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Supporting Information

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A New General and Highly Versatile Method for C,C-Cross-Coupling Synthesis of Conjugated Enynes: One-Pot Sequence Starting from All-Carbonyl Precursors

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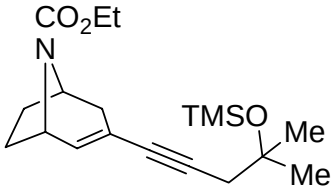
General. NMR spectra were recorded on *Bruker* WH 270, *Bruker 400 UltraShield*, and *Bruker* AMX 500 instruments in $CDCl_3$ as a solvent unless stated otherwise. ^1H and ^{13}C chemical shifts are expressed as ppm downfield from $SiMe_4$ ($\delta = 0$) used as an internal standard. Mass spectra were registered with *Varian* MAT 711 and with *Finnigan MAT 95XP* (HRMS) spectrometers. Microanalyses were performed with *Euro Elemental Analyser*. IR spectra were measured with a spectrometer 5 SXC Nicolet. TLC-analysis was performed using *Merck* silica gel *60 F_{254}* plates. Column chromatography was conducted on silica gel 60 (40–63 μm, *Fluka*).

The *one-pot* nonaflation–elimination–Sonogashira coupling sequences were carried out under an atmosphere of dry argon in heat-gun dried reaction flasks by adding the components via syringes unless stated otherwise. Solvents for reactions were dried by standard procedures. Nonafluorobutane-1-sulfonyl fluoride was obtained from *Bayer AG*; it can also be purchased from *Aldrich*.

One-Pot Synthesis and Spectroscopic Data of the Coupling Products 4 and 6

Typical procedure for the preparation of the compound **4a** is given in the manuscript.

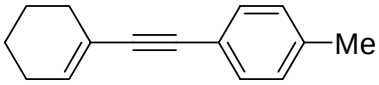
Synthesis of ethyl 3-(4-Methyl-4-trimethylsilyloxy-pent-1-ynyl)-8-aza-bicyclo[3.2.1]oct-2-ene-8-carboxylate (4b).



Pre-dried LiCl (0.064 g, 1.50 mmol) was placed into a reaction flask equipped with a three-way tap and a magnet stirrer coated with Teflon, and heated to *ca*. 250–300°C with a heat-gun under high vacuum for a few minutes. After flushing with dry argon and cooling down, DMF (1 ml), *N*-ethoxycarbonyl tropinone **1a** (0.197 g, 1.00 mmol), 4-methyl-4-trimethylsilyloxy-pentan-2-one **2b** (0.245 g, 1.30 mmol) and NfF (0.765 g, 2.53 mmol) were successively added, the reaction mixture was cooled down to 10°C under vigorous stirring, and P_1-base (2.406 g, 7.70 mmol) was added dropwise for 2–3 min. After completion of the nonaflation–elimination step (24 h at r.t., ^1H NMR control), *i*Pr_2NH (1.5 ml) was added, followed by solid PPh_3 (0.026 g, 0.10 mmol), CuI (0.019 g, 0.10 mmol), $Pd(OAc)_2$ (0.011 g, 0.05 mmol) (all together in one lot), and the reaction mixture was stirred at 60°C for 4 h. After cooling down to ambient temperature, the reaction mixture was subjected to the aqueous workup as described in *the typical procedure* for the compound **4a** using hexane as a solvent for extraction. Column chromatography (silica gel, gradient elution: hexane to *t*BuOMe/hexane 1:20 to 1:10 to 1:8) furnished the pure product **4b** (0.286 g, 82% yield) as a yellowish oil. ^1H NMR (C_6D_6, 500 MHz, 75°C): $\delta = 0.15$ (s, 9 H, $OSiMe_3$), 1.05 (t, $J = 7.1$ Hz, 3 H, $OCH_2\mathit{Me}$), 1.29 (s, 6 H, CMe_2), 1.32–1.38 (br.m, 1 H), 1.56 (br.m_c, 1 H), 1.61–1.69 (m, 1 H), 1.75–1.82 (m, 2 H), 2.96 (br.d, $J = 15$ Hz, 1 H) (all

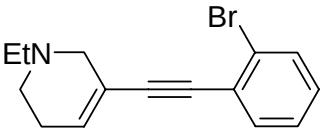
CH_2), 2.42 (s, 2 H, CH_2C≡C), 4.07 (m_c, 2 H, OCH_2Me), 4.30 (br.s, 1 H, CHN), 4.37 (br.s, 1 H, CHN), 6.18 (br.d, J = 5 Hz, CH=); ^{13}C (C_6D_6, 125.8 MHz, 75°C): δ = 2.5 (q, $OSiMe_3$), 14.7 (q, OCH_2*Me*), 29.7 (q, C*Me*$_2$), 29.9, 34.6, 38.8 (all br.t., CH_2), 36.3 (t, C≡C*C*H_2), 52.4, 53.5 (both d, CHN), 60.8 (t, O*C*H_2Me), 73.9 (s, *C*Me_2), 82.9, 87.7 (both s, C≡C), 120.5 (br.s, *C*=CH), 137.2 (br.d, C=*C*H), 154.4 (s, C=O). IR (film): $\tilde{\nu}$ = 2980–2860 cm^{-1} (C-H), 2220 (C≡C), 1700 (C=O). MS (EI, 80 eV): m/z (%) = 349 (M^+, 2.3), 334 ([M^+ – CH_3], 5.4), 291 ([M^+ – $SiMe_2$], 30), 131 ([$Me_3SiOCMe_2^+$], 100), 73 ([Me_3Si^+], 29), 29 ($C_2H_5^+$, 6.3). C,H,N-analysis (%): calcd. for $C_{19}H_{31}NO_3Si$ (349.5): C 65.29, H 8.94, N, 4.01; found C 64.80, H 8.71, N, 3.99.

Synthesis of 1-cyclohex-1-enylethynyl-4-methyl-benzene (4c).



Pre-dried LiCl (0.127 g, 3.00 mmol) was placed in the reaction flask equipped with three-way tap and magnet stirrer coated with Teflon and heated to *ca*. 250–300°C with heat-gun in a high vacuum for a few minutes. After flushing with dry argon and cooling down, DMF (2 mL) cyclohexanone **1b** (0.196 g, 2.00 mmol) and 4-methylacetophenone **2c** (0.309 g, 2.30 mmol) and NfF (1.429 g, 4.73 mmol) were successively added, the reaction mixture was cooled down to 10°C under vigorous stirring, and P_1-base (2.268 g, 7.26 mmol) was added dropwise for 2–3 min. After the completion of the nonaflation–elimination step (24 h at ambient temperature then ^{1}H NMR control), *i*Pr_2NH (4 mL) was added followed by solid PPh_3 (0.052 g, 0.20 mmol), CuI (0.038 g, 0.20 mmol), $Pd(OAc)_2$ (0.022 g, 0.10 mmol) (all together in one lot), and the reaction mixture was stirred at ambient temperature for 24 h. Aqueous workup as described in the *typical procedure* for the compound **4a** using hexane as a solvent for extraction followed by column chromatography (silica gel, hexane) furnished the pure product **4c** (0.262 g, 67% yield) as a yellowish oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.64 (m_c, 4 H), 2.09–2.17 (m, 2 H), 2.18–2.25 (m, 2 H) (all CH_2), 2.33 (s, 3 H, Me), 6.18 (tt, ^3J = 4 Hz, ^4J = 2 Hz, CH=), 7.09 (2 H, CH_{Ar}), 7.31 (2 H, CH_{Ar}) (both AA'BB' system, ^3J = 8.1 Hz, 4-MeC_6H_4); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 21.4 (q, Me), 21.5, 22.3, 25.7, 29.3 (all t, CH_2), 86.9, 90.5 (both s, C≡C), 120.6, 120.8 (both s, *C*=CH, C_{Ar}C≡C), 128.9, 131.3 (both d, CH_{Ar}), 134.7 (d, C=*C*H), 137.7 (s, C_{Ar}Me). m/z (%) = 196 (M^+, 100), 181 ([M^+ – CH_3], 54), 168 ([M^+ – C_2H_4], 61).

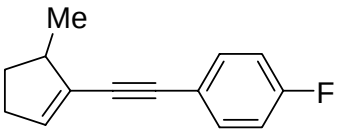
Synthesis of 5-(2-Bromo-phenylethynyl)-1-ethyl-1,2,3,6-tetrahydro-pyridine (4d)



Pre-dried LiCl (0.127 g, 3.00 mmol) was placed in the reaction flask equipped with three-way tap and magnet stirrer coated with Teflon and heated to *ca*. 250–300°C with heat-gun in a high vacuum for a few minutes. After flushing with dry argon and cooling down, DMF (2 mL) 1-ethyl-piperidin-3-one **1c** (0.255 g, 2.00 mmol) and 2-bromoacetophenone **2c** (0.438 g, 2.20 mmol) and NfF (1.396 g, 4.62 mmol) were successively added, the reaction mixture was cooled down to 10°C under vigorous stirring, and P_1-base (2.200 g, 7.04 mmol) was added dropwise for 2–3 min. After the completion of the nonaflation–elimination step (24 h at ambient temperature then ^{1}H NMR control), *i*Pr_2NH (4 mL) was added followed by solid PPh_3 (0.052 g, 0.20 mmol), CuI (0.038 g, 0.20 mmol), $Pd(OAc)_2$ (0.022 g, 0.10 mmol) (all together in one lot), and the reaction mixture was stirred was stirred at ambient temperature for 2 h and then at 45–47°C overnight (15 h). Aqueous workup as described in the *typical procedure* for the compound **4a** using hexane as a solvent for extraction followed by column chromatography (silica gel, gradient elution: hexane to Et_3N/hexane 1:20 to Et_3N/*t*BuOMe/hexane 1:1:20 to 1:2:20) furnished the pure product **4d** (0.435 g, 75% yield) as a yellow oil. ^{1}H NMR (C_6D_6, 400.23 MHz): δ = 0.95 (t, ^3J = 7.2 Hz, 3 H, Me), 1.99 (m_c, 2 H, CH_2), 2.25 (q, ^3J = 7.2 Hz, 2 H, NCH_2Me), 2.27 (t, ^3J = 5.6 Hz, 2 H, NC$H_2$$CH_2$), 3.19 ($m_c$, 2 H, NC$H_2$C=), 6.27 ($m_c$, 1 H, *CH*=C),

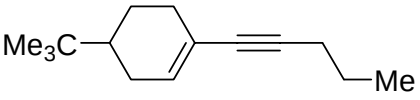
6.55 (td, 1 H, ^3J = 7.8 Hz, ^4J = 1.7 Hz, CH_{Ar}), 6.71 (m_c, 1 H, CH_{Ar}), 7.28–7.32 (m, 2 H, $2CH_{Ar}$); ^{13}C (C_6D_6, 100.65 MHz): δ = 12.2 (q, Me), 26.5 (t, CH_2), 48.7 (t, N*C*H_2Me), 51.7, 54.8 (both t, NCH_2), 86.7, 93.3 (both s, C≡C), 119.6, 125.4, 125.6 (all s, *C*=CH, C_{Ar}C≡C, C–Br), 126.9, 129.1, 132.4, 133.1, 133.5 (all d, $4CH_{Ar}$ and *C*H=C). IR (film): $\tilde{\nu}$ = 2980–2860, 2190, 1595, 1490, 1435 cm^{-1}. MS (EI, 80 eV): m/z (%) = 291 (M^+{^{81}Br}, 49), 289 (M^+{^{79}Br}, 50), 276 ([$M^+ - CH_3$]{^{81}Br}, 22), 274 ([$M^+ - CH_3$]{^{79}Br}, 23), 234 ([$M^+ - CH_2$=NEt]{^{81}Br}, 98), 232 ([$M^+ - CH_2$=NEt]{^{79}Br}, 100), 153 ([$M^+ - CH_2$=NEt – Br], 72), 152 ([$M^+ - CH_2$=NEt – HBr], 99.7). HRMS: calcd. for $C_{15}H_{16}{}^{79}BrN$ (M^+) 289.0466, found 289.0479; calcd. for $C_{15}H_{16}{}^{81}BrN$ (M^+) 291.0446, found 291.0457.

Synthesis of 1-fluoro-4-(5-methyl-cyclopent-1-enylethynyl)-benzene (4e).



The mixture of 2-methylcyclopentanone **1d** (0.098 g, 1.00 mmol), LiCl (0.085 g, 2.00 mmol), and NfF (0.725 g, 2.40 mmol) in THF (3 mL) was cooled down to –78°C under vigorous stirring, and P_2-base (0.6 mL, 2 mmol/mL soln. in THF, 1.20 mmol) was added dropwise for 3–4 min. After stirring at –75°C for 2 h, the reaction mixture was gradually allowed to warm up to ambient temperature for 2.5 h, and then 4-fluoroacetophenone **2e** (0.166 g, 1.20 mmol) was added. After dropwise addition of P_1-base (0.825 g, 2.64 mmol) for 2–3 min, the resulting mixture was stirred overnight (17 h), and then *i*Pr_2NH (1 mL) was added. Solid PPh_3 (0.026 g, 0.10 mmol), CuI (0.019 g, 0.10 mmol) and $Pd(OAc)_2$ (0.011 g, 0.05 mmol) (all together in one lot) were added, and the reaction mixture was stirred at ambient temperature for 2 h and then at 45–47°C overnight (15 h). Aqueous workup as described in the *typical procedure* for the compound **4a** using hexane as a solvent for extraction followed by column chromatography (silica gel, hexane) furnished the desired product **4e** containing traces of PPh_3; no tetrasubstituted C,C-double bond regioisomer has been detected by NMR. The following preparative HPLC separation resulted in pure compound **4e** (0.162 g, 81% yield) as a yellowish oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.18 (d, ^3J = 6.9 Hz, 3 H, Me), 1.41–1.54 (m, 1 H), 2.13–2.25 (m, 1 H), 2.31–2.54 (m, 2 H), 2.83 (m_c, 1 H) (both CH_2 and *CH*Me), 6.10 (td, J = 2.7, 2.1 Hz, 1 H, CH=), 7.00 (2 H, $^3J_{^1H,^{19}F}$ = 8.8 Hz, CH_{Ar}), 7.42 (2 H, $^4J_{^1H,^{19}F}$ = 5.4 Hz, CH_{Ar}) (both AA'BB' system, ^3J = 8.8 Hz, 4-FC_6H_4); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 19.7 (q, Me), 32.0, 32.2 (both t, CH_2), 42.8 (d, *C*HMe), 85.9, 90.2 (both s, C≡C), 115.5 (dd, $^2J_{^{13}C,^{19}F}$ = 22.1 Hz, CH_{Ar}), 119.7 (d, $^4J_{^{13}C,^{19}F}$ = 3.4 Hz, C_{Ar}C≡C), 130.1 (s, *C*=CH), 133.3 (dd, $^3J_{^{13}C,^{19}F}$ = 8.2 Hz, CH_{Ar}), 137.2 (d, *C*H=C), 162.3 (d, $^1J_{^{13}C,^{19}F}$ = 249.0 Hz, C_{Ar}–F). IR (film): $\tilde{\nu}$ = 2930, 2860, 2200, 1600, 1505, 1435 cm^{-1}. MS (EI, 80 eV): m/z (%) = 200 (M^+, 100), 185 ([$M^+ - CH_3$], 37), 172 ([$M^+ - C_2H_4$], 64), 133 ([$M^+ - C_5H_7$], 42). C,H-analysis (%): calcd. for $C_{14}H_{13}F$ (200.3): C 83.97, H 6.54; found C 83.65, H 6.52.

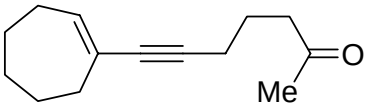
Synthesis of 4-*tert*-butyl-1-pent-1-ynyl-cyclohexene (4f).



The mixture of 4-*tert*-butylcyclohexanone **1e** (0.154 g, 1.00 mmol), pentanal **3a** (0.121 g, 1.40 mmol) and NfF (0.798 g, 2.64 mmol) in DMF (1.5 mL) was cooled down to 0°C under vigorous stirring, and P_1-base (1.306 g, 4.18 mmol) was added dropwise for 3–4 min. After the completion of the nonaflation–elimination step (24 h at ambient temperature, then ^{1}H NMR control showing 100% pentanal to 1-pentyne conversion and at least 90% 4-*tert*-butylcyclohexanone to the nonaflate conversion), *i*Pr_2NH (2 mL) and LiCl (0.064 g, 1.50 mmol) were added. Solid PPh_3 (0.026 g, 0.10 mmol), CuI (0.019 g, 0.10 mmol) and $Pd(OAc)_2$ (0.011 g, 0.05 mmol) (all together in one lot) were added under an argon atmosphere, and the reaction mixture was stirred at ambient temperature for 24 h. Aqueous workup as described in the *typical procedure* for the compound

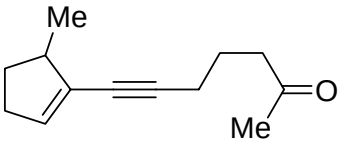
4a using hexane as a solvent for extraction followed by column chromatography (silica gel, hexane) furnished the desired product containing traces of deca-4,6-diyne that was removed after the exposure in high vacuum (ambient temperature/0.05 mbar/14 h) upon stirring to give the pure product **4f** (0.169 g, 83% yield) as a colourless oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 0.86 (s, 9 H, CMe_3), 0.99 (t, ^3J = 7.3 Hz, 3 H, Me), 1.11–1.30 (2 H), 1.76–1.91 (2 H), 2.04–2.20 (3 H) (all m, 3 CH_2 + CH) 1.54 (sextet, ^3J = 7.3 Hz, 2 H, CH_2Me), 2.27 (t, ^3J = 7.1 Hz, 2 H, CH_2C≡C), 6.01 (m_c, 1 H, CH=); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 13.5 (q, Me), 21.3, 22.4, 23.8 (all t, CH_2), 27.1 (q, CMe_3), 27.2, 31.1 (both t, CH_2), 32.1 (s, CMe$_3$), 43.3 (d, CH), 82.1, 87.4 (both s, C≡C), 120.8 (s, C=CH), 133.4 (d, C=CH). IR (film): $\tilde{\nu}$ = 2215, 1675, 1470, 1365 cm^{-1}. MS (EI, 80 eV): m/z (%) = 204 (M^+, 100), 189 ([M^+ – CH_3], 13), 161 ([M^+ – C_3H_7], 38), 147 ([M^+ – C_4H_9], 22). C,H-analysis (%): calcd. for $C_{15}H_{24}$ (204.4): C 88.16, H 11.84; found C 88.53, H 11.77.

Synthesis of 7-cyclohept-1-enyl-hept-6-yn-2-one (4g).



The mixture of cycloheptanone **1f** (0.225 g, 2.00 mmol) and NfF (1.463 g, 4.84 mmol) in DMF (2 mL) was cooled down to 0°C under vigorous stirring, and P_1-base (2.187 g, 7.00 mmol) was added dropwise for 2–3 min. After the complete conversion to the cyclic nonaflate (36 h at ambient temperature, then ^{1}H NMR control), it was cooled down to –10°C, and 6-oxo-heptanal **3b** (0.308 g, 2.40 mmol) was added dropwise for 2–3 min. The reaction mixture was gradually allowed to warm up to ambient temperature for 5 h and stirred for additional 12 h before iPr$_2$NH (2 mL) and LiCl (0.127 g, 3.00 mmol) were added. Solid PPh_3 (0.052 g, 0.20 mmol), CuI (0.038 g, 0.20 mmol) and $Pd(OAc)_2$ (0.022 g, 0.10 mmol) (all together in one lot) were added, and the reaction mixture was stirred at ambient temperature for 24 h. Aqueous workup as described in the *typical procedure* for the compound **4a** using hexane as a solvent for extraction followed by column chromatography (silica gel, gradient elution: hexane to tBuOMe/hexane 1:10) furnished the pure product **4g** (0.306 g, 75% yield) as a yellowish oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.45–1.60 (m, 4 H), 1.69–1.77 (m, 2 H), (all CH_2), 1.78 (quintet, ^3J = 7 Hz, 2 H, $CH_2CH_2CH_2$), 2.12–2.20 (m, 2 H, CH_2), 2.16 (s, 3 H, MeC=O), 2.27–2.32 (m, 2 H, CH_2), 2.33 (t, ^3J = 6.8 Hz, 2 H, CH_2C≡C), 2.57 (t, ^3J = 7.2 Hz, 2 H, CH_2C=O), 6.19 (tt, ^3J = 6.7 Hz, ^4J = 0.6 Hz); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 18.7, 22.7, 26.48, 26.50, 28.9 (all t, CH_2), 30.0 (q, MeC=O), 32.1, 34.4, 42.3 (all t, CH_2), 84.7, 86.0 (both s, C≡C), 127.0 (s, C=CH), 138.5 (d, C=CH), 208.4 (s, C=O). IR (film): $\tilde{\nu}$ = 2215, 1715, 1680, 1460, 1365 cm^{-1}. MS (EI, 80 eV): m/z (%) = 204 (M^+, 16), 189 ([M^+ – CH_3], 5), 161 ([M^+ – CH_3CO], 29), 43 (CH_3CO^+, 100). HRMS: calcd. for $C_{14}H_{20}O$ (M^+) 204.1514, found 204.1519.

Synthesis of 7-(5-methyl-cyclopent-1-enyl)-hept-6-yn-2-one (4h).

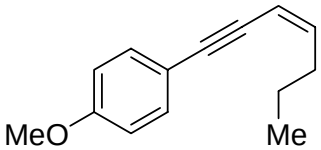


The mixture of 2-methylcyclopentanone **1d** (0.196 g, 2.00 mmol), LiCl (0.170 g, 4.00 mmol), and NfF (1.463 g, 4.84 mmol) in THF (6 mL) was cooled down to –78°C upon vigorous stirring, and P_2-base (1.2 mL, 2 mmol/mL soln. in THF, 2.40 mmol) was added dropwise for *ca*. 5 min. After stirring at –75°C for 2 h, the reaction mixture was gradually allowed to warm up to ambient temperature for 2.5 h. After addition of P_1-base (1.650 g, 5.28 mmol), the reaction mixture was cooled down to –10°C, and 6-oxo-heptanal **3b** (0.308 g, 2.40 mmol) was added dropwise for 3–4 min. The reaction mixture was gradually allowed to warm up to ambient temperature for 5 h and stirred for additional 12 h before iPr$_2$NH (2 mL) was added. Solid PPh_3 (0.052 g, 0.20 mmol), CuI (0.038 g, 0.20 mmol) and $Pd(OAc)_2$ (0.022 g, 0.10 mmol) (all together in one lot) were added, and the

reaction mixture was stirred at ambient temperature for 2 h and then at 45–47°C overnight (15 h). Aqueous workup as described in the *typical procedure* for the compound **4a** using hexane as a solvent for extraction followed by column chromatography (silica gel, gradient elution: hexane to *t*BuOMe/hexane 1:10) furnished the pure product **4h** (0.281 g, 74% yield) as a yellowish oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.10 (d, ^3J = 6.9 Hz, 3 H, Me), 1.34–1.48 (1 H), 1.76–1.87 (2 H), 2.09–2.19 (1 H), 2.30–2.47 (4 H) (all m, all CH_2), 2.16 (s, 3 H, MeC=O), 2.59 (t, ^3J = 7.2 Hz, 2 H, CH_2C=O), 2.64–2.77 (m, 1 H C*H*Me), 5.91 (td, *J* = 2.5, 2.2 Hz, 1 H, CH=); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 18.7 (t, CH_2), 18.9 (q, CH*Me*), 22.7 (t, CH_2), 30.0 (q, *Me*C=O), 31.6, 32.0, 42.2 (all t, CH_2), 42.7 (d, *C*HMe), 77.9, 90.8 (both s, C≡C), 130.4 (s, CH=*C*), 135.3 (d, *C*H=C), 208.3 (C=O). IR (film): $\tilde{\nu}$ = 2210, 1715, 1665, 1440, 1425 cm^{-1}. MS (EI, 80 eV): m/z (%) = 190 (M^+, 30), 175 ([$M^+ - CH_3$], 8), 147 ([$M^+ - CH_3CO$], 45), 43 (CH_3CO^+, 100). HRMS: calcd. for $C_{13}H_{18}O$ (M^+) 190.1358, found 190.1365.

The synthesis carried out on 2 mmol scale starting from 2-methylcyclopentanone **1d** and 6-oxo-heptanal **3b** using P_1-base only, under the conditions described for the product **4g** (see above) resulted an inseparable 1.2:1 mixture of tri- and tetrasubstituted C,C-double bond regioisomers **4h/4h'** (0.287 g, 76% yield) as a yellowish oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.10 (d, ^3J = 6.9 Hz, 3 H, Me), 1.34–1.48 (1 H), 1.76–1.89, 2.09–2.19, 2.30–2.47, 2.58–2.64, 2.64–2.77 (all m, all CH_2, C*H*Me and *Me*C=C), 2.163 and 2.165 (both s, MeC=O), 5.91 (td, *J* = 2.5, 2.2 Hz, 1 H, CH=); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 15.7 (q, *Me*C=C), 18.7 (t, CH_2), 18.9 (q, CH*Me*), 19.6, 22.3, 22.7, 22.8 (all t, CH_2), 30.0 (q, both *Me*C=O), 31.6, 32.0, 36.7, 37.6, 42.19, 42.23 (all t, CH_2), 42.7 (d, *C*HMe), 77.9, 78.2, 90.8, 92.2 (all s, both C≡C), 117.8, 130.4, 146.2 (all s, Me*C*=C and both *C*C≡C), 135.3 (d, *C*H=C), 208.26, 208.34 (both C=O).

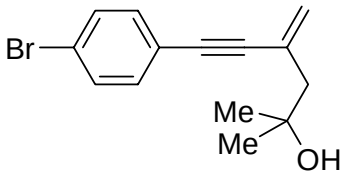
Synthesis of 1-hept-3-en-1-ynyl-4-methoxy-benzene (6a).



The mixture of 4-methoxyacetophenone **2f** (0.210 g, 1.40 mmol) and NfF (0.798 g, 2.64 mmol) in DMF (1 mL) was cooled down to 10°C under vigorous stirring, and P_1-base (0.962 g, 3.08 mmol) was added dropwise for 2–3 min. After stirring at ambient temperature for 36 h, it was diluted with EtCN (1 mL), cooled down to –75°C, and (*Z*)-1-trimethylsilyloxypent-1-ene **5a** (0.158 g, 1.00 mmol) was added dropwise for *ca*. 5 min. The temperature was gradually allowed to rise up to 3°C for 1 h before the ingredients for the Sonogashira coupling step: *i*Pr_2NH (2 mL), LiCl (0.064 g, 1.50 mmol), then solid PPh_3 (0.026 g, 0.10 mmol), CuI (0.019 g, 0.10 mmol) and $Pd(OAc)_2$ (0.011 g, 0.05 mmol) (all together in one lot) were added at 0°C. The reaction mixture was stirred at 0–5°C for 2 h, then gradually warmed up to ambient temperature for 1.5 h and stirred overnight (17 h). It was then diluted with *t*BuOMe, filtrated through the pad of celite, the volatiles were removed in vacuum, and the residue was subjected to the column chromatography (hexane) to give the desired product **6a** (0.148 g) containing a little amount of 4-methoxyphenylacetylene that was removed in high vacuum (ambient temperature/0.05 mbar/14 h) upon stirring to afford the pure compound **6a** (0.130 g, 65% yield, *Z*/*E* > 40:1) as a yellow oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 0.96 (t, ^3J = 7.3 Hz, 3 H, Me), 1.48 (sextet, ^3J = 7.3 Hz, 2 H, CH_2Me), 2.37 (qd, ^3J = 7.4 Hz, ^4J = 1.4 Hz, 2 H, CH_2CH=), 3.80 (s, 3 H, OMe), 5.67 (dt, ^3J = 10.8 Hz, ^4J = 1.4 Hz, 1 H, =C*H*C≡C), 5.93 (dt, ^3J = 10.8, 7.4 Hz, 1 H, =C*H*CH_2), 6.84 (2 H, CH_{Ar}), 7.37 (2 H, CH_{Ar}) (both AA'BB' system, ^3J = 8.7 Hz, 4-$MeOC_6H_4$); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 13.8 (q, Me), 22.2, 32.3 (both t, CH_2), 55.2 (q, OMe), 85.2, 93.3 (both s, C≡C), 109.3, 143.2 (both d, CH=CH), 113.9, 132.8 (both d, CH_{Ar}), 115.9 (s, C_{Ar}C≡C), 159.4 (s, C_{Ar}OMe). IR (film): $\tilde{\nu}$ = 2170, 1575, 1430 cm^{-1}. MS (EI, 80 eV): m/z (%) = 200 (M^+, 100), 185 ([$M^+ - CH_3$], 48), 172

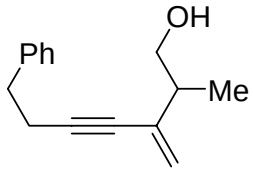
([$M^+ - C_2H_4$], 91), 145 ([$M^+ - C_4H_7$], 100). C,H-analysis (%): calcd. for $C_{14}H_{16}O$ (200.3): C 83.96, H 8.05; found C 83.77, H 8.14.

Synthesis of 6-(4-bromo-phenyl)-2-methyl-4-methylene-hex-5-yn-2-ol (6b).



The mixture of 4-bromoacetophenone **2g** (0.199 g, 1.00 mmol) and NfF (0.970 g, 3.20 mmol) in THF (3 mL) was cooled down to –75°C under vigorous stirring, and P_2-base (1.10 mL, 2 mmol/mL soln. in THF, 2.20 mmol) was added dropwise for *ca*. 5 min. After stirring at –75°C to –70°C for 1 h, the reaction mixture was gradually allowed to warm up to 15°C for 1 h followed by re-cooling to -75°C. 4-Methyl-2,4-bis[(trimethylsilyl)oxy]-1-pentene **5b** (0.520 g, 2.00 mmol) was added dropwise for *ca*. 5 min keeping the temperature of the reaction mixture below –70°C. After stirring at -75°C for 0.5 h, it was gradually allowed to warm up to 5°C for 1.5 h. The ingredients for the Sonogashira coupling step: *i*Pr_2NH (1 mL), LiCl (0.064 g, 1.50 mmol), then solid PPh_3 (0.026 g, 0.10 mmol), CuI (0.019 g, 0.10 mmol) and $Pd(OAc)_2$ (0.011 g, 0.05 mmol) (all together in one lot) were added at 0°C. The reaction mixture was stirred at 0–5°C for 2 h, then gradually warmed up to ambient temperature for 1.5 h and stirred for 24 h. The reaction mixture was then diluted with 1 *M* TBAF solution in THF (ACROS, contains 5% water) (5 mL) and stirred at ambient temperature for 7 h. Aqueous workup as described in the *typical procedure* for the compound **4a** using *t*BuOMe as a solvent for extraction followed by column chromatography (silica gel, gradient elution: hexane to *t*BuOMe/hexane 1:20 to 1:10 to 1:5) furnished the pure product **6b** (0.161 g, 58% yield) as an orange oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.32 (s, 6 H, CMe_2), 2.08 (s, 1 H, OH), 2.45 (d, ^4J = 1.0 Hz, 2 H, CH_2), 5.40 (dt, ^2J = 2.0 Hz, ^4J = 1.0 Hz, 1 H, CH_2=), 5.62 (d, ^2J = 2.0 Hz, 1 H, CH_2=), 7.28 (2 H, CH_{Ar}), 7.45 (2 H, CH_{Ar}) (both AA'BB' system, ^3J = 8.7 Hz, 4-BrC_6H_4); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 29.2 (q, C*Me*$_2$OH), 50.6 (t, CH_2), 70.7 (s, *C*Me_2OH), 89.1, 91.6 (both s, C≡C), 121.8, 122.6, 127.2 (all s, C_{Ar}Br, *C*$_{Ar}$C≡C and *C*=CH_2) 126.1 (t, CH_2=), 131.6, 132.8 (both d, CH_{Ar}). IR (film): $\tilde{\nu}$ = 3360, 2850, 2210, 1595, 1435 cm^{-1}. MS (EI, 80 eV): m/z (%) = 280 (M^+{^{81}Br}, 31), 278 (M^+{^{79}Br}, 32), 221 ([M^+ – Me_2COH]{^{81}Br}, 97), 219 ([M^+ – Me_2COH]{^{79}Br}, 100), 199 ([M^+ – Br], 6), 140 ([M^+ – Me_2COH – Br], 52). C,H,Br-analysis (%): calcd. for $C_{14}H_{15}BrO$ (279.2): C 60.23, H 5.42, Br 28.62; found C 60.86, H 5.39, Br 28.40.

Synthesis of 2-Methyl-3-methylene-7-phenyl-hept-4-yn-1-ol (6c).



The mixture of 4-phenylbutanal **3c** (0.148 g, 1.00 mmol) and NfF (0.970 g, 3.20 mmol) in THF (3 mL) was cooled down to –75°C under vigorous stirring, and P_2-base (1.10 mL, 2 mmol/mL soln. in THF, 2.20 mmol) was added dropwise for *ca*. 5 min. After stirring at –75°C to –70°C for 1 h, the reaction mixture was gradually allowed to warm up to 15°C for 1 h followed by re-cooling to -75°C. 3-Methyl-2,4-bis-trimethylsilyloxy-but-1-ene **5c** (0.493 g, 2.00 mmol) was added dropwise for *ca*. 5 min keeping the temperature of the reaction mixture below –70°C. After stirring at -75°C for 0.5 h, it was gradually allowed to warm up to 5°C for 1.5 h. The ingredients for the Sonogashira coupling step: *i*Pr_2NH (1 mL), LiCl (0.064 g, 1.50 mmol), then solid PPh_3 (0.026 g, 0.10 mmol), CuI (0.019 g, 0.10 mmol) and $Pd(OAc)_2$ (0.011 g, 0.05 mmol) (all together in one lot) were added at 0°C. The reaction mixture was stirred at 0–5°C for 2 h, then gradually warmed up to ambient temperature for 1.5 h

and stirred for 24 h. Then the volatiles were removed in vacuum, the residue was dissolved in methanol (7 mL), and NH_4F (0.111 g, 3.00 mmol) was added. The reaction mixture was stirred at ambient temperature for 3.5 h. Aqueous workup as described in the *typical procedure* for the compound **4a** using *t*BuOMe as a solvent for extraction followed by column chromatography (silica gel, gradient elution: hexane to *t*BuOMe/hexane 1:20 to 1:10) furnished the pure product **6c** (0.150 g, 70% yield) as a yellowish oil. ^{1}H NMR ($CDCl_3$, 270 MHz): δ = 1.00 (d, ^3J = 6.9 Hz, 3 H, Me), 1.61 (br. s, 1 H, OH), 2.41 (m_c, 1 H, C*H*Me), 2.61 (m_c, 2 H, CH_2C≡C), 2.85 (m_c, 2 H, CH_2Ph), 3.42–3.54 (m, 2 H, CH_2OH), 5.25 (dd, ^2J = 2.0 Hz, ^4J = 0.7 Hz, 1 H, CH_2=), 5.34 (d, ^2J = 2.0 Hz, 1 H, CH_2=), 7.18–7.33 (m, 5 H, Ph); ^{13}C ($CDCl_3$, 67.9 MHz): δ = 15.5 (q, Me), 21.3 (t, *C*H_2C≡C), 34.9 (t, *C*H_2Ph), 43.7 (d, *C*HMe), 65.8 (t, CH_2OH), 79.3, 90.8 (both s, C≡C), 121.3 (t, CH_2=), 126.2 (d, CH_p), 128.3, 128.4 (both d, CH_o and CH_m), 133.7, 140.4 (both s, C_{Ph} and *C*=CH_2). IR (film): $\tilde{\nu}$ = 3070, 3040, 2860, 2190, 1600 cm^{-1}. MS (EI, 80 eV): m/z (%) = 214 (M^+, 88), 183 ([M^+ – CH_2OH], 60), 123 ([M^+ – $PhCH_2$], 31), 91 ($PhCH_2^+$, 100). C,H-analysis (%): calcd. for $C_{15}H_{18}O$ (214.3): C 84.07, H 8.47; found C 83.61, H 8.44.