7k**).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 3.89 (s, 3 H, 4-OCH_3), 6.64 (dd, *J* = 2.3 Hz, J_{H-F} = 12.4 Hz, 1 H, 3-H), 6.79 (dd, *J* = 8.7, 2.3 Hz, 1 H, 5-H), 7.82 (t, *J* = J_{H-F} = 8.7 Hz, 1 H, 6-H), 10.21 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 55.9 (4-OCH_3), 101.4 (d, *J* = 24.2 Hz, C-3), 111.2 (d, *J* = 2.7 Hz, C-5), 117.8 (d, *J* = 8.3 Hz, C-1), 130.1 (d, *J* = 3.8 Hz, C-6), 166.1 (d, *J* = 11.9 Hz, C-4), 166.2 (d, *J* = 258 Hz, C-2), 186.1 (d, *J* = 16.0 Hz, 1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 154.1 (68, $[M]^+$), 153.1 (100, $[M - H]^+$), 110.0 (11, $[M - CH_3 - CO - H]^+$).

2,6-Dichloro-4-methoxybenzaldehyde (6l)
To a solution of the anisole **4l** (17.2 g, 97.4 mmol, 1.00 equiv) in concd HCl (260 mL) and concd H_2SO_4 (2.6 mL) was added paraformaldehyde (5.23 g, 174 mmol, 1.79 equiv) and the resulting mixture was stirred for 7 h at 70 °C. After cooling, the mixture was

extracted with CH_2Cl_2 (3 × 150 mL). The combined organic layers were washed with H_2O (200 mL), dried (Na_2SO_4) and the solvent was evaporated under reduced pressure. The crude product was dissolved in a mixture of dioxane (90 mL) and aq 1 N NaOH (180 mL) and refluxed for 7 h. The aqueous phase was extracted with Et_2O (2 × 100 mL), the combined organic layers were dried (Na_2SO_4) and the solvent was evaporated under reduced pressure. Column chromatography (*n*-pentane–Et_2O, 50:50) gave the benzyl alcohol, 3,5-dichloro-4-hydroxymethyl-1-methoxybenzene (7.90 g, 38.2 mmol) and its regioisomer (3.74 g, 18.1 mmol). The benzyl alcohol (7.30 g, 38.2 mmol, 1.00 equiv) was dissolved in toluene (150 mL), then MnO_2 (17.4 g, 200 mmol, 5.24 equiv) was added. The resulting suspension was heated for 6.5 h in a Dean–Stark apparatus. The mixture was filtered over Celite and washed with EtOAc (3 × 100 mL). The solvent was evaporated; yield: 17.2 g (86%, over two steps).

^{1}H NMR (200 MHz, $CDCl_3$): δ = 3.88 (s, 3 H, 4-OCH_3), 6.91 (s, 2 H, 3-H, 5-H), 10.42 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 56.1 (4-OCH_3), 115.7 (C-3, C-5), 122.8 (C-1), 139.0 (C-2, C-6), 162.7 (C-4), 187.6 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 203.0/204.9 (100/69, $[M]^+$).

4-Triisopropylsilyloxy-2-triisopropylsilyloxymethylbenzaldehyde (6m)

To a solution of **11** (4.02 g, 20.0 mmol) in EtOH (100 mL) was added $NaBH_4$ (3.79 g, 100 mmol, 5.00 equiv) in three portions at r.t. within 22 min. The mixture was stirred for 2 h at r.t., diluted with aq sat. NH_4Cl (50 mL) and H_2O (100 mL), and extracted with EtOAc (3 × 150 mL). The combined organic layers were washed with aq 1 M HCl (2 × 50 mL) and brine (50 mL), dried ($MgSO_4$), and the solvent was evaporated under reduced pressure. To a solution of the crude product in DMF (100 mL) were added imidazole (5.45 g, 80.1 mmol, 4.00 equiv) and TIPSCl (9.40 mL, 8.46 g, 43.9 mmol, 2.19 equiv). After 39 h at r.t., the reaction mixture was poured into H_2O (350 mL) and extracted with Et_2O (4 × 150 mL). The combined organic layers were washed with brine (3 × 50 mL), dried ($MgSO_4$), and the solvent was evaporated under reduced pressure. To a solution of the crude product in THF (75 mL) was added a solution of *t*-BuLi (1.5 M in pentane, 20 mL, 30 mmol, 1.5 equiv) at –78 °C within 17 min. The reaction mixture was stirred for 30 min at –78 °C. DMF (7.80 mL, 7.36 g, 101 mmol, 5.0 equiv) was added at –78 °C within 4 min. After stirring for 5 min at –78 °C and 3 h at r.t., the mixture was poured into H_2O (250 mL) and extracted with Et_2O (4 × 100 mL). The combined organic layers were washed with brine (3 × 50 mL), dried ($MgSO_4$), and the solvent was evaporated under reduced pressure. The crude product was purified by column chromatography (*n*-pentane–EtOAc, 50:1 → *n*-pentane–EtOAc, 30:1); yield: 3.95 g (43%, over three steps).

IR (film): 2945, 2867, 2726, 1691, 1601, 1564, 1495, 1464, 1390, 1369, 1296, 1230, 1204, 1166, 1121, 1066, 986, 919, 883, 825, 781, 684 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.11 [d, *J* = 7.2 Hz, 36 H, 6 × SiCH(C*H*$_3$)$_2$], 1.15–1.39 [m, 6 H, 6 × SiC*H*(CH$_3$)$_2$], 5.22 (s, 2 H, 1′-CH_2), 6.88 (dd, *J* = 8.3, 2.3 Hz, 1 H, 5-H), 7.42 (d, *J* = 2.3 Hz, 1 H, 3-H), 7.68 (d, *J* = 8.3 Hz, 1 H, 6-H), 9.96 (s, 1 H, 1-CHO).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 12.0 [4-OSi[CH(*C*H$_3$)$_2$]$_3$], 12.7 (1′-OSi[CH(*C*H$_3$)$_2$]$_3$), 17.8, 18.0 [4-OSi[*C*H(CH$_3$)$_2$]$_2$), 1′-OSi[*C*H(CH$_3$)$_2$]$_3$], 63.0 (C-1′), 117.5, 117.9 (C-3, C-5), 126.1 (C-1), 136.8 (C-6), 147.4 (C-2), 161.6 (C-4), 191.8 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 464.5 (0.06, $[M]^+$), 421.4 (100, $[M - C_3H_7]^+$).

EI-HRMS: *m*/*z* calcd for $C_{26}H_{48}O_3Si_2$ (464.83): 464.3142; found: 464.3142.

UV (MeCN): λ_{max} (log ε) = 201.0 (4.221), 221.5 (4.161), 274.0 nm (4.208).

4-Methoxynaphthalene-1-carbaldehyde (6n)

Yield: 81% (over two steps).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 4.09 (s, 3 H, 4-OCH_3), 6.91 (d, *J* = 8.2 Hz, 1 H, 3-H), 7.57 (ddd, *J* = 8.5, 7.1, 1.2 Hz, 1 H, 6-H), 7.69 (ddd, *J* = 8.5, 7.1, 1.5 Hz, 1 H, 7-H), 7.91 (d, *J* = 8.2 Hz, 1 H, 2-H), 8.32 (d, *J* = 8.5 Hz, 1 H, 5-H), 9.30 (d, *J* = 8.5 Hz, 1 H, 8-H), 10.19 (s, 1 H, 1-CHO).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 55.9 (4-OCH_3), 102.9 (C-3), 122.3 (C-5), 124.8 (C-8), 124.9 (C-1), 125.4 (C-4a), 126.4 (C-6), 129.5 (C-7), 131.8 (C-8a), 139.7 (C-2), 160.8 (C-4), 192.3 (1-CHO).

MS (EI, 70 eV): *m*/*z* (%) = 186.1 (62, $[M]^+$), 185.1 (59, $[M - H]^+$), 115.1 (100, $[M - CH_3 - 2\ CO]^+$), 89.0 (15, $[C_7H_5]^+$), 63.0 (22, $[C_5H_3]^+$).

EI-HRMS: *m*/*z* calcd for $C_{12}H_{10}O_2$ (186.21): 186.0681; found: 186.0681.

Dibromovinyl Compounds 7 from Aldehydes 6 Using the Corey–Fuchs Method with Subsequent Cleavage of the Methyl Ether Moiety and THP-Protection of the Resulting Phenols; General Procedure

Step 1: To a solution of CBr_4 (2.01 equiv) in CH_2Cl_2 (5.3–6.7 mL/mmol) was added Zn powder (2.02 equiv) and the mixture stirred for 5 min at r.t. A solution of Ph_3P (2.00 equiv) in CH_2Cl_2 (1.0–1.5 mL/mmol) was slowly added and the mixture was stirred for another 30 min. Then, a solution of the aldehyde **6** (5.05–63.8 mmol) in CH_2Cl_2 (1.0–1.5 mL/mmol) was slowly added and the mixture stirred at r.t. for 17 h. For the termination of the reaction, the mixture was diluted with *n*-pentane (10 mL/mmol) and stirred vigorously for 5 min. The solution was then decanted from a brown oil, which was extracted two more times with pentane (10 mL/mmol). The combined solutions were evaporated under reduced pressure and the residue purified by column chromatography.

Steps 2 and 3: To a solution of the above methyl ether in CH_2Cl_2 (10 mL/mmol) was added a solution of BBr_3 (1.00 M in CH_2Cl_2, 1.50–3.00 equiv) dropwise at –78 °C and the resulting mixture stirred for 30 min at –78 °C and then at r.t. for about 6 h (TLC). After completion of the reaction, the mixture was diluted with H_2O (15 mL/mmol) and the aqueous layer extracted with CH_2Cl_2 (5.0 mL/mmol) and Et_2O (2 × 10 mL/mmol). The combined organic layers were washed with aq 2 M HCl (5.0 mL/mmol) and aq sat. $NaHCO_3$ (5.0 mL/mmol), dried (Na_2SO_4), and the solvent evaporated under reduced pressure. To a solution of the crude product in CH_2Cl_2 (4.0–5.0 mL/mmol) were added DHP (5.05 equiv) and PPTS (25.1 mol%) and the mixture was stirred at r.t. for about 17 h (TLC). The solvent was evaporated at reduced pressure and the residue purified by column chromatography.

2-[4-(2,2-Dibromovinyl)-3-methylphenoxy]tetrahydropyran (7a)

Yield: 79% (over three steps).

IR (film): 2943, 2874, 1604, 1569, 1494, 1453, 1388, 1356, 1288, 1250, 1200, 1182, 1168, 1122, 1098, 1077, 1038, 1021, 972, 907, 870, 819, 759, 747, 714 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.53–2.09 (m, 6 H, 3-CH_2, 4-CH_2, 5-CH_2), 2.24 (s, 3 H, 3′-CH_3), 3.61 (dtd, *J* = 11.4, 4.0, 1.4 Hz, 1 H, 6-H_a), 3.90 (ddd, *J* = 11.4, 9.2, 2.8 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.86–6.92 (m, 2 H, 2′-H, 6′-H), 7.36–7.42 (m, 2 H, 5′-H, 1″-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.7 (C-4), 20.1 (3′-CH_3), 25.2 (C-5), 30.3 (C-3), 62.0 (C-6), 90.4 (C-2″), 96.1 (C-2), 113.4 (C-6′), 117.7 (C-2′), 128.4 (C-4′), 129.6 (C-5′), 136.2 (C-1″), 137.7 (C-3′), 157.0 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 376.1 (4, $[M]^+$), 292.0 (100, $[M - C_5H_8O]^+$), 132.1 (66, $[M - C_5H_8O - 2\ Br]^+$) 85.1 (62, $[C_5H_9O]^+$).

UV (MeCN): λ_{max} (log ε) = 264.5 nm (4.073).

2-[4-(2,2-Dibromovinyl)-3-ethylphenoxy]tetrahydro-2*H*-pyran (7b)

Yield: 43% (over three steps).

IR (film): 3345, 2943, 1606, 1571, 1490, 1454, 1356, 1250, 1200, 1123, 1037, 965, 902, 869, 814, 757 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.19 (t, *J* = 7.5 Hz, 3 H, 3′-CH_2CH_3), 1.53–1.76 (m, 3 H, 4-H_a, 5-CH_2), 1.80–2.10 (m, 3 H, 3-CH_2, 4-H_b), 2.56 (q, *J* = 7.5 Hz, 2 H, 3′-CH_2CH_3), 3.57–3.67 (m, 1 H, 6-H_a), 3.91 (ddd, *J* = 11.6, 9.4, 3.1 Hz, 1 H, 6-H_b), 5.44 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.87–6.94 (m, 2 H, 2′-H, 6′-H), 7.33–7.39 (m, 1 H, 5′-H), 7.44 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 14.7 (3′-CH_2CH_3), 18.7 (C-4), 25.2 (C-5), 26.7 (3′-CH_2CH_3), 30.3 (C-3), 62.1 (C-6), 90.7 (4′-CH=CBr_2), 96.2 (C-2), 113.2, 116.2 (C-2′, C-6′), 127.9 (C-4′), 130.0 (C-5′), 136.1 (4′-CH=CBr_2), 143.7 (C-3′), 157.3 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 388.0/390.0/392.0 (1/2/1, $[M]^+$), 303.9/305.9/307.9 (40/85/42, $[M - C_5H_8O]^+$), 146.1 (100, $[M - 2\ Br - C_5H_8O]^+$), 85.0 (59, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{15}H_{18}Br_2O_2$ (390.110): 410.95658 $[M + Na]^+$; found: 410.95666 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 192.5 (4.4338), 263.0 nm (4.0441).

2-[4-(2,2-Dibromovinyl)-3-isopropylphenoxy]tetrahydro-2*H*-pyran (7c)

Yield: 69% (over three steps).

IR (KBr): 2954, 2869, 1606, 1567, 1486, 1360, 1287, 1241, 1198, 1179, 1117, 1071, 1038, 1022, 976, 909, 872, 819, 762, 734, 587, 505 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.21 [d, *J* = 6.8 Hz, 6 H, 3′-$CH(CH_3)_2$], 1.54–1.76 (m, 3 H, 4-H_a, 5-CH_2), 1.81–2.11 (m, 3 H, 3-CH_2, 4-H_b), 2.96 [sept, *J* = 6.8 Hz, 1 H, 3′-$CH(CH_3)_2$], 3.58–3.67 (m, 1 H, 6-H_a), 3.93 (ddd, *J* = 11.3, 9.3, 3.2 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.3 Hz, 1 H, 2-H), 6.91 (dd, *J* = 8.5, 2.6 Hz, 1 H, 5′-H), 6.95 (d, *J* = 2.6 Hz, 1 H, 3′-H), 7.27 (d, *J* = 8.5 Hz, 1 H, 6′-H), 7.48 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 18.8 (C-4), 23.2, 23.2 [3′-$CH(CH_3)_2$], 25.2 (C-5), 30.4 (C-3), 30.5 [3′-$CH(CH_3)_2$], 62.1 (C-6), 91.3 (4′-CH=CBr_2), 96.3 (C-2), 112.9 (C-2′), 113.5 (C-6′), 127.7 (C-4′), 130.2 (C-5′), 136.6 (4′-CH=CBr_2), 148.2 (C-3′), 157.5 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 402.2/404.2/406.2 (1/2/1, $[M]^+$), 318.1/320.1/322.1 (36/72/36, $[M - C_5H_8O]^+$), 160.1 (100, $[M - C_5H_8O - 2\ Br]^+$), 85.1 (48, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{16}H_{20}Br_2O_2$ (404.137): 401.9830; found: 401.9830.

UV (MeCN): λ_{max} (log ε) = 203.0 (4.4301), 259.0 nm (4.0450).

2-[4-(2,2-Dibromovinyl)-3-*tert*-butylphenoxy]tetrahydro-2*H*-pyran (7d)

Yield: 26% (over three steps).

^1H NMR (300 MHz, $CDCl_3$): δ = 1.35 [s, 9 H, 3′-$C(CH_3)_3$], 1.54–1.76 (m, 3 H, 4-H_a, 5-CH_2), 1.81– 1.90 (m, 2 H, 3-CH_2), 1.90–2.11 (m, 1 H, 4-H_b), 3.58–3.66 (m, 1 H, 6-H_a), 3.93 (ddd, *J* = 11.4, 9.2, 3.3 Hz, 1 H, 6-H_b), 5.42 (t, *J* = 3.3 Hz, 1 H, 2-H), 6.91 (dd, *J* = 8.5, 2.5 Hz, 1 H, 6′-H), 7.08 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.12 (d, *J* = 8.5 Hz, 1 H, 5′-H), 7.72 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.9 (C-4), 25.2 (C-5), 30.4 (C-3), 30.6 [3′-$C(CH_3)_3$], 35.7 [3′-$C(CH_3)_3$], 62.2 (C-6), 91.5 (4′-CH=CBr_2), 96.3 (C-2), 112.5 (C-6′), 115.1 (C-2′), 128.6 (C-4′), 132.4 (C-5′), 140.2 (4′-CH=CBr_2), 149.6 (C-3′), 157.0 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 416.0/418.0/420.0 (1/2/1, $[M]^+$), 332.0/334.0/336.0 (50/100/48, $[M - C_5H_8O]^+$), 238.0/240.0 (10/10, $[M - Br - C_5H_8O - CH_3]^+$), 159.1 (26, $[M - 2\ Br - C_5H_8O - CH_3]^+$), 85.0 (40, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{17}H_{22}Br_2O_2$ (418.163): 415.9987; found: 415.9985.

2-[4-(2,2-Dibromovinyl)-3-*n*-propylphenoxy]tetrahydro-2*H*-pyran (7e)

Yield: 62% (over three steps).

IR (film): 2955, 2871, 1605, 1568, 1489, 1356, 1247, 1200, 1123, 1078, 1038, 981, 909, 869, 759 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.96 (t, *J* = 7.4 Hz, 3 H, 3′-$CH_2CH_2CH_3$), 1.52–1.77 (m, 5 H, 4-Ha, 5-CH_2, 3′-$CH_2CH_2CH_3$), 1.81–1.89 (m, 2 H, 3-CH_2), 1.89–2.10 (m, 1 H, 4-H_b), 2.50 (dd, *J* = 7.4, 6.3 Hz, 2 H, 3′-$CH_2CH_2CH_3$), 3.62 (dt, *J* = 11.4, 1.6 Hz, 1 H, 6-H_a), 3.91 (ddd, *J* = 11.4, 9.5, 3.2 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.88 (d, *J* = 2.6 Hz, 1 H, 2′-H), 6.91 (dd, *J* = 8.3, 2.6 Hz, 1 H, 6′-H), 7.36 (d, *J* = 8.3 Hz, 1 H, 5′-H), 7.45 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.9 (3′-$CH_2CH_2CH_3$), 18.7 (C-4), 23.7 (3′-$CH_2CH_2CH_3$), 25.2 (C-5), 30.3 (C-3), 35.7 (3′-$CH_2CH_2CH_3$), 62.0 (C-6), 90.7 (4′-CH=CBr_2), 96.1 (C-2), 113.3 (C-6′), 117.0 (C-2′), 128.1 (C-4′), 130.0 (C-5′), 136.3 (4′-CH=CBr_2), 142.3 (C-3′), 157.1 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 402.0/404.0/406.0 (1/1/1, $[M]^+$), 317.9/319.9/321.9 (47/99/45, $[M - C_5H_8O]^+$), 239.0/241.0 (7/10, $[M - Br - C_5H_8O]^+$), 160.1 (86, $[M - 2\ Br - C_5H_8O]^+$), 85.0 (100, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd $C_{16}H_{20}Br_2O_2$ (404.137): 402.99028 $[M + H]^+$, 424.97223 $[M + Na]^+$; found: 402.99050 $[M + H]^+$, 442.97245 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 197.0 (4.4095), 201.0 (4.4121), 262.0 nm (4.0495).

2-[4-(2,2-Dibromovinyl)-3-*n*-butylphenoxy]tetrahydro-2*H*-pyran (7f)

Yield: 67% (over three steps).

IR (film): 2952, 2871, 1605, 1568, 1489, 1356, 1245, 1201, 1123, 1078, 1038, 980, 909, 871, 758 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.94 (t, *J* = 7.3 Hz, 3 H, 4″-CH_3), 1.37 (sext, *J* = 7.3 Hz, 2 H, 3″-CH_2), 1.47–1.77 (m, 5 H, 2″-CH_2, 4-H_b, 5-CH_2), 1.81–1.90 (m, 2 H, 3-CH_2), 1.90–2.10 (m, 1 H, 4-H_b), 2.52 (t, *J* = 7.7 Hz, 2 H, 1″-CH_2), 3.62 (dt, *J* = 11.4, 1.4 Hz, 1 H, 6-H_a), 3.91 (ddd, *J* = 11.4, 9.5, 3.1 Hz, 1 H, 6-H_b), 5.44 (t, *J* = 3.1 Hz, 1 H, 2-H), 6.87–6.93 (m, 2 H, 2′-H, 6′-H), 7.35 (d, *J* = 8.1 Hz, 1 H, 5′-H), 7.45 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.9 (C-4″), 18.7 (C-4), 22.4 (C-3″), 25.2 (C-5), 30.3 (C-3), 32.7 (C-2″), 33.3 (C-1″), 62.0 (C-6), 90.7 (4′-CH=CBr_2), 96.1 (C-2), 113.3 (C-6′), 116.9 (C-2′), 128.1 (C-4′), 130.0 (4′-CH=CBr_2), 136.3 (C-5′), 142.5 (C-3′), 157.1 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 416.0/418.0/420.0 (1/2/1, $[M]^+$), 332.0/334.0/336.0 (46/100/46, $[M - C_5H_8O]^+$), 174.1 (37, $[M - 2\ Br - C_5H_8O]^+$), 85.0 (94, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{17}H_{22}Br_2O_2$ (418.163): 417.00593 $[M + H]^+$, 438.98788 $[M + Na]^+$; found: 417.00589 $[M + H]^+$, 438.98781 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 194.5 (4.4434), 262.0 nm (4.0540).

2-[4-(2,2-Dibromovinyl)-3-*n*-nonylphenoxy]tetrahydro-2*H*-pyran (7g)
Yield: 65% (over three steps).

IR (film): 2926, 2853, 1605, 1568, 1489, 1466, 1356, 1247, 1200, 1123, 1038, 982, 908, 871, 759 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.89 (t, *J* = 6.9 Hz, 3 H, 9″-CH_3), 1.20–1.40 (m, 12 H, 3″-CH_2, 4″-CH_2, 5″-CH_2, 6″-CH_2, 7″-CH_2, 8″-CH_2), 1.47–1.77 (m, 5 H, 2″-CH_2, 4-H_a, 5-CH_2), 1.81–1.90 (m, 2 H, 3-CH_2), 1.90–2.10 (m, 1 H, 4-H_b), 2.51 (t, *J* = 7.8 Hz, 2 H, 1″-CH_2), 3.62 (dt, *J* = 11.4 Hz, 1.4 Hz, 1 H, 6-H_a), 3.91 (ddd, *J* = 11.4, 9.5, 3.0 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.88 (d, *J* = 2.6 Hz, 1 H, 2′-H), 6.90 (dd, *J* = 8.3, 2.6 Hz, 1 H, 6′-H), 7.35 (d, *J* = 8.3 Hz, 1 H, 5′-H), 7.44 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 14.1 (C-9″), 18.7 (C-4), 22.7 (C-8″), 25.2 (C-5), 29.3 (C-7″), 29.3 (C-6″), 29.4 (C-5″), 29.5 (C-4″), 30.3, 30.5 (C-3, C-3″), 31.9 (C-2″), 33.6 (C-1″), 62.0 (C-6), 90.7 (4′-CH=*C*Br_2), 96.1 (C-2), 113.3 (C-6′), 116.9 (C-2′), 128.1 (C-4′), 130.0 (C-5′), 136.3 (4′-*C*H=CBr_2), 142.6 (C-3′), 157.1 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 486.1/488.1/490.1 (1/2/1, $[M]^+$), 402.1/404.1/406.1 (48/100/46, $[M - C_5H_8O]^+$), 244.2 (7, $[M - 2\ Br - C_5H_8O]^+$), 85.0 (64, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{22}H_{32}Br_2O_2$ (488.296): 487.08418 $[M + H]^+$, 509.06613 $[M + Na]^+$; found 487.08410 $[M + H]^+$, 509.06593 $[M + Na]^+$.

2-[4-(2,2-Dibromovinyl)-3,5-dimethylphenoxy]tetrahydropyran (7h)
Yield: 59% (over three steps).

IR (KBr): 2970, 2948, 2882, 1603, 1479, 1443, 1385, 1354, 1312, 1258, 1198, 1183, 1146, 1124, 1103, 1025, 977, 949, 907, 887, 866, 826, 816, 758, 714, 644, 614, 436 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.53–2.08 (m, 6 H, 3-CH_2, 4-CH_2, 5-CH_2), 2.21 (s, 6 H, 3′-CH_2, 5′-CH_2), 3.61 (dtd, *J* = 11.6, 3.9, 1.6 Hz, 1 H, 6-H_a), 3.91 (ddd, *J* = 11.6, 9.4, 3.0 Hz, 1 H, 6-H_b), 5.41 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.75 (s, 2 H, 2′-H, 6′-H), 7.33 (s, 1 H, 1″-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.7 (C-4), 20.3 (3′-CH_3, 5′-CH_3), 25.2 (C-5), 30.4 (C-3), 62.0 (C-6), 93.0 (C-2″), 96.1 (C-2), 115.1 (C-2′, C-6′), 129.2 (C-4′), 137.2 (C-3′, C-5′), 137.3 (C-1″), 156.6 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 390.1 (1, $[M]^+$), 306.0 (22, $[M - C_5H_8O]^+$), 146.1 (77, $[M - C_5H_8O - 2\ Br]^+$), 85.1 (100, $[C_5H_9O]^+$), 57.1 (33, $[C_3H_5O]^+$), 41.0 (40, $[C_3H_5]^+$).

EI-HRMS: *m*/*z* calcd for $C_{15}H_{18}Br_2O_2$ (390.11): 387.9674; found: 387.9674.

UV (MeCN): λ_{max} (log ε) = 203.5 (4.542), 241.5 nm (3.874).

2-[4-(2,2-Dibromovinyl)-3-phenylphenoxy]tetrahydro-2*H*-pyran (7i)
Yield: 62% (over three steps, 8:1 mixture with regioisomer **9i**).

^1H NMR (300 MHz, $CDCl_3$): δ = 1.55–1.78 (m, 3 H, 4-H_a, 5-CH_2), 1.83–1.92 (m, 2 H, 3-CH_2), 1.92–2.10 (m, 1 H, 4-H_b), 3.59–3.68 (m, 1 H, 6-H_a), 3.93 (ddd, *J* = 11.2, 9.6, 3.1 Hz, 1 H, 6-H_b), 5.50 (t, *J* = 3.1 Hz, 1 H, 2-H), 7.06–7.10 (m, 2 H, 2′-H, 6′-H), 7.14 (s, 1 H, 4′-C*H*=CBr_2), 7.31–7.48 (m, 5 H, 2″-H, 3″-H, 4″-H, 5″-H, 6″-H), 7.63–7.70 (m, 1 H, 5′-H).

^{13}C NMR (126 MHz, $CDCl_3$): δ = 18.6 (C-4), 25.1 (C-5), 30.3 (C-3), 62.1 (C-6), 89.3 (4′-CH=*C*Br_2), 96.2 (C-2), 114.9, 117.6 (C-2′, C-6′), 127.1 (C-4′), 127.6 (C-4″), 128.2 (C-2″, C-6″), 129.5 (C-3″, C-5″), 130.4 (C-5′), 137.0 (4′-*C*H=CBr_2), 140.0, 142.6 (C-1″, C-3′), 157.0 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 436.0/438.0/440.0 (1/2/1, $[M]^+$), 351.9/353.9/356.0 (11/21/9, $[M - C_5H_8O]^+$), 194.1 (100, $[M - 2\ Br - C_5H_8O]^+$), 85.0 (36, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{19}H_{18}Br_2O_2$ (438.153): 458.95658 $[M + Na]^+$; found: 458.95668 $[M + Na]^+$.

2-[4-(2,2-Dibromovinyl)-3-trifluoromethylphenoxy]tetrahydro-2*H*-pyran (7j)
Yield: 55% (over three steps).

IR (KBr): 2948, 2879, 1614, 1566, 1493, 1442, 1316, 1258, 1228, 1164, 1123, 1048, 1020, 964, 883, 823, 752, 604, 536, 483, 423 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.55–1.79 (m, 3 H, 4-H_a, 5-CH_2), 1.82–1.91 (m, 2 H, 3-CH_2), 1.91–2.09 (m, 1 H, 4-H_b), 3.63 (dt, *J* = 11.5, 1.4 Hz, 1 H, 6-H_a), 3.86 (ddd, *J* = 11.5, 9.8, 3.0 Hz, 1 H, 6-H_b), 5.48 (t, *J* = 2.9 Hz, 1 H, 2-H), 7.22 (dd, *J* = 8.7, 2.5 Hz, 1 H, 6′-H), 7.34 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.52 (d, *J* = 8.7 Hz, 1 H, 5′-H), 7.55 (q, *J* = 2.1 Hz, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.4 (C-4), 25.0 (C-5), 30.1 (C-3), 62.0 (C-6), 92.9 (4′-CH=*C*Br_2), 96.4 (C-1), 114.4 (q, *J* = 5.6 Hz, C-2′), 118.8 (C-6′), 123.4 (q, *J* = 273 Hz, 3′-CF_3), 127.0 (q, *J* = 1.9 Hz, C-4′), 129.1 (q, *J* = 30.3 Hz, C-3′), 132.0 (C-5′), 133.9 (4′-*C*H=CBr_2), 156.8 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 428.0/430.0/432.0 (1/1/1, $[M]^+$), 343.9/345.9/347.9 (6/12/6, $[M - C_5H_8O]^+$), 186.0 (10, $[M - 2\ Br - C_5H_8O]^+$), 85.0 (100, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{14}H_{13}Br_2F_3O_2$ (430.055): 427.9234; found: 427.9234.

UV (MeCN): λ_{max} (log ε) = 192.0 (4.5068), 250.5 nm (3.9719).

2-[4-(2,2-Dibromovinyl)-3-fluorophenoxy]tetrahydro-2*H*-pyran (7k)
Yield: 17% (over five steps).

IR (KBr): 3023, 2942, 2871, 1619, 1600, 1566, 1497, 1427, 1388, 1359, 1297, 1254, 1200, 1163, 1122, 1112, 1087, 1051, 1026, 976, 950, 906, 870, 845, 810, 769, 710, 632, 620, 581, 521, 482, 465, 431 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.53–2.07 (m, 6 H, 3-CH_2, 4-CH_2, 5-CH_2), 3.62 (dtd, *J* = 11.3, 4.0, 1.5 Hz, 1 H, 6-H_a), 3.85 (ddd, *J* = 11.3, 9.8, 3.0 Hz, 1 H, 6-H_b), 5.41 (t, *J* = 3.0 Hz, 1 H, 2-H), 6.79 (dd, *J* = 2.4 Hz, J_{H-F} = 12.1 Hz, 1 H, 2′-H), 6.84 (dd, *J* = 8.7, 2.4 Hz, 1 H, 6′-H), 7.48 (s, 1 H, 1″-H), 7.73 (t, *J* = J_{H-F} = 8.7 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.5 (C-4), 25.0 (C-5), 30.0 (C-3), 62.0 (C-6), 90.0 (d, *J* = 1.7 Hz, C-2″), 96.4 (C-2), 103.8 (d, *J* = 25.5 Hz, C-2′), 111.9 (d, *J* = 3.2 Hz, C-6′), 116.4 (d, *J* = 12.9 Hz, C-4′), 129.3 (d, *J* = 4.0 Hz, C-5′), 129.5 (d, *J* = 4.8 Hz, C-1″), 158.5 (d, *J* = 11.5 Hz, C-1′), 160.2 (d, *J* = 250 Hz, C-3′).

MS (EI, 70 eV): *m*/*z* (%) = 380.0 (2, $[M]^+$), 296.0 (42, $[M - C_5H_8O]^+$), 136.1 (12, $[M - C_5H_8O - 2\ Br]^+$), 107.1 (11, $[M - C_5H_8O - 2\ Br - CO - H]^+$), 85.1 (100, $[C_5H_9O]^+$), 57.1 (15, $[C_3H_5O]^+$), 41.0 (15, $[C_3H_5]^+$).

EI-HRMS: *m*/*z* calcd for $C_{13}H_{13}Br_2FO_2$ (380.05): 377.9266; found: 377.9266.

UV (MeCN): λ_{max} (log ε) = 264.0 nm (4.182).

2-[4-(2,2-Dibromovinyl)-3,5-dichlorophenoxy]tetrahydro-2*H*-pyran (7l)
The methyl protected compound **7** (R^1 = Me, R^2 = R^3 = Cl) was synthesized according to the general procedure. The product (5.49 g, 15.2 mmol, 1.00 equiv) was dissolved in CH_2Cl_2 (120 mL) and cooled down to –78 °C. A solution of BBr_3 (1.00 M in CH_2Cl_2, 45.6 mL, 45.6 mmol, 3.00 equiv) was added, the mixture was stirred at

–78 °C for 30 min and 7 d at r.t. The mixture was diluted with H_2O (200 mL) and extracted with CH_2Cl_2 (75 mL) and EtOAc (2 × 150 mL). The combined organic layers were washed with aq 2 M HCl (75 mL) and aq sat. $NaHCO_3$ (75 mL), dried (Na_2SO_4), and the solvent was evaporated under reduced pressure. DHP (7.00 mL, 6.48 g, 77.0 mmol, 5.07 equiv) and PPTS (958 mg, 3.81 mmol, 25.1 mol%) in CH_2Cl_2 (100 mL) were added and the mixture was stirred for 15.5 h at r.t. The solvent was evaporated under reduced pressure and the residue was purified by column chromatography (pentane–EtOAc–Et_3N, 98:2:1); yield: 5.84 g (72%, over three steps).

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.54–1.78 (m, 3 H, 4-H_a, 5-CH_2), 1.79–1.88 (m, 2 H, 3-CH_2), 1.88–2.04 (m, 1 H, 4-H_b), 3.64 (dt, *J* = 11.3, 1.5 Hz, 1 H, 6-H_a), 3.83 (ddd, *J* = 11.3, 10.0 Hz, 3.0 Hz, 1 H, 6-H_b), 5.40 (t, *J* = 2.9 Hz, 1 H, 2-H), 7.07 (s, 2 H, 2′-H, 6′-H), 7.25 (s, 1 H, 4′-C*H*=CBr_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.3 (C-4), 24.9 (C-5), 30.0 (C-3), 62.0 (C-6), 96.6 (C-2), 96.9 (4′-CH=*C*Br_2), 116.2 (C-2′, C-6′), 127.2 (C-4′), 132.9 (4′-*C*H=CBr_2), 134.5 (C-3′, C-5′), 157.4 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 427.9/429.9/431.9/435.9 (3/10/8/2, $[M]^+$), 85.0 (100, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{13}H_{12}Br_2Cl_2O_2$ (430.947): 427.8581; found: 427.8581.

1-(2,2-Dibromovinyl)-4-triisopropylsilyloxy-2-triisopropylsilyloxymethylbenzene (7m)

In this case the compound was not deprotected and reprotected with DHP.

Yield: 80%.

IR (film): 2944, 2867, 1605, 1567, 1489, 1464, 1422, 1385, 1295, 1255, 1193, 1167, 1122, 1067, 995, 919, 883, 836, 807, 767, 683 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.02–1.35 [m, 6 H, 6 × SiC*H*$(CH_3)_2$], 1.09 [d, *J* = 7.1 Hz, 36 H, 6 × SiCH(C*H*$_3)_2$], 4.67 (s, 2 H, 1″-CH_2), 6.77 (dd, *J* = 8.5, 2.5 Hz, 1 H, 5-H), 7.06 (d, *J* = 2.5 Hz, 1 H, 3-H), 7.33 (d, *J* = 8.5 Hz, 1 H, 6-H), 7.44 (s, 1 H, 1′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 12.0 {4-OSi[CH(*C*$H_3)_2]_3$}, 12.7 {1′-OSi[CH(*C*$H_3)_2]_3$}, 17.9, 18.0 {4-OSi[*C*H$(CH_3)_2]_3$, 1′-OSi[*C*H$(CH_3)_2]_3$}, 63.1 (C-1″), 90.6 (C-2′), 118.0, 118.2 (C-3, C-5), 126.0 (C-1), 129.6 (C-6), 135.2 (C-1′), 140.8 (C-2), 156.4 (C-4).

MS (EI, 70 eV): *m*/*z* (%) = 620.3 (33, $[M]^+$), 577.2 (73, [M – $C_3H_7]^+$), 498.3 (17, [M – C_3H_7 – Br]$^+$), 367.2 (20, [M – HBr – *i*-$Pr_3SiO]^+$), 139.0 (22, $[C_7H_{11}OSi]^+$), 115.1 (29, [*i*-$Pr_2SiH]^+$), 73.1 (40, $[Me_3Si]^+$), 59.0 (100, $[Me_2SiH]^+$), 43.0 (93, $[C_3H_7]^+$).

EI-HRMS: *m*/*z* calcd for $C_{27}H_{48}Br_2O_2Si_2$ (620.65): 618.1560; found: 618.1560.

UV (MeCN): λ_{max} (log ε) = 268.5 nm (4.065).

1-(2,2-Dibromovinyl)-4-methoxynaphthalene (7n)

In this case the compound was not deprotected and reprotected with DHP.

Yield: 84%.

IR (KBr): 2962, 2934, 1580, 1509, 1460, 1448, 1421, 1379, 1332, 1285, 1263, 1244, 1224, 1154, 1092, 1021, 973, 933, 868, 847, 816, 795, 756, 713, 637, 601, 509, 496, 469, 438, 418 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 4.02 (s, 3 H, 4-OCH_3), 6.82 (d, *J* = 8.0 Hz, 1 H, 3-H), 7.47–7.59 (m, 3 H, 2-H, 6-H, 7-H), 7.80–7.85 (m, 2 H, 8-H, 1′-H), 8.27–8.33 (m, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 55.6 (4-OCH_3), 91.7 (C-2′), 103.1 (C-3), 122.5 (C-5), 123.8 (C-8), 125.4, 125.4 (C-1, C-4a), 125.5, 127.0, 127.3 (C-2, C-6, C-7), 131.7 (C-8a), 135.7 (C-1′), 155.9 (C-4).

MS (EI, 70 eV): *m*/*z* (%) = 342.1 (31, $[M]^+$), 182.2 (100, [M – 2 Br]$^+$), 167.1 (29, [M – 2 Br – $CH_3]^+$), 139.1 (59, [M – 2 Br – CH_3 – CO]$^+$).

EI-HRMS: *m*/*z* calcd for $C_{13}H_{10}Br_2O$ (342.03): 339.9098; found: 339.9099.

UV (MeCN): λ_{max} (log ε) = 199.0 (4.475), 235.5 (4.536), 312.0 nm (4.054).

Alkynes 8 from Dibromovinyl Compounds 7; General Procedure

To a solution of the dibromovinyl compound **7** (1.85–15.8 mmol) in THF (7.0–7.5 mL/mmol) was slowly added *n*-BuLi (2.50 M in hexane, 2.20 equiv) at –78 °C. The mixture was stirred for 30 min at –78 °C, then at r.t. until completion (TLC), and poured into H_2O (10 mL/mmol); the layers were separated and the aqueous layer was extracted with Et_2O (3 × 4.0 mL/mmol). The combined organic layers were washed with brine (4.0 mL/mmol) and dried (Na_2SO_4). The solvent was evaporated at reduced pressure and the alkyne **8** purified by column chromatography.

2-(4-Ethynyl-3-methylphenoxy)tetrahydro-2*H*-pyran (8a)

Yield: 94%.

IR (film): 3288, 2945, 2875, 2101, 1608, 1566, 1494, 1454, 1389, 1357, 1289, 1241, 1202, 1183, 1167, 1122, 1099, 1077, 1038, 1022, 970, 906, 872, 821 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.53–2.09 (m, 6 H, 3-CH_2, 4-CH_2, 5-CH_2), 2.42 (s, 3 H, 3′-CH_3), 3.19 (s, 1 H, 2″-H), 3.60 (dtd, *J* = 11.4, 4.0, 1.5 Hz, 1 H, 6-H_a), 3.87 (ddd, *J* = 11.4, 9.5, 3.0 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.1 Hz, 1 H, 2-H), 6.83 (dd, *J* = 8.5, 2.5 Hz, 1 H, 6′-H), 6.90 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.38 (d, *J* = 8.5 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.6 (C-4), 20.8 (3′-CH_3), 25.1 (C-5), 30.2 (C-3), 61.9 (C-6), 79.5 (C-2″), 82.6 (C-1″), 96.0 (C-2), 113.6 (C-6′), 114.9 (C-4′), 117.3 (C-2′), 133.7 (C-5′), 142.4 (C-3′), 157.2 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 216.2 (27, $[M]^+$), 132.1 (100, [M – $C_5H_8O]^+$), 85.1 (13, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{14}H_{16}O_2$ (216.28): 216.1150; found: 216.1150.

UV (MeCN): λ_{max} (log ε) = 207.5 (4.496), 250.5 (4.288), 280.5 (3.163), 291.5 nm (3.039).

2-(3-Ethyl-4-ethynylphenoxy)tetrahydro-2*H*-pyran (8b)

Yield: 95%.

IR (film): 3287, 2943, 2878, 2101, 1606, 1565, 1489, 1455, 1357, 1291, 1235, 1201, 1167, 1122, 1038, 991, 963, 900, 872, 821 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 1.24 (t, *J* = 7.6 Hz, 3 H, 3′-CH_2CH_3), 1.54–1.77 (m, 3 H, 4-H_a, 5-CH_2), 1.80–2.10 (m, 3 H, 3-CH_2, 4-H_b), 2.79 (q, *J* = 7.6 Hz, 2 H, 3′-CH_2CH_3), 3.17 (s, 1 H, 4′-C≡C*H*), 3.56–3.66 (m, 1 H, 6-H_a), 3.88 (ddd, *J* = 11.6, 9.5, 3.1 Hz, 1 H, 6-H_b), 5.44 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.84 (dd, *J* = 8.4, 2.5 Hz, 1 H, 6′-H), 6.90 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.39 (d, *J* = 8.4 Hz, 1 H, 5′-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 14.7 (3′-CH_2*C*H_3), 18.7 (C-4), 25.2 (C-5), 27.7 (3′-*C*H_2CH_3), 30.3 (C-3), 62.0 (C-6), 79.2 (4′-C≡*C*H), 82.4 (4′-*C*≡CH), 96.1 (C-2), 113.4, 116.1 (C-2′, C-6′), 114.3 (C-4′), 134.1 (C-5′), 148.6 (C-3′), 157.5 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 230.2 (19, $[M]^+$), 146.1 (100, [M – $C_5H_8O]^+$), 85.0 (45, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{15}H_{18}O_2$ (230.302): 253.11990 [M + Na]$^+$; found: 253.11986 [M + Na]$^+$.

UV (MeCN): λ_{max} (log ε) = 208.5 (4.4999), 251.0 (4.2696), 280.0 (3.1723), 291.0 nm (3.0479).

2-(4-Ethynyl-3-isopropylphenoxy)tetrahydro-2*H*-pyran (8c)
Yield: 92%.

IR (KBr): 3291, 2965, 2881, 2099, 1606, 1560, 1486, 1388, 1357, 1288, 1261, 1232, 1198, 1179, 1118, 1040, 1020, 971, 905, 873, 820 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.25 [d, *J* = 6.9 Hz, 6 H, 3′-CH(CH_3)$_2$], 1.55–1.76 (m, 3 H, 4-H_a, 5-CH_2), 1.80–2.10 (m, 3 H, 3-CH_2, 4-H_b), 3.17 (s, 1 H, 4′-C≡C*H*), 3.44 [sept, *J* = 6.9 Hz, 1 H, 3′-C*H*(CH_3)$_2$], 3.57–3.65 (m, 1 H, 6-H_a), 3.89 (ddd, *J* = 11.4, 9.4, 3.2 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.2 Hz, 1 H, 2-H), 6.85 (dd, *J* = 8.5, 2.5 Hz, 1 H, 6′-H), 6.93 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.40 (d, *J* = 8.5 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.7 (C-4), 23.0, 23.0 [3′-CH(*C*H_3)$_2$], 25.1 (C-5), 30.3 (C-3), 31.5 [3′-*C*H(CH_3)$_2$], 62.0 (C-6), 79.3 (4′-C≡*C*H), 82.4 (4′-*C*≡CH), 96.1 (C-2), 113.1, 113.5 (C-2′, C-6′), 113.9 (C-4′), 134.2 (C-5′), 152.9 (C-4′), 157.7 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 244.2 (14, $[M]^+$), 160.1 (100, $[M - C_5H_8O]^+$), 145.1 (20, $[M - C_5H_8O - CH_3]^+$), 85.0 (46, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{16}H_{20}O_2$ (244.329): 244.1463; found: 244.1463.

UV (MeCN): λ_{max} (log ε) = 208.5 (4.5064), 250.5 (4.2672), 279.5 (3.2097), 291.0 nm (3.0464).

2-(3-*tert*-Butyl-4-ethynylphenoxy)tetrahydro-2*H*-pyran (8d)
Yield: 62%.

IR (film): 3310, 2952, 2097, 1602, 1561, 1482, 1363, 1291, 1222, 1201, 1113, 1078, 1038, 975, 903, 873, 821 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.50 [s, 9 H, 3′-C(CH_3)$_3$], 1.54–1.76 (m, 3 H, 4-H_a, 5-CH_2), 1.81–1.90 (m, 2 H, 3-CH_2), 1.90–2.10 (m, 1 H, 4-H_b), 3.32 (s, 1 H, 4′-C≡C*H*), 3.57–3.65 (m, 1 H, 6-H_a), 3.90 (ddd, *J* = 11.4, 9.3, 3.3 Hz, 1 H, 6-H_b), 5.42 (t, *J* = 3.3 Hz, 1 H, 2-H), 6.85 (dd, *J* = 8.5, 2.5 Hz, 1 H, 6′-H), 7.02 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.45 (d, *J* = 8.5 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.7 (C-4), 25.2 (C-5), 29.8 [3′-C(*C*H_3)$_3$], 30.3 (C-3), 35.8 [3′-*C*(CH_3)$_3$], 62.1 (C-6), 81.6 (4′-C≡*C*H), 85.2 (4′-*C*≡CH), 96.2 (C-2), 112.5 (C-6′), 113.5 (C-4′), 114.7 (C-2′), 137.4 (C-5′), 154.0 (C-3′), 157.2 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 258.2 (6, $[M]^+$), 174.1 (100, $[M - C_5H_8O]^+$), 159.1 (39, $[M - CH_3 - C_5H_8O]^+$), 85.0 (55, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{17}H_{22}O_2$ (258.355): 281.15120 $[M + Na]^+$; found: 281.15127 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 206.5 (4.4577), 254.0 nm (4.2495).

2-(4-Ethynyl-3-*n*-propylphenoxy)tetrahydro-2*H*-pyran (8e)
Yield: 73%.

IR (KBr): 3254, 2946, 2871, 2100, 1606, 1564, 1489, 1358, 1289, 1244, 1202, 1122, 1070, 1038, 981, 906, 819, 640 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.97 (t, *J* = 7.5 Hz, 3 H, 3′-$CH_2CH_2CH_3$), 1.53–1.76 (m, 5 H, 4-H_a, 5-CH_2, 3′-$CH_2CH_2CH_3$), 1.82–1.89 (m, 2 H, 3-CH_2), 1.89–2.09 (m, 1 H, 4-H_b), 2.74 (dd, *J* = 7.2, 6.5 Hz, 2 H, 3′-$CH_2CH_2CH_3$), 3.16 (s, 1 H, 4′-C≡C*H*), 3.61 (dt, *J* = 11.4, 1.5 Hz, 1 H, 6-H_a), 3.88 (dd, *J* = 11.4, 9.6, 3.1 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.1 Hz, 1 H, 2-H), 6.84 (dd, *J* = 8.5, 2.6 Hz, 1 H, 6′-H), 6.89 (d, *J* = 2.6 Hz, 1 H, 2′-H), 7.39 (d, *J* = 8.5 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 13.9 (3′-$CH_2CH_2CH_3$), 18.6 (C-4), 23.6 (3′-$CH_2CH_2CH_3$), 25.1 (C-5), 30.2 (C-3), 36.6 (3′-$CH_2CH_2CH_3$), 61.9 (C-6), 79.0 (4′-C≡*C*H), 82.5 (4′-*C*≡CH), 96.1 (C-2), 113.5 (C-6′), 114.5 (C-1′), 116.8 (C-2′), 134.0 (C-5′), 147.0 (C-3′), 157.3 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 244.2 (15, $[M]^+$), 160.1 (100, $[M - C_5H_8O]^+$), 145.1 (13, $[M - C_5H_8O - CH_3]^+$), 131.1 (13, $[M - C_5H_8O - C_2H_5]^+$), 85.0 (42, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{16}H_{20}O_2$ (244.329): 245.15361 $[M + H]^+$, 267.13555 $[M + Na]^+$; found: 245.15385 $[M + H]^+$, 267.13581 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 209.0 (4.5267), 251.0 (4.2777), 280.0 (3.2257), 291.5 nm (3.0727).

2-(3-*n*-Butyl-4-ethynylphenoxy)tetrahydro-2*H*-pyran (8f)
Yield: 97%.

IR (film): 3288, 2953, 2102, 1605, 1564, 1489, 1357, 1286, 1240, 1202, 1166, 1123, 1078, 1038, 979, 908, 872, 821 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.94 (t, *J* = 7.3 Hz, 3 H, 4″-CH_3), 1.38 (sext, *J* = 7.3 Hz, 2 H, 3″-CH_2), 1.53–1.76 (m, 5 H, 2″-CH_2, 4-H_a, 5-CH_2), 1.80–1.90 (m, 2 H, 3-CH_2), 1.90–2.11 (m, 1 H, 4-H_b), 2.75 (t, *J* = 7.8 Hz, 2 H, 1″-CH_2), 3.16 (s, 1 H, 4′-C≡C*H*), 3.61 (dt, *J* = 11.4, 1.5 Hz, 1 H, 6-H_a), 3.88 (ddd, *J* = 11.4, 9.5, 3.0 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.1 Hz, 1 H, 2-H), 6.84 (dd, *J* = 8.5, 2.5 Hz, 1 H, 6′-H), 6.88 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.39 (d, *J* = 8.5 Hz, 1 H, 5′-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 13.9 (C-4″), 18.6 (C-4), 22.5 (C-3″), 25.1 (C-5), 30.2 (C-3), 32.6 (C-2″), 34.3 (C-1″), 62.0 (C-6), 79.1 (4′-C≡*C*H), 82.5 (4′-*C*≡CH), 96.1 (C-2), 113.5 (C-6′), 114.5 (C-4′), 116.7 (C-2′), 134.1 (C-5′), 147.3 (C-3′), 157.3 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 258.1 (19, $[M]^+$) 174.1 (100, $[M - C_5H_8O]^+$), 159.0 (66, $[M - C_5H_8O - CH_3]^+$), 145.1 (13, $[M - C_5H_8O - C_2H_5]^+$), 131.0 (20, $[M - C_5H_8O - C_3H_7]^+$), 85.0 (54, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{17}H_{22}O_2$ (258.355): 259.16926 $[M + H]^+$, 281.15120 $[M + Na]^+$; found: 259.16933 $[M + H]^+$, 281.15131 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 209.5 (4.5222), 250.5 (4.2702), 280.5 (3.1703), 291.5 nm (3.0402).

2-(4-Ethynyl-3-*n*-nonylphenoxy)tetrahydro-2*H*-pyran (8g)
Yield: 96%.

IR (KBr): 3314, 2926, 2854, 2102, 1605, 1565, 1489, 1467, 1357, 1287, 1239, 1201, 1123, 1038, 980, 906, 872, 821 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.89 (t, *J* = 6.9 Hz, 3 H, 9″-CH_3), 1.21–1.43 (m, 12 H, 3″-CH_2, 4″-CH_2, 5″-CH_2, 6″-CH_2, 7″-CH_2, 8″-CH_2), 1.54–1.77 (m, 5 H, 2″-CH_2, 4-H_a, 5-CH_2), 1.81–1.90 (m, 2 H, 3-CH_2), 1.90–2.09 (m, 1 H, 4-H_b), 2.75 (t, *J* = 7.8 Hz, 2 H, 1″-CH_2), 3.16 (s, 1 H, 4′-C≡C*H*), 3.61 (dt, *J* = 11.4, 1.5 Hz, 1 H, 6-H_a), 3.88 (ddd, *J* = 11.4, 9.5, 3.1 Hz, 1 H, 6-H_b), 5.43 (t, *J* = 3.1 Hz, 1 H, 2-H), 6.84 (dd, *J* = 8.4, 2.5 Hz, 1 H, 6′-H), 6.88 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.39 (d, *J* = 8.4 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 14.1 (C-9″), 18.6 (C-4), 22.7 (C-8″), 25.1 (C-5), 29.3, 29.4, 29.5 (C-4″, C-5″, C-6″, C-7″), 30.2, 30.5 (C-3, C-3″), 31.9 (C-2″), 34.6 (C-1″), 61.9 (C-6), 79.0 (4′-C≡*C*H), 82.5 (4′-*C*≡CH), 96.1 (C-2), 113.5 (C-6′), 114.5 (C-4′), 116.7 (C-2′), 134.0 (C-5′), 147.3 (C-3′), 157.3 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 328.3 (32, $[M]^+$), 244.2 (27, $[M - C_5H_8O]^+$), 229.2 (12, $[M - C_5H_8O - CH_3]^+$), 159.1 (60, $[M - C_5H_8O - C_6H_{13}]^+$), 145.1 (29, $[M - C_5H_8O - C_7H_{15}]^+$), 85.0 (100, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{22}H_{32}O_2$ (328.488): 329.24751 $[M + H]^+$; found: 329.24770 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 209.5 (4.5364), 250.5 (4.2806), 280.5 (3.1627), 291.5 nm (3.0270).

2-(4-Ethynyl-3,5-dimethylphenoxy)tetrahydropyran (8h)
Yield: 95%.

IR (film): 3287, 2945, 2875, 2097, 1606, 1477, 1441, 1377, 1356, 1311, 1284, 1260, 1203, 1184, 1147, 1123, 1107, 1078, 1033, 977, 946, 906, 885, 872, 859, 819, 725, 641 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.52–2.08 (m, 6 H, 3-CH_2, 4-CH_2, 5-CH_2), 2.42 (s, 6 H, 3′-CH_3, 5′-CH_3), 3.42 (s, 1 H, 2″-H), 3.60 (dtd, *J* = 11.4, 3.9, 1.5 Hz, 1 H, 6-H_a), 3.87 (ddd, *J* = 11.4, 9.6, 3.2 Hz, 1 H, 6-H_b), 5.42 (t, *J* = 3.1 Hz, 1 H, 2-H), 6.75 (s, 2 H, 2′-H, 6′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.6 (C-4), 21.2 (3′-CH_3, 5′-CH_3), 25.2 (C-5), 30.2 (C-3), 61.9 (C-6), 81.3 (C-1″), 83.8 (C-2″), 95.9 (C-2), 114.7 (C-2′, C-6′), 115.1 (C-4′), 142.6 (C-3′, C-5′), 156.6 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 230.2 (8, $[M]^+$), 146.1 (100, $[M - C_5H_8O]^+$), 85.1 (21, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{15}H_{18}O_2$ (230.30): 230.1307; found: 230.1307.

UV (MeCN): λ_{max} (log ε) = 212.0 (4.466), 252.5 nm (4.190).

2-(4-Ethynyl-3-phenylphenoxy)tetrahydro-2*H*-pyran (8i)
Yield: 92%.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.56–1.77 (m, 3 H, 4-Ha, 5-CH_2), 1.84–1.91 (m, 2 H, 3-CH_2), 1.91–2.07 (m, 1 H, 4-H_b), 2.96 (s, 1 H, 4′-C≡C*H*), 3.62 (dt, *J* = 11.4, 1.5, 1 H, 6-H_a), 3.89 (ddd, *J* = 11.4, 9.6, 3.1 Hz, 1 H, 6-H_b), 5.49 (t, *J* = 3.1 Hz, 1 H, 2-H), 7.00 (dd, *J* = 8.5, 2.5 Hz, 1 H, 6′-H), 7.07 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.33–7.47 (m, 3 H, 3″-H, 4″-H, 5″-H), 7.54 (d, *J* = 8.5 Hz, 1 H, 5′-H), 7.56–7.63 (m, 2 H, 2″-H, 6″-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.6 (C-4), 25.1 (C-5), 30.2 (C-3), 62.0 (C-6), 78.7 (4′-C≡*C*H), 83.1 (4′-*C*≡CH), 96.2 (C-2), 113.4 (C-4′), 115.0 (C-6′), 117.5 (C-2′), 127.6 (C-4″), 127.9 (C-2″, C-6″), 129.2 (C-3″, C-5″), 135.2 (C-5′), 140.2 (C-1″), 145.9 (C-3′), 157.3 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 278.1 (15, $[M]^+$), 194.1 (100, $[M - C_5H_8O]^+$), 85.0 (28, $[C_5H_9O]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{19}H_{18}O_2$ (278.345): 279.13796 $[M + H]^+$, 301.11990 $[M + Na]^+$; found: 279.13817 $[M + H]^+$, 301.12005 $[M + Na]^+$.

2-(4-Ethynyl-3-trifluoromethylphenoxy)tetrahydro-2*H*-pyran (8j)
Yield: 78%.

IR (KBr): 3255, 2965, 2881, 1613, 1497, 1433, 1328, 1259, 1233, 1206, 1187, 1162, 1118, 1048, 1021, 958, 935, 900, 870, 816, 730, 701, 657, 592, 449 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.54–1.79 (m, 3 H, 4-H_a, 5-CH_2), 1.83–1.91 (m, 2 H, 3-CH_2), 1.91–2.07 (m, 1 H, 4-H_b), 3.26 (s, 1 H, 4′-C≡C*H*), 3.62 (dt, *J* = 11.5, 1.5 Hz, 6-H_a), 3.82 (ddd, *J* = 11.5, 10.1, 3.1 Hz, 1 H, 6-H_b), 5.48 (t, *J* = 2.9 Hz, 1 H, 2-H), 7.16 (dd, *J* = 8.6, 2.5 Hz, 1 H, 6′-H), 7.33 (d, *J* = 2.5 Hz, 1 H, 2′-H), 7.55 (d, *J* = 8.6 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.3 (C-4), 24.9 (C-5), 30.0 (C-3), 61.9 (C-6), 79.4 (4′-C≡*C*H), 81.1 (4′-*C*≡CH), 96.3 (C-2), 112.7 (q, *J* = 2.2 Hz, C-4′), 114.5 (q, *J* = 5.3 Hz, C-2′), 118.8 (C-6′), 123.1 (q, *J* = 274 Hz, 3′-CF_3), 133.4 (q, *J* = 31 Hz, C-3′), 136.1 (C-5′), 157.0 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 270.1 (13, $[M]^+$), 186.0 (9, $[M - C_5H_8O]^+$), 167.0 (6, $[M - F - C_5H_8O]^+$), 85.0 (100, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{14}H_{13}F_3O_2$ (270.247): 270.0868; found: 270.0867.

UV (MeCN): λ_{max} (log ε) = 201.5 (4.4419), 252.5 (4.3170), 287.5 (3.5309), 295.5 nm (3.4683).

2-(4-Ethynyl-3-fluorophenoxy) tetrahydropyran (8k)
Yield: 10%.

IR (KBr): 3298, 2981, 2941, 2872, 2114, 1621, 1566, 1504, 1434, 1393, 1359, 1315, 1285, 1259, 1207, 1187, 1159, 1125, 1097, 1052, 1040, 1023, 978, 948, 906, 872, 856, 823, 810, 756, 665, 610, 585, 540, 474, 442 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.53–2.07 (m, 6 H, 3-CH_2, 4-CH_2, 5-CH_2), 3.22 (s, 1 H, 2″-H), 3.62 (dtd, *J* = 11.3, 3.9, 1.5 Hz, 1 H, 6-H_a), 3.84 (ddd, *J* = 11.3, 9.8, 3.0 Hz, 1 H, 6-H_b), 5.41 (t, *J* = 3.0 Hz, 1 H, 2-H), 6.79 (dd, *J* = 2.4 Hz, J_{H-F} = 6.8 Hz, 1 H, 2′-H), 6.82 (dd, *J* = 8.8, 2.4 Hz, 1 H, 6′-H), 7.37 (t, *J* = J_{H-F} = 8.8 Hz, 1 H, 5′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.4 (C-4), 25.0 (C-5), 30.0 (C-3), 62.0 (C-6), 77.2 (C-1″), 80.9 (d, *J* = 3.3 Hz, C-2″), 96.4 (C-2), 103.3 (d, *J* = 15.9 Hz, C-4′), 104.1 (d, *J* = 24.7 Hz, C-2′), 112.3 (d, *J* = 3.3 Hz, C-6′), 134.3 (d, *J* = 4.8 Hz, C-5′), 158.8 (d, *J* = 11.1 Hz, C-1′), 164.0 (d, *J* = 252 Hz, C-3′).

MS (EI, 70 eV): *m*/*z* (%) = 220.1 (22, $[M]^+$), 136.1 (26, $[M - C_5H_8O]^+$), 107.1 (10, $[M - C_5H_8O - CO - H]^+$), 85.1 (100, $[C_5H_9O]^+$), 67.1 (16, $[C_5H_7]^+$), 57.1 (19, $[C_3H_5O]^+$), 41.0 (18, $[C_3H_5]^+$).

EI-HRMS: *m*/*z* calcd for $C_{13}H_{13}FO_2$ (220.24): 220.0900; found: 220.0900.

UV (MeCN): λ_{max} (log ε) = 202.0 (4.374), 248.5 (4.310), 278.5 (3.422), 282.0 (3.406), 288.0 nm (3.377).

2-[3,5-Dichloro-4-ethynylphenoxy]tetrahydro-2*H*-pyran (8l)
The reaction was quenched with H_2O at –78 °C; yield: 96%.

IR (KBr): 3298, 2949, 2869, 1593, 1543, 1455, 1403, 1359, 1280, 1247, 1202, 1183, 1121, 1058, 1024, 970, 899, 880, 849, 822, 802, 710, 663, 627 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.54–1.78 (m, 3 H, 4-H_a, 5-CH_2), 1.80–1.88 (m, 2 H, 3-CH_2), 1.88–2.06 (m, 1 H, 4-H_b), 3.57 (s, 1 H, 4′-C≡C*H*), 3.63 (dt, *J* = 11.1, 1.5 Hz, 1 H, 6-H_a), 3.74–3.84 (m, 1 H, 6-H_b), 5.41 (t, *J* = 2.8 Hz, 1 H, 2-H), 7.06 (s, 2 H, 2′-H, 6′-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 18.1 (C-4), 24.9 (C-5), 29.8 (C-3), 61.9 (C-6), 77.3 (4′-*C*≡CH), 85.9 (4′-C≡*C*H), 96.5 (C-2), 115.0 (C-4′), 116.0 (C-2′, C-6′), 138.1 (C-3′, C-5′), 157.2 (C-1′).

MS (EI, 70 eV): *m*/*z* (%) = 270.0/272.0 (12/8, $[M]^+$), 186.0/188.0 (12/7, $[M - C_5H_8O]^+$), 85.0 (100, $[C_5H_9O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{13}H_{12}Cl_2O_2$ (271.139): 270.0214; found: 270.0215.

UV (MeCN): λ_{max} (log ε) = 219.5 (4.5833), 256.0 (4.2386), 262.0 (4.2223), 287.5 (3.0432), 300.0 nm (2.8995).

1-Ethynyl-4-triisopropylsilyloxy-2-triisopropylsilyloxymethylbenzene (8m)
Yield: quant.

IR (film): 3315, 2944, 2867, 2104, 1604, 1562, 1489, 1464, 1424, 1384, 1373, 1294, 1238, 1165, 1120, 1067, 1013, 982, 919, 883, 838, 822, 756, 685, 662, 587 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.09 [d, *J* = 7.0 Hz, 18 H, 3 × SiCH(CH_3)$_2$], 1.10 [d, *J* = 6.0 Hz, 18 H, 3 × SiCH(CH_3)$_2$], 1.13–1.35 [m, 6 H, 6 × SiC*H*(CH_3)$_2$], 3.21 (s, 1 H, 2′-H), 4.93 (s, 2 H, 1″-CH_2), 6.70 (dd, *J* = 8.3, 2.6 Hz, 1 H, 5-H), 7.19 (d, *J* = 2.6 Hz, 1 H, 3-H), 7.31 (d, *J* = 8.3 Hz, 1 H, 6-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 12.0 [4-OSi[CH(*C*H_3)$_2$]$_3$], 12.7 [1′-OSi[CH(*C*H_3)$_2$]$_3$], 17.9, 18.0 [4-OSi[*C*H(CH_3)$_2$]$_3$, 1′-OSi[*C*H(CH_3)$_2$]$_3$], 63.1 (C-1″), 80.7 (C-2 ′), 81.1 (C-1 ′), 110.6 (C-1), 116.9 (C-3), 118.1 (C-5), 133.6 (C-6), 146.0 (C-2), 157.1 (C-4).

MS (EI, 70 eV): *m*/*z* (%) = 460.5 (7, $[M]^+$), 417.4 (100, $[M - C_3H_7]^+$), 375.3 (19, $[M - C_3H_7 - C_3H_6]^+$).

UV (MeCN): λ_{max} (log ε) = 208.0 (4.465), 253.0 (4.285), 290.0 nm (2.895).

1-Ethynyl-4-methoxynaphthalene (8n)
Yield: 97%.

IR (film): 3292, 3065, 3006, 2937, 2840, 2099, 1582, 1510, 1462, 1423, 1387, 1322, 1279, 1241, 1223, 1162, 1094, 1020, 972, 819, 766, 716, 687, 656, 621 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 3.38 (s, 1 H, 2′-H), 4.01 (s, 3 H, 4-OCH_3), 6.76 (d, *J* = 8.0 Hz, 1 H, 3-H), 7.51 (ddd, *J* = 8.3, 6.9, 1.1 Hz, 1 H, 6-H), 7.60 (ddd, *J* = 8.3, 6.9, 1.1 Hz, 1 H, 7-H), 7.67 (d, *J* = 8.0 Hz, 1 H, 2-H), 8.27 (dd, *J* = 8.3, 1.1 Hz, 1 H, 8-H), 8.30 (dd, *J* = 8.3, 1.1 Hz, 1 H, 5-H).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 55.6 (4-OCH_3), 80.2 (C-2′), 82.1 (C-1'), 103.3 (C-3), 111.8 (C-1), 122.2 (C-5), 125.2 (C-4a), 125.8, 125.8, 127.4 (C-6, C-7, C-8), 131.9 (C-2), 134.4 (C-8a), 156.3 (C-4).

MS (EI, 70 eV): *m*/*z* (%) = 182.1 (100, $[M]^+$), 167.1 (32, $[M - CH_3]^+$), 139.1 (59, $[M - CH_3 - CO]^+$).

EI-HRMS: *m*/*z* calcd for $C_{13}H_{10}O$ (182.22): 182.0732; found: 182.0732.

UV (MeCN): λ_{max} (log ε) = 224.0 (4.544), 309.0 (4.025), 327.0 nm (3.936).

Vinyl Iodides 12 and 13; General Procedure
To a stirred solution of Ph_3P (1.10–1.30 equiv) in MeCN (10 mL/mmol) was added I_2 (1.15–1.30 equiv) at r.t. and the stirring was continued for 30 min. Et_3N (1.17–1.37 equiv) was then added and the solution stirred for 5 min. The corresponding 1,3-dione (28.9–103 mmol) was added and the solution heated to reflux. After completion of the reaction, the solvent was evaporated at reduced pressure, the remaining solid was dissolved in Et_2O (10 mL/mmol), stirred, and the solvent decanted. The latter procedure was repeated three times. The combined organic extracts were filtered over SiO_2, which was washed with Et_2O. The solvent was evaporated under reduced pressure to give vinyl iodides **12** and **13**, respectively**.**

3-Iodo-2-methylcyclopent-2-en-1-one (12a)
Yield: 96%.

^1H NMR (200 MHz, $CDCl_3$): δ = 1.80 (t, *J* = 2.2 Hz, 3 H, 2-CH_3), 2.48–2.55 (m, 2 H, 5-CH_2), 2.99 (tq, *J* = 4.7, 2.3 Hz, 2 H, 4-CH_2).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 12.9 (2-CH_3), 36.5 (C-5), 39.0 (C-4), 133.8 (C-3), 147.8 (C-2), 202.6 (C-1).

HRMS (EI^+): *m*/*z* calcd for C_6H_7IO: 221.9542 $[M]^+$; found: 221.9542.

2-Ethyl-3-iodocyclopent-2-en-1-one (12b)
Yield: 93%.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.00 (t, *J* = 7.5 Hz, 3 H, 2-CH_2CH_3), 2.27 (tq, *J* = 7.5, 1.0 Hz, 2 H, 2-CH_2CH_3), 2.51 (mc, 2 H, 5-CH_2), 2.96–3.02 (m, 2 H, 4-CH_2).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 11.7 (2-CH_2CH_3), 20.9 (2-CH_2CH_3), 36.8 (C-5), 39.1 (C-4), 133.1 (C-3), 152.4 (C-2), 202.3 (C-1).

HRMS (EI^+): *m*/*z* calcd for C_7H_9IO: 235.9698 $[M]^+$; found: 235.9696.

3-Iodo-2-isopropylcyclopent-2-en-1-one (12c)
Yield: 78%.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.19 [d, *J* = 7.0 Hz, 6 H, 2-$CH(CH_3)_2$], 2.47 (mc, 2 H, 5-CH_2), 2.82 [sept, *J* = 7.0 Hz, 1 H, 2-$CH(CH_3)_2$], 2.97 (mc, 2 H, 4-CH_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 19.2 [2-$CH(CH_3)_2$], 30.2 [2-$CH(CH_3)_2$], 37.5 (C-4), 39.6 (C-5), 132.5 (C-3), 154.0 (C-2), 201.9 (C-1).

HRMS (EI^+): *m*/*z* calcd for $C_8H_{11}IO$: 249.9855 $[M]^+$; found: 289.9850.

3-Iodo-2-methylcyclohex-2-en-1-one (13a)
Yield: 86%.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.93–2.02 (m, 2 H, 5-CH_2), 2.03 (t, *J* = 2.0 Hz, 3 H, 2-CH_3), 2.46–2.53 (m, 2 H, 6-CH_2), 3.04 (tq, *J* = 6.0, 2.0 Hz, 2 H, 4-CH_2).

^{13}C NMR (50.3 MHz, $CDCl_3$): δ = 21.7 (2-CH_3), 24.5 (C-5), 37.8 (C-6), 42.7 (C-4), 128.0 (C-3), 142.0 (C-2), 193.2 (C-l).

2-Ethyl-3-iodocyclohex-2-en-1-one (13b)
Yield: 90%.

^1H NMR (300 MHz, $CDCl_3$): δ = 0.96 (t, *J* = 7.5 Hz, 3 H, 2-CH_2CH_3), 1.90–2.00 (m, 2 H, 5-CH_2), 2.43–2.53 (m, 4 H, 4-CH_2, 2-CH_2CH_3), 3.03 (t, *J* = 6.1 Hz, 2 H, 6-CH_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 12.3 (2-CH_2CH_3), 24.5 (C-5), 28.9 (2-CH_2CH_3), 38.1 (C-6), 42.9 (C-4), 127.2 (C-3), 147.0 (C-2), 192.8 (C-1).

HRMS (EI^+): *m*/*z* calcd for $C_8H_{11}IO$: 249.9855 $[M]^+$; found: 289.9854.

3-Iodo-2-isopropylcyclohex-2-en-1-one (13c)
Yield: 88%.

^1H NMR (300 MHz, $CDCl_3$): δ = 1.17 [d, *J* = 7.0 Hz, 6 H, 2-$CH(CH_3)_2$], 1.84–1.95 (m, 2 H, 5-CH_2), 2.41–2.48 (m, 2 H, 4-CH_2), 2.94 [sept, *J* = 7.0 Hz, 1 H, 2-$CH(CH_3)_2$], 3.04 (t, *J* = 6.1 Hz, 2 H, 6-CH_2).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 19.8 [2-$CH(CH_3)_2$], 24.3 (C-5), 39.8 (C-6), 40.3 [2-$CH(CH_3)_2$], 43.7 (C-4), 127.3 (C-3), 148.8 (C-2), 192.7 (C-1).

HRMS (EI^+): *m*/*z* calcd for $C_9H_{13}IO$: 265.0011 $[M]^+$; found: 265.0011.

Sonogashira Reactions for the Synthesis of Estrogen Analogues 14 and 15; General Procedure
To a solution of the cyclic vinyl iodide **12** or **13** (0.820–1.20 equiv) and the appropriate alkyne **8** (1.54–4.73 mmol) in DMF (2.50 mL/mmol) was added Et_3N (1.20–1.80 equiv) at r.t. and the mixture degassed by repeated evacuation of the reaction flask with subsequent flooding with argon. $Pd(PPh_3)_2Cl_2$ (1.50 mol%) and CuI (3.00 mol%) were added, the resulting suspension heated to 50–60 °C and stirred at r.t. Upon completion of the reaction, the mixture was diluted with H_2O (7.5 mL/mmol) and extracted with Et_2O (3 × 3.0 mL/mmol). The combined organic layers were washed with brine (3.0 mL/mmol), dried (Na_2SO_4) and the solvent was evaporated at reduced pressure. The estrogen analogue **14** or **15** was isolated by column chromatography.

3-(4-Methoxynaphthalene-1-ylethynyl)-2-methylcyclopent-2-enone (14a)
Yield: 91%.

IR (KBr): 2939, 2183, 1680, 1615, 1577, 1511, 1467, 1424, 1398, 1375, 1344, 1318, 1298, 1251, 1159, 1095, 1053, 1013, 868, 827, 819, 773, 723, 611, 580, 476, 442 cm^{-1}.

^1H NMR (300 MHz, $CDCl_3$): δ = 2.02 (t, *J* = 2.2 Hz, 3 H, 2-CH_3), 2.46–2.51 (m, 2 H, 5-CH_2), 2.79 (tq, *J* = 4.8, 2.2 Hz, 2 H, 4-CH_2),

4.03 (s, 3 H, 4″-OCH_3), 6.81 (d, *J* = 8.1 Hz, 1 H, 3″-H), 7.54 (ddd, *J* = 8.2, 7.0, 1.2 Hz, 1 H, 6″-H), 7.63 (ddd, *J* = 8.3, 7.0, 1.2 Hz, 1 H, 7″-H), 7.72 (d, *J* = 8.1 Hz, 1 H, 2″-H), 8.26 (d, *J* = 8.3 Hz, 1 H, 8″-H), 8.30 (d, *J* = 8.2 Hz, 1 H, 5″-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 9.9 (2-CH_3), 30.2 (C-4), 34.0 (C-5), 55.7 (4″-OCH_3), 88.9 (C-1′), 103.6 (C-3″), 104.6 (C-2′), 111.7 (C-1″), 122.5 (C-5″), 125.3 (C-4a″), 125.5, 126.0, 127.8 (C-6″, C-7″, C-8″), 132.5 (C-2″), 133.8 (C-8a″), 143.4 (C-3), 150.6 (C-2), 157.2 (C-4″), 209.0 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 276.2 (100, $[M]^+$), 261.2 (22, $[M - CH_3]^+$).

EI-HRMS: *m*/*z* calcd $C_{19}H_{16}O_2$ (276.33): 276.1150; found: 276.1150.

UV (MeCN): λ_{max} (log ε) = 205.0 (4.539), 242.0 (4.429), 271.5 (3.981), 282.0 (3.969), 353.5 nm (4.431).

3-(4-Methoxynaphthalene-1-ylethynyl)-2-methylcyclohex-2-enone (15a)

Yield: 85%.

IR (KBr): 2942, 2181, 1651, 1574, 1508, 1464, 1419, 1391, 1371, 1354, 1323, 1307, 1257, 1235, 1194, 1152, 1099, 1038, 1012, 908, 854, 814, 776, 714, 610, 577, 446, 418 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 2.06 (quint, *J* = 6.4 Hz, 2 H, 5-CH_2), 2.16 (t, *J* = 1.8 Hz, 3 H, 2-CH_3), 2.50 (t, *J* = 6.4 Hz, 2 H, 6-CH_2), 2.68 (tq, *J* = 6.4, 1.8 Hz, 2 H, 4-CH_2), 4.02 (s, 3 H, 4″-OCH_3), 6.79 (d, *J* = 8.1 Hz, 1 H, 3″-H), 7.53 (ddd, *J* = 8.3, 6.9, 1.4 Hz, 1 H, 6″-H), 7.62 (ddd, *J* = 8.3, 6.9, 1.4 Hz, 1 H, 7″-H), 7.67 (d, *J* = 8.1 Hz, 1 H, 2″-H), 8.24 (d, *J* = 8.3 Hz, 1 H, 8″-H), 8.29 (d, *J* = 8.3 Hz, 1 H, 5″-H).

^{13}C NMR (75.5 MHz, $CDCl_3$): δ = 14.2 (2-CH_3), 22.7 (C-5), 31.4 (C-4), 37.9 (C-6), 55.7 (4″-OCH_3), 92.0 (C-1′), 102.3 (C-2′), 103.6 (C-3″), 112.2 (C-1″), 122.4 (C-5″), 125.3 (C-4a″), 125.6, 125.9, 127.7 (C-6″, C-7″, C-8″), 132.1 (C-2″), 133.9 (C-8a″), 137.8, 138.1 (C-2, C-3), 156.9 (C-4″), 198.5 (C-1).

UV (MeCN): λ_{max} (log ε) = 206.5 (4.561), 242.0 (4.411), 274.0 (3.971), 284.0 (3.965), 356.0 nm (4.427).

MS (EI, 70 eV): *m*/*z* (%) = 290.3 (100, $[M]^+$).

EI-HRMS: *m*/*z* calcd for $C_{20}H_{18}O_2$ (290.36): 290.1307; found: 290.1307.

Cleavage of THP Ethers 14, 15 for the Synthesis of Estrogen Analogues 2 and 3; General Procedure

To a solution of the THP ethers **14** or **15** (0.0452–3.16 mmol) in CH_2Cl_2 (15–16 mL/mmol) was added trifluoroacetic acid (1.5–1.6 mL/mmol) at r.t. and the resulting mixture was stirred until completion of the reaction. The solvent was evaporated at reduced pressure and the residue dissolved in THF. The resulting solution was slowly added to *n*-pentane (75 mL/mmol) and the formed precipitate was collected by filtration.

Cleavage of TIPS Protecting Groups in 2g and 3p; General Procedure

To a solution of the TIPS ether **2g** or **3p** (2.25–2.53 mmol) in THF (19–25 mL/mmol) was added *n*-$Bu_4NF{\cdot}3H_2O$ (1.86–3.03 equiv) at 0 °C. After stirring for 15 min at 0 °C, the stirring was continued at r.t. until completion of the reaction. The mixture was diluted with H_2O (40 mL/mmol), the layers were separated, and the aqueous layer was extracted with Et_2O (3 × 5.0 mL/mmol). The combined organic layers were washed with brine (5.0 mL/mmol), dried (Na_2SO_4) and the solvent was evaporated at reduced pressure. The product was isolated by column chromatography.

3-(4-Hydroxy-2-methylphenylethynyl)-2-methylcyclopent-2-enone (2a)

Yield: 45% (over two steps).

IR (KBr): 3128, 2188, 1653, 1592, 1456, 1394, 1355, 1305, 1272, 1220, 1084, 1046, 883, 858, 817, 745, 569 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.79 (t, *J* = 2.2 Hz, 3 H, 2-CH_3), 2.35 (s, 3 H, 2″-CH_3), 2.35–2.40 (m, 2 H, 5-CH_2), 2.67 (tq, *J* = 4.8, 2.2 Hz, 2 H, 4-CH_2), 6.65 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 6.73 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.34 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.98 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 9.4 (2-CH_3), 20.4 (2″-CH_3), 29.6 (C-4), 33.5 (C-5), 87.7 (C-1′), 105.2 (C-2′), 111.4 (C-1″), 113.5 (C-5″), 116.7 (C-3″), 133.9 (C-6″), 142.0, 142.1 (C-3, C-2″), 149.8 (C-2), 159.1 (C-4″), 207.5 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 226.1 (100, $[M]^+$), 183.1 (15, $[M - C_2H_2O - H]^+$), 170.1 (12, $[M - CO - C_2H_4]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{15}H_{14}O_2$ (226.27): 227.10721 $[M + H]^+$; found: 227.10666 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 239.0 (3.931), 260.5 (3.812), 325.0 nm (4.388).

3-(2-Ethyl-4-hydroxyphenylethynyl)-2-methylcyclopent-2-enone (2b)

Yield: 57% (over two steps).

IR (KBr): 3192, 2964, 2184, 1664, 1592, 1459, 1388, 1352, 1296, 1237, 1084, 881, 755 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.18 (t, *J* = 7.5 Hz, 3 H, 2″-CH_2CH_3), 1.79 (t, *J* = 2.0 Hz, 3 H, 2-CH_3), 2.33–2.39 (m, 2 H, 5-CH_2), 2.62–2.67 (m, 2 H, 4-CH_2), 2.71 (q, *J* = 7.5 Hz, 2 H, 2″-CH_2CH_3), 6.66 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 6.73 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.33 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.97 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 9.3 (2-CH_3), 14.6 (2″-CH_2CH_3), 27.2 (2″-CH_2CH_3), 29.6 (C-4), 33.5 (C-5), 87.3 (C-1′), 105.0 (C-2′), 110.6 (C-1″), 113.5 (C-5″), 115.2 (C-3″), 134.2 (C-6″), 141.9 (C-3), 148.2 (C-2″), 149.8 (C-2), 159.4 (C-4″), 207.4 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 240.2 (100, $[M]^+$), 225.1 (6, $[M - CH_3]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{16}H_{16}O_2$ (240.297): 241.12231 $[M + H]^+$; found: 241.12224 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 192.5 (4.4036), 239.5 (4.0017), 324.5 nm (4.4315).

3-(4-Hydroxy-2-*n*-propylphenylethynyl)-2-methylcyclopent-2-enone (2c)

Yield: 71% (over two steps).

IR (KBr): 3225, 2960, 2188, 1664, 1569, 1499, 1386, 1351, 1294, 1086, 826 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 0.91 (t, *J* = 7.5 Hz, 3 H, 2″-$CH_2CH_2CH_3$), 1.60 (sext, *J* = 7.5 Hz, 2 H, 2″-$CH_2CH_2CH_3$), 1.79 (t, *J* = 1.9 Hz, 3 H, 2-CH_3), 2.34–2.40 (m, 2 H, 5-CH_2), 2.63–2.71 (m, 4 H, 4-CH_2, 2″-$CH_2CH_2CH_3$), 6.66 (dd, *J* = 8.3, 2.4 Hz, 1 H, 5″-H), 6.71 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.34 (d, *J* = 8.3 Hz, 1 H, 6″-H), 9.97 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 9.3 (2-CH_3), 13.7 (2″-$CH_2CH_2CH_3$), 23.3 (2″-$CH_2CH_2CH_3$), 29.6 (C-4), 33.5 (C-5), 36.1 (2″-$CH_2CH_2CH_3$), 87.2 (C-1′), 105.2 (C-2′), 110.9 (C-1″), 113.6 (C-5″), 116.0 (C-3″), 134.2 (C-6″), 141.7 (C-3), 146.6 (C-2″), 149.8 (C-2), 159.1 (C-4″), 207.4 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 254.2 (100, $[M]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{17}H_{18}O_2$ (254.324): 255.13796 [M + H]$^+$, 277.11990 [M + Na]$^+$; found: 255.13803 [M + H]$^+$, 277.11998 [M + Na]$^+$.

UV (MeCN): λ_{max} (log ε) = 191.5 (4.5034), 240.0 (4.0230), 324.5 nm (4.4434).

3-(2-*n*-Butyl-4-hydroxyphenylethynyl)-2-methylcyclopent-2-enone (2d)

Yield: 55% (over two steps).

IR (KBr): 3219, 2928, 2186, 1663, 1590, 1455, 1386, 1352, 1295, 1272, 1238, 1087, 871, 820, 628 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 0.89 (t, *J* = 7.4 Hz, 3 H, 4‴-CH_3), 1.33 (sext, *J* = 7.4 Hz, 2 H, 3‴-CH_2), 1.50–1.62 (m, 2 H, 2‴-CH_2), 1.79 (t, *J* = 1.8 Hz, 3 H, 2-CH_3), 2.33–2.42 (m, 2 H, 5-CH_2), 2.61–2.75 (m, 4 H, 1‴-CH_2, 4-CH_2), 6.66 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 6.71 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.34 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.95 (br s, 1 H, 4″-OH).

^{13}C NMR (126 MHz, DMSO-d_6): δ = 9.3 (2-CH_3), 13.6 (C-4‴), 21.9 (C-3‴), 29.6 (C-4), 32.3 (C-2‴), 33.5, 33.7 (C-1‴, C-5), 87.2 (C-1′), 105.2 (C-2′), 110.9 (C-1″), 113.6 (C-5″), 115.9 (C-3″), 134.2 (C-6″), 141.7 (C-3), 146.8 (C-2″), 149.8 (C-2), 159.2 (C-4″), 207.4 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 268.2 (100, [M]$^+$).

EI-HRMS: *m*/*z* calcd for $C_{18}H_{20}O_2$ (268.350): 268.1463; found: 268.1457.

UV (MeCN): λ_{max} (log ε) = 240.0 (4.0243), 327.0 nm (4.4093).

3-(2-Trifluoromethyl-4-hydroxyphenylethynyl)-2-methylcyclopent-2-enone (2e)

Yield: 76% (over two steps).

IR (KBr): 3197, 2196, 1670, 1598, 1458, 1388, 1329, 1266, 1168, 1124, 1056, 894, 758 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.78 (t, *J* = 1.9 Hz, 3 H, 2-CH_3), 2.34–2.41 (m, 2 H, 5-CH_2), 2.62–2.69 (m, 2 H, 4-CH_2), 7.07 (dd, *J* = 8.5, 2.3 Hz, 1 H, 5″-H), 7.16 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.61 (d, *J* = 8.5 Hz, 1 H, 6″-H), 10.74 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 9.1 (2-CH_3), 29.3 (C-4), 33.5 (C-5), 88.0 (C-1′), 100.9 (C-2′), 108.8 (q, *J* = 2.2 Hz, C-1″), 113.3 (q, *J* = 5.3 Hz, C-3″), 119.1 (C-5″), 123.1 (q, *J* = 274 Hz, 2″-CF_3), 131.6 (q, *J* = 30 Hz, C-2″), 136.4 (C-6″), 143.6 (C-3), 148.5 (C-2), 159.0 (C-4″), 207.5 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 280.1 (100, [M]$^+$).

EI-HRMS: *m*/*z* calcd for $C_{15}H_{11}F_3O_2$ (280.242): 280.0711; found: 280.0711.

UV (MeCN): λ_{max} (log ε) = 319 nm (4.4520).

3-(2,6-Dichloro-4-hydroxyphenylethynyl)-2-methylcyclopent-2-enone (2f)

Yield: 82% (over two steps).

IR (KBr): 3137, 2198, 1665, 1588, 1435, 1394, 1356, 1289, 1093, 1065, 954, 863, 811, 751 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.82 (t, *J* = 1.9 Hz, 3 H, 2-CH_3), 2.36–2.43 (m, 2 H, 5-CH_2), 2.64–2.72 (m, 2 H, 4-CH_2), 6.96 (s, 2 H, 3″-H, 5″-H), 11.07 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 9.5 (2-CH_3), 29.2 (C-4), 33.5 (C_5), 92.6 (C-1′), 98.5 (C-2′), 111.5 (C-1″), 115.6 (C-3″, C-5″), 137.1 (C-2″, C-6″), 144.0 (C-3), 148.2 (C-2), 159.6 (C-4″), 207.4 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 280.0/282.0 (100/62, [M]$^+$), 245.1/247.1 (34/10, [M – Cl]$^+$), 182.1 (30, [M – 2 Cl – CO]$^+$).

ESI-HRMS: *m*/*z* calcd for $C_{14}H_{10}Cl_2O_2$ (281.134): 281.01306 [M + H]$^+$; found: 281.01317 [M + H]$^+$.

UV (MeCN): λ_{max} (log ε) = 204.5 (4.3576), 242.5 (4.0954), 248.0 (4.0876), 320.0 (4.4208), 409.5 nm (3.4482).

3-(4-Hydroxy-2-hydroxymethylphenylethynyl)-2-methylcyclopent-2-enone (2g)

Yield: 60% (over two steps).

IR (KBr): 3473, 2918, 2689, 2191, 1648, 1584, 1462, 1386, 1351, 1296, 1236, 1159, 1081, 1038, 874, 814, 630, 519 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.80 (t, *J* = 2.1 Hz, 3 H, 2-CH_3), 2.35–2.41 (m, 2 H, 5-CH_2), 2.67 (tq, *J* = 4.5, 2.1 Hz, 2 H, 4-CH_2), 4.62 (s, 2 H, 1‴-CH_2), 5.28 (s, 1 H, 1‴-OH), 6.68 (dd, *J* = 8.4, 2.3 Hz, 1 H, 5″-H), 7.02 (d, *J* = 2.3 Hz, 1 H, 3″-H), 7.34 (d, *J* = 8.4 Hz, 1 H, 6″-H), 10.03 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 9.4 (2-CH_3), 29.5 (C-4), 33.5 (C-5), 61.0 (C-1‴), 88.3 (C-1′), 103.8 (C-2′), 108.5 (C-1″), 113.5, 113.9 (C-3″, C-5″), 133.8 (C-6″), 142.1 (C-3), 146.8 (C-2″), 149.7 (C-2), 159.4 (C-4″), 207.5 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 242.1 (100, [M]$^+$), 157.1 (16, [M – 2 CO – C_2H_4 – H]$^+$).

EI-HRMS: *m*/*z* calcd for $C_{15}H_{14}O_3$ (242.27): 242.0943; found: 242.0943.

UV (MeCN): λ_{max} (log ε) = 239.0 (3.999), 324.5 nm (4.448).

3-(4-Hydroxy-2-methylphenylethynyl)-2-methylcyclohex-2-enone (3a)

Yield: 50% (over two steps).

IR (KBr): 3151, 2943, 2184, 1630, 1605, 1579, 1500, 1459, 1381, 1359, 1334, 1301, 1237, 1199, 1132, 1105, 1061, 953, 865, 816, 694, 584, 536, 483 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.92 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 1.94 (quint, *J* = 6.3 Hz, 2 H, 5-CH_2), 2.33 (s, 3 H, 2″-CH_3), 2.39 (t, *J* = 6.3 Hz, 2 H, 6-CH_2), 2.54 (tq, *J* = 6.3, 1.6 Hz, 2 H, 4-CH_2), 6.63 (dd, *J* = 8.4, 2.3 Hz, 1 H, 5″-H), 6.71 (d, *J* = 2.3 Hz, 1 H, 3″-H), 7.30 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.91 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.7 (2-CH_3), 20.4 (2″-CH_3), 22.2 (C-5), 30.6 (C-4), 37.2 (C-6), 90.8 (C-1′), 103.0 (C-2′), 111.8 (C-1″), 113.4 (C-5″), 116.6 (C-3″), 133.7 (C-6″), 136.2, 137.6 (C-2, C-3), 141.9 (C-2″), 158.8 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 240.2 (100, [M]$^+$), 212.2 (22, [M – CO]$^+$), 184.1 (10, [M – CO – C_2H_4]$^+$).

EI-HRMS: *m*/*z* calcd for $C_{16}H_{16}O_2$ (240.30): 240.1150; found: 240.1150.

UV (MeCN): λ_{max} (log ε) = 241.0 (3.999), 330.5 nm (4.429).

3-(2-Ethyl-4-hydroxyphenylethynyl)-2-methylcyclohex-2-enone (3b)

Yield: 45% (over two steps).

IR (KBr): 3255, 2934, 2181, 1635, 1585, 1496, 1452, 1382, 1358, 1336, 1297, 1233, 1199, 1064, 912, 880, 835, 715 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.17 (t, *J* = 7.5 Hz, 3 H, 2′-CH_2CH_3), 1.88–1.99 (m, 2 H, 5-CH_2), 1.92 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 2.39 (t, *J* = 6.6 Hz, 2 H, 6-CH_2), 2.50–2.58 (m, 2 H, 4-CH_2), 2.69 (q, *J* = 7.5 Hz, 2 H, 2″-CH_2CH_3), 6.64 (dd, *J* = 8.4, 2.3 Hz, 1 H, 5″-H), 6.71 (d, *J* = 2.3 Hz, 1 H, 3″-H), 7.30 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.92 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.5 (2-CH_3), 14.7 (2″-CH_2CH_3), 22.2 (C-5), 27.2 (2″-CH_2CH_3), 30.6 (C-4), 37.2 (C-6), 90.3 (C-1′), 102.8 (C-2′), 111.0 (C-1″), 113.4, 115.2 (C-3″, C-5″),

134.0 (C-6″), 136.1, 137.6 (C-2, C-3), 148.0 (C-2″), 159.1 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 254.2 (100, $[M]^+$), 239.2 (8, $[M - CH_3]^+$), 226.2 (13, $[M - C_2H_4]^+$).

EI-HRMS: *m*/*z* calcd for $C_{17}H_{18}O_2$ (254.324): 254.1307; found: 254.1307.

UV (MeCN): λ_{max} (log ε) = 192.0 (4.5330), 241.5 (4.0283), 332.0 nm (4.4434).

3-(2-Ethyl-4-hydroxyphenylethynyl)-2-ethylcyclohex-2-enone (3c)

Yield: 42% (over two steps).

IR (KBr): 3311, 2964, 2181, 1634, 1614, 1568, 1495, 1376, 1334, 1299, 1253, 1218, 1083, 820 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 0.96 (t, *J* = 7.5 Hz, 3 H, 2-CH_2CH_3), 1.16 (t, *J* = 7.5 Hz, 3 H, 2″-CH_2CH_3), 1.91 (quint, *J* = 6.4 Hz, 2 H, 5-CH_2), 2.33–2.39 (m, 2 H, 6-CH_2), 2.43 (q, *J* = 7.5 Hz, 2 H, 2-CH_2CH_3), 2.53 (t, *J* = 6.0 Hz, 2 H, 4-CH_2), 2.68 (q, *J* = 7.5 Hz, 2 H, 2″-CH_2CH_3), 6.65 (dd, *J* = 8.3, 2.4 Hz, 1 H, 5″-H), 6.71 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.29 (d, *J* = 8.3 Hz, 1 H, 6″-H), 9.92 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.4 (2-CH_2CH_3), 14.9 (2″-CH_2CH_3), 21.1 (2-CH_2CH_3), 22.2 (C-5), 27.2 (2″-CH_2CH_3), 30.7 (C-4), 37.4 (C-6), 89.9 (C-1′), 102.2 (C-2′), 111.0 (C-1″), 113.5 (C-5″), 115.2 (C-3″), 134.1 (C-6″), 137.3 (C-3), 142.1 (C-2), 148.0 (C-2″), 159.1 (C-4″), 196.6 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 268.2 (100, $[M]^+$), 253.2 (11, $[M - CH_3]^+$), 240.1 (17, $[M - CO]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{18}H_{20}O_2$ (268.350): 269.15361 $[M + H]^+$; found: 269.15354 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 194.5 (4.4425), 242.0 (3.9861), 332.0 nm (4.3858).

3-(4-Hydroxy-2-isopropylphenylethynyl)-2-methylcyclohex-2-enone (3d)

Yield: 59% (over two steps).

IR (KBr): 3323, 2956, 2181, 1634, 1583, 1444, 1384, 1357, 1333, 1297, 1221, 1198, 1057, 820 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.20 [d, *J* = 6.9 Hz, 6 H, 2″-$CH(CH_3)_2$], 1.89–1.99 (m, 2 H, 5-CH_2), 1.92 (t, *J* = 1.7 Hz, 2-CH_3), 2.35–2.43 (m, 2 H, 6-CH_2), 2.50–2.58 (m, 2 H, 4-CH_2), 3.21–3.38 [sept, *J* = 6.9 Hz, 1 H, 2″-$CH(CH_3)_2$], 6.64 (dd, *J* = 8.5, 2.5 Hz, 1 H, 5″-H), 6.74 (d, *J* = 2.5 Hz, 1 H, 3″-H), 7.30 (d, *J* = 8.5 Hz, 1 H, 6″-H), 9.92 (br s, 1 H, 4″-OH).

^{13}C NMR (50.3 MHz, DMSO-d_6): δ = 13.5 (2-CH_3), 22.2 (C-5), 22.7 [2″-$CH(CH_3)_2$], 30.6 (C-4), 31.2 [2″-$CH(CH_3)_2$], 37.2 (C-6), 90.6 (C-1′), 102.8 (C-2′), 110.7 (C-1″), 112.2, 113.4 (C-3″, C-5″), 134.2 (C-6″), 136.1 (C-2), 137.6 (C-3), 152.3 (C-2″), 159.2 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 268.2 (100, $[M]^+$), 253.1 (24, $[M - CH_3]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{18}H_{20}O_2$ (268.350): 269.15361 $[M + H]^+$; found: 269.15353 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 195.5 (4.4027), 241.5 (3.9942), 332.0 nm (4.4093).

3-(2-*tert*-Butyl-4-hydroxyphenylethynyl)-2-methylcyclohex-2-enone (3e)

Yield: 41% (over two steps).

IR (KBr): 3229, 2949, 2176, 1637, 1583, 1443, 1382, 1359, 1298, 1240, 1058, 881 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.43 [s, 9 H, 2″-$C(CH_3)_3$], 1.88–1.99 (m, 2 H, 5-CH_2), 1.93 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 2.38 (dd, *J* = 7.4, 6.2 Hz, 2 H, 6-CH_2), 2.50–2.58 (m, 2 H, 4-CH_2), 6.64 (dd, *J* = 8.4, 2.3 Hz, 1 H, 5″-H), 6.83 (d, *J* = 2.3 Hz, 1 H, 3″-H), 7.33 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.90 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.6 (2-CH_3), 22.2 (C-5), 29.6 [2″-$C(CH_3)_3$], 30.2 (C-4), 35.3 [2″-$C(CH_3)_3$], 37.2 (C-6), 92.1 (C-1′), 105.6 (C-2′), 110.0 (C-1″), 112.8 (C-5″), 113.3 (C-3″), 135.9 (C-2), 137.2 (C-6″), 137.7 (C-3), 153.3 (C-2″), 158.8 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 282.3 (100, $[M]^+$).

EI-HRMS: *m*/*z* calcd for $C_{19}H_{22}O_2$ (282.377): 282.1620; found: 282.1620.

UV (MeCN): λ_{max} (log ε) = 242.2 (3.9987), 332.5 nm (4.4078).

3-(4-Hydroxy-2-*n*-propylphenylethynyl)-2-methylcyclohex-2-enone (3f)

Yield: 56% (over two steps).

IR (KBr): 2951, 2185, 1578, 1447, 1379, 1360, 1308, 1233, 1060, 861, 479 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 0.91 (t, *J* = 7.3 Hz, 3 H, 2″-$CH_2CH_2CH_3$), 1.59 (sext, *J* = 7.5 Hz, 2 H, 2″-$CH_2CH_2CH_3$), 1.88–1.99 (m, 2 H, 5-CH_2), 1.93 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 2.39 (t, *J* = 6.7 Hz, 2 H, 6-CH_2), 2.50–2.57 (m, 2 H, 4-CH_2), 2.65 (t, *J* = 7.7 Hz, 2 H, 2″-$CH_2CH_2CH_3$), 6.65 (dd, *J* = 8.3, 2.4 Hz, 1 H, 5″-H), 6.70 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.30 (d, *J* = 8.3 Hz, 1 H, 6″-H), 9.90 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.5, 13.6 (2-CH_3, 2″-$CH_2CH_2CH_3$), 22.2 (C-5), 23.3 (2″-$CH_2CH_2CH_3$), 30.6 (C-4), 36.1 (2″-$CH_2CH_2CH_3$), 37.2 (C-4), 90.2 (C-1′), 103.1 (C-2′), 111.4 (C-1″), 113.5 (C-5″), 116.0 (C-3″), 134.0 (C-6″), 136.0 (C-3), 137.6 (C-2), 146.4 (C-2″), 158.9 (C-4″), 197.0 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 268.2 (100, $[M]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{18}H_{20}O_2$ (268.350): 269.15361 $[M + H]^+$, 291.13555 $[M + Na]^+$; found: 269.15372 $[M + H]^+$, 291.13573 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 241.5 (4.0025), 332.0 nm (4.3951).

3-(4-Hydroxy-2-*n*-butylphenylethynyl)-2-methylcyclohex-2-enone (3g)

Yield: 57% (over two steps).

IR (KBr): 3122, 2935, 2183, 1626, 1578, 1451, 1380, 1359, 1304, 1235, 1061, 865 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 0.88 (t, *J* = 7.4 Hz, 3 H, 4‴-CH_3), 1.32 (sext, *J* = 7.4 Hz, 2 H, 3‴-CH_2), 1.48–1.61 (m, 2 H, 2‴-CH_2), 1.88–1.98 (m, 2 H, 5-CH_2), 1.92 (t, *J* = 1.7 Hz, 3 H, 2-CH_3), 2.38 (t, *J* = 6.6 Hz, 2 H, 6-CH_2), 2.49–2.57 (m, 2 H, 4-CH_2), 2.66 (t, *J* = 7.6 Hz, 2 H, 1‴-CH_2), 6.64 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 6.69 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.29 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.90 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.6, 13.6 (C-4‴, 2-CH_3), 21.9 (C-3‴), 22.2 (C-5), 30.6 (C-4), 32.3 (C-2‴), 33.8 (C-1‴), 37.2 (C-6), 90.2 (C-1′), 103.1 (C-2′), 111.3 (C-1″), 113.5 (C-5″), 115.9 (C-3″), 134.1 (C-6″), 136.1 (C-3), 137.6 (C-2), 146.6 (C-2″), 158.9 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 282.2 (100, $[M]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{19}H_{22}O_2$ (282.377): 283.16926 $[M + H]^+$, 305.15120 $[M + Na]^+$; found: 283.16930 $[M + H]^+$, 305.15125 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 191.5 (4.5363), 242.0 (4.0317), 331.5 nm (4.4398).

3-(4-Hydroxy-2-*n*-nonylphenylethynyl)-2-methylcyclohex-2-enone (3h)
Yield: 60% (over two steps).

IR (KBr): 3380, 2921, 2850, 2182, 1639, 1578, 1444, 1382, 1358, 1291, 1218, 1060, 876, 822, 659 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 0.83 (t, *J* = 7.0 Hz, 3 H, 9‴-CH_3), 1.15–1.35 (m, 12 H, 3‴-CH_2, 4‴-CH_2, 5‴-CH_2, 6‴-CH_2, 7‴-CH_2, 8‴-CH_2), 1.48–1.61 (m, 2 H, 2‴-CH_2), 1.87–1.98 (m, 2 H, 5-CH_2), 1.92 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 2.38 (t, *J* = 6.7 Hz, 2 H, 6-CH_2), 2.47–2.56 (m, 2 H, 4-CH_2), 2.65 (t, *J* = 7.7 Hz, 2 H, 1‴-CH_2), 6.64 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 6.68 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.29 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.89 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.6, 13.8 (C-9‴, 2-*C*H_3), 22.0, 22.2 (C-5, C-8‴), 28.6 (C-7‴), 28.7 (C-6‴), 28.8 (C-5‴), 28.9 (C-4‴), 30.2, 30.6, 31.2 (C-2‴, C-3‴, C-4), 34.1 (C-1‴), 37.2 (C-6), 90.2 (C-1′), 103.1 (C-2′), 111.3 (C-1″), 113.5 (C-5″), 115.8 (C-3″), 134.0 (C-6″), 136.0 (C-3), 137.6 (C-2), 146.6 (C-2″), 158.9 (C-4″), 196.9 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 352.3 (100, $[M]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{24}H_{32}O_2$ (352.510): 353.24751 $[M + H]^+$; found: 353.24758 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 194.0 (4.4735), 242.0 (4.0226), 332.0 nm (4.4237).

3-(4-Hydroxy 2-phenylphenylethynyl)-2-methylcyclohex-2-enone (3i)
Yield: 23% (over two steps).

IR (KBr): 3310, 2182, 1633, 1580, 1433, 1382, 1359, 1308, 1226, 1068, 772, 701 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.64 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 1.85 (sext, *J* = 6.3 Hz, 2 H, 5-CH_2), 2.29–2.39 (m, 2 H, 4-CH_2, 6-CH_2), 6.81–6.87 (m, 2 H, 3-H, 5-H), 7.35–7.55 (m, 6 H, 2‴-H, 3‴-H, 4‴-H, 5‴-H, 6″-H, 6‴-H), 10.18 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.3 (2-*C*H_3), 22.1 (C-5), 30.2 (C-4), 37.2 (C-6), 89.3 (C-1′), 103.9 (C-2′), 110.4 (C-1″), 114.9 (C-5″), 116.3 (C-3″), 127.6 (C-4‴), 128.0 (C-2‴, C-6‴), 128.7 (C-3‴, C-5‴), 135.0 (C-6″), 136.4, 137.4, 139.7 (C-1‴, C-2, C-3), 145.5 (C-2″), 158.9 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 302.3 (100, $[M]^+$).

EI-HRMS: *m*/*z* calcd for $C_{21}H_{18}O_2$ (302.366): 302.1307; found: 302.1307.

UV (MeCN): λ_{max} (log ε) = 199.5 (4.5188), 229.5 (4.2247), 261.5 (4.1881), 334.5 nm (4.3579).

3-(2-Trifluoromethyl-4-hydroxyphenylethynyl)-2-methylcyclohex-2-enone (3j)
Yield: 82% (over two steps).

IR (KBr): 3132, 2955, 2191, 1634, 1612, 1579, 1508, 1457, 1383, 1363, 1330, 1263, 1201, 1167, 1133, 1078, 1042, 908, 886 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.90 (t, *J* = 1.7 Hz, 3 H, 2-CH_3), 1.90–1.99 (m, 2 H, 5-CH_2), 2.39 (t, *J* = 6.7 Hz, 2 H, 6-CH_2), 2.50–2.54 (m, 2 H, 4-CH_2), 7.06 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 7.14 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.57 (d, *J* = 8.4 Hz, 1 H, 6″-H), 10.68 (br s, 1 H, 4″-O*H*).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.4 (2-CH_3), 22.1 (C-5), 30.2 (C-4), 37.2 (C-6), 91.1 (C-1′), 98.6 (C-2′), 109.2 (q, *J* = 2.2 Hz, C-1″), 113.2 (q, *J* = 5.2 Hz, C-3″), 119.13 (C-5″), 123.1 (q, *J* = 274 Hz, 2″-CF_3), 131.3 (q, *J* = 30 Hz, C-2″), 136.3 (C-6″), 136.5, 137.7 (C-2, C-3), 158.7 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 294.1 (100, $[M]^+$), 266.0 (37, $[M - CO]^+$).

EI-HRMS: *m*/*z* calcd for $C_{16}H_{13}F_3O_2$ (294.268): 294.0868; found: 294.0868.

UV (MeCN): λ_{max} (log ε) = 236.5 (3.8499), 322.0 nm (4.4478).

3-(2-Trifluoromethyl-4-hydroxyphenylethynyl)-2-isopropylcyclohex-2-enone (3k)
Yield: 42% (over two steps).

IR (KBr): 3332, 2946, 2186, 1611, 1568, 1449, 1326, 1259, 1168, 1135, 912, 877 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.15 [d, *J* = 7.1 Hz, 6 H, 2-CH(C*H*$_3$)$_2$], 1.88 (m, 2 H, 5-CH_2), 2.34 (t, *J* = 6.7 Hz, 2 H, 6-CH_2), 2.51 (t, *J* = 6.0 Hz, 2 H, 4-CH_2), 3.24 [sept, *J* = 7.1 Hz, 1 H, 2-C*H*(CH$_3$)$_2$], 7.06 (dd, *J* = 8.5, 2.4 Hz, 1 H, 5″-H), 7.14 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.55 (d, *J* = 8.5 Hz, 1 H, 6″-H), 10.70 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 20.3 [2-CH(*C*H$_3$)$_2$], 22.0 (C-5), 29.4 [2-*C*H(CH$_3$)$_2$], 31.1 (C-4), 38.4 (C-5), 91.0 (C-1′), 98.8 (C-2′), 109.3 (q, *J* = 2.3 Hz, C-1″), 113.3 (q, *J* = 5.2 Hz, C-3″), 119.2 (C-5″), 123.1 (q, *J* = 274 Hz, 2″-CF_3), 131.2 (q, *J* = 30 Hz, C-2″), 135.7 (C-3), 136.2 (C-6″), 146.3 (C-2), 158.7 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 322.2 (100, $[M]^+$), 307.2 (70, $[M - CH_3]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{18}H_{17}F_3O_2$ (322.322): 323.12534 $[M + H]^+$, 345.10729 $[M + Na]^+$; found: 323.12524 $[M + H]^+$, 345.10716 $[M + Na]^+$.

UV (MeCN): λ_{max} (log ε) = 237.0 (3.8253), 322.0 nm (4.4263).

3-(4-Hydroxy-2,6-dimethylphenylethynyl)-2-methylcyclohex-2-enone (3l)
Yield: 46% (over two steps).

IR (KBr): 3326, 2938, 2178, 1638, 1609, 1579, 1466, 1382, 1359, 1321, 1307, 1257, 1217, 1197, 1165, 1068, 860, 691 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.92 (t, *J* = 1.7 Hz, 3 H, 2-CH_3), 1.94 (quint, *J* = 6.4 Hz, 2 H, 5-CH_2), 2.31 (s, 6 H, 2″-CH_3, 6″-CH_3), 2.39 (t, *J* = 6.4 Hz, 2 H, 6-CH_2), 2.56 (tq, *J* = 6.4, 1.7 Hz, 2 H, 4-CH_2), 6.55 (s, 2 H, 3″-H, 5″-H), 9.79 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.7 (2-CH_3), 20.7 (2″-CH_3, 6″-CH_3), 22.2 (C-5), 30.7 (C-4), 37.2 (C-6), 95.2 (C-1′), 102.1 (C-2′), 112.0 (C-1″), 114.2 (C-3″, C-5″), 135.6, 137.9 (C-2, C-3), 142.1 (C-2″, C-6″), 158.3 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 254.2 (100, $[M]^+$), 226.2 (15, $[M - CO]^+$), 198.2 (12, $[M - CO - C_2H_4]^+$), 183.1 (12, $[M - CO - C_3H_6 - H]^+$), 145.1 (11, $[M - CO - C_2H_2O - C_3H_3]^+$), 115.1 (14, $[C_9H_7]^+$), 55.0 (14, $[C_3H_3O]^+$), 44.0 (29, $[C_2H_3O]^+$), 41.0 (33, $[C_3H_5]^+$).

(EI-HRMS): *m*/*z* calcd for $C_{17}H_{18}O_2$ (254.32): 254.1307; found: 254.1307.

UV (MeCN): λ_{max} (log ε) = 197.0 (4.441), 245.0 (4.022), 337.0 nm (4.458).

3-(2-Fluoro-4-hydroxyphenylethynyl)-2-methylcyclohex-2-enone (3m)
Yield: 40% (over two steps).

IR (KBr): 3071, 2946, 2186, 1622, 1572, 1508, 1458, 1384, 1362, 1330, 1308, 1238, 1162, 1106, 1063, 968, 845, 811, 608, 582, 488 cm^{-1}.

^1H NMR (300 MHz, DMSO-d_6): δ = 1.90 (t, *J* = 1.8 Hz, 3 H, 2-CH_3), 1.93 (quint, *J* = 6.4 Hz, 2 H, 5-CH_2), 2.39 (t, *J* = 6.4 Hz, 2 H, 6-CH_2), 2.52 (tq, *J* = 6.4, 1.7 Hz, 2 H, 4-CH_2), 6.63–6.70 (m, 2 H, 3″-H, 5″-H), 7.38 (t, $J_{ortho} = J_{H-F}$ = 8.6 Hz, 1 H, 6″-H), 10.55 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.6 (2-CH_3), 22.2 (C-5), 30.2 (C-4), 37.2 (C-6), 91.5 (d, *J* = 3.2 Hz, C-1′), 96.7 (C-2′), 100.1 (d, *J* = 15.8 Hz, C-1″), 103.0 (d, *J* = 22.7 Hz, C-3″), 112.4 (d, *J* = 2.5 Hz, C-5″), 134.2 (d, *J* = 2.9 Hz, C-6″), 136.8, 137.2 (C-2, C-3), 160.8 (d, *J* = 11.7 Hz, C-4″), 162.9 (d, *J* = 250 Hz, C-2″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 244.2 (100, $[M]^+$), 216.2 (15, $[M - CO]^+$), 188.2 (17, $[M - CO - C_2H_4]^+$), 85.1 (44, $[C_4H_2FO]^+$), 57.1 (14, $[C_3H_3O]^+$), 43.0 (18, $[C_2H_2O]^+$).

EI-HRMS: *m*/*z* calcd for $C_{15}H_{13}FO_2$ (244.26): 244.0900; found: 244.0900.

UV (MeCN): λ_{max} (log ε) = 236.5 (4.000), 257.0 (3.892), 321.0 nm (4.465).

3-(2,6-Dichloro-4-hydroxyphenylethynyl)-2-methylcyclohex-2-enone (3n)

Yield: 51% (over two steps).

IR (KBr): 3261, 2193, 1639, 1583, 1432, 1384, 1361, 1299, 1226, 1051, 860, 810 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.89–2.00 (m, 2 H, 5-CH_2), 1.94 (t, *J* = 1.6 Hz, 3 H, 2-CH_3), 2.40 (t, *J* = 6.7 Hz, 2 H, 6-CH_2), 2.50–2.58 (m, 2 H, 4-CH_2), 6.94 (s, 2 H, 3″-H, 5″-H), 11.00 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.8 (2-CH_3), 22.2 (C-5), 30.13 (C-4), 37.2 (C-6), 95.7 (C-1′), 96.5 (C-2′), 111.8 (C-1″), 115.6 (C-3″, C-5″), 136.3 (C-3), 137.1 (C-2″, C-6″), 137.9 (C-2), 159.4 (C-4‴), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 294.0/296.0 (100/61, $[M]^+$), 266.0/268.0 (38/23, $[M - CO]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{15}H_{12}Cl_2O_2$ (295.161): 295.02871 $[M + H]^+$; found: 295.02880 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 204.0 (4.3091), 243.0 (4.0115), 322.5 (4.3592), 414.0 nm (3.3796).

3-(2,6-Dichloro-4-hydroxyphenylethynyl)-2-ethylcyclohex-2-enone (3o)

Yield: 64% (over two steps).

IR (KBr): 2965, 2196, 1620, 1556, 1433, 1375, 1335, 1306, 1265, 1197, 1102, 1061, 849, 815 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 0.95 (t, *J* = 7.5 Hz, 3 H, 2-CH_2CH_3), 1.93 (quint, *J* = 6.3 Hz, 2 H, 5-CH_2), 2.39 (t, *J* = 6.7 Hz, 2 H, 6-CH_2), 2.47 (q, *J* = 7.5 Hz, 2 H, 2-CH_2CH_3), 2.54 (t, *J* = 6.0 Hz, 2 H, 4-CH_2), 6.94 (s, 2 H, 3″-H, 5″-H), 11.00 (br s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.3 (2-CH_2CH_3), 21.1 (2-CH_2CH_3), 22.2 (C-5), 30.2 (C-4), 37.5 (C-6), 95.3, 96.1 (C-1′, C-2′), 111.8 (C-1″), 115.6 (C-3″, C-5″), 136.0 (C-3), 137.1 (C-2″, C-6″), 143.8 (C-2), 159.4 (C-4″), 196.7 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 308.0/310.1 (100/65, $[M]^+$).

ESI-HRMS: *m*/*z* calcd for $C_{16}H_{14}Cl_2O_2$ (309.187): 309.04436 $[M + H]^+$; found: 309.04429 $[M + H]^+$.

UV (MeCN): λ_{max} (log ε) = 204.5 (4.0896), 243.5 (3.7912), 324.5 (4.1372), 416.0 nm (3.0889).

3-(4-Hydroxy-2-hydroxymethylphenylethynyl)-2-methylcyclohex-2-enone (3p)

Yield: 45% (over two steps).

IR (KBr): 3507, 3291, 2946, 2184, 1632, 1574, 1494, 1465, 1383, 1361, 1334, 1298, 1241, 1198, 1161, 1133, 1106, 1066, 1035, 910, 876, 826, 689, 489 cm^{-1}.

^{1}H NMR (300 MHz, DMSO-d_6): δ = 1.92 (t, *J* = 1.7 Hz, 3 H, 2-CH_3), 1.94 (quint, *J* = 6.4 Hz, 2 H, 5-CH_2), 2.39 (t, *J* = 6.4 Hz, 2 H, 6-CH_2), 2.54 (tq, *J* = 6.4, 1.7 Hz, 2 H, 4-CH_2), 4.58 (s, 2 H, 1‴-CH_2), 5.25 (s, 1 H, 1‴-OH), 6.66 (dd, *J* = 8.4, 2.4 Hz, 1 H, 5″-H), 7.00 (d, *J* = 2.4 Hz, 1 H, 3″-H), 7.30 (d, *J* = 8.4 Hz, 1 H, 6″-H), 9.99 (s, 1 H, 4″-OH).

^{13}C NMR (75.5 MHz, DMSO-d_6): δ = 13.7 (2-CH_3), 22.2 (C-5), 30.6 (C-4), 37.3 (C-6), 61.1 (C-1‴), 91.4 (C-1′), 101.7 (C-2′), 108.9 (C-1″), 113.4, 113.9 (C-3″, C-5″), 133.7 (C-6″), 136.3, 137.5 (C-2, C-3), 146.6 (C-2″), 159.2 (C-4″), 197.1 (C-1).

MS (EI, 70 eV): *m*/*z* (%) = 256.1 (100, $[M]^+$), 238.1 (22, $[M - OH - H]^+$), 182.1 (32, $[M - OH - 2 CO - H]^+$), 157.1 (40, $[M - OH - 2 CO - C_2H_2]^+$), 128.1 (35, $[M - OH - 2 CO - C_2H_4 - C_2H_2 - H]^+$), 115.1 (42, $[C_9H_7]^+$), 91.1 (30, $[C_7H_7]^+$), 77.0 (39, $[C_6H_5]^+$), 55.0 (33, $[C_3H_3O]^+$), 42.0 (52, $[C_3H_6]^+$), 41.0 (62, $[C_3H_5]^+$).

EI-HRMS: *m*/*z* calcd for $C_{16}H_{16}O_3$ (256.30): 256.1099; found: 256.1099.

UV (MeCN): λ_{max} (log ε) = 241.0 (3.990), 330.0 nm (4.431).

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