Supporting Information

Gold Promoted Arylative Cyclization of Alkynoic Acids with Arenediazonium Salts

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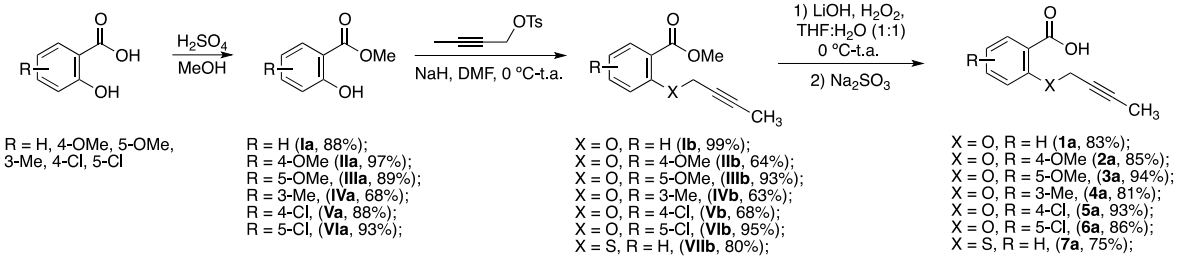
General Information

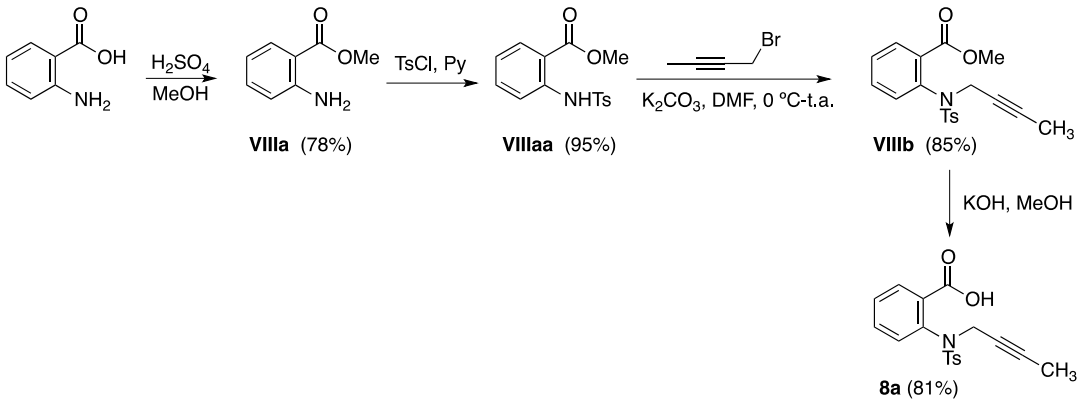
All reactions (except the hydrolysis of esthers **Ib-XVb**) were carried out under a nitrogen atmosphere using standard Schlenk techniques. MeOH, acetone, diethyl ether and DCM were dried by standard methods and freshly distilled prior to use. Dry DMSO, DMF and MeCN were purchased from Aldrich and used as received without further purification. $CDCl_3$, DMSO-d_6 and commercial reagents were also purchased from Aldrich and used as received without further purification. Gold complexes were stored under a N_2 atmosphere. Reactions were monitored by thin layer chromatography using TLC Alugram G/UV254 0.20 mm. Chromatography purifications were performed using flash grade silica gel (SDS Chromatogel 60 Acc, 40-60 μm). NMR spectra were recorded at 25 ºC on a Jeol Eclipse 300 Mz, Bruker Avance 400 Mz and Varian Unity Inova 500 MHz spectrometers. Chemical shifts are reported in ppm. High resolution mass spectra (HRMS) were recorded and on a Jeol The Accutof JMS-T100LC spectrometer using plolyethylene glycol as internal standard. Melting points were determined using a Reichert microscope apparatus and were uncorrected.

Synthesis of starting materials

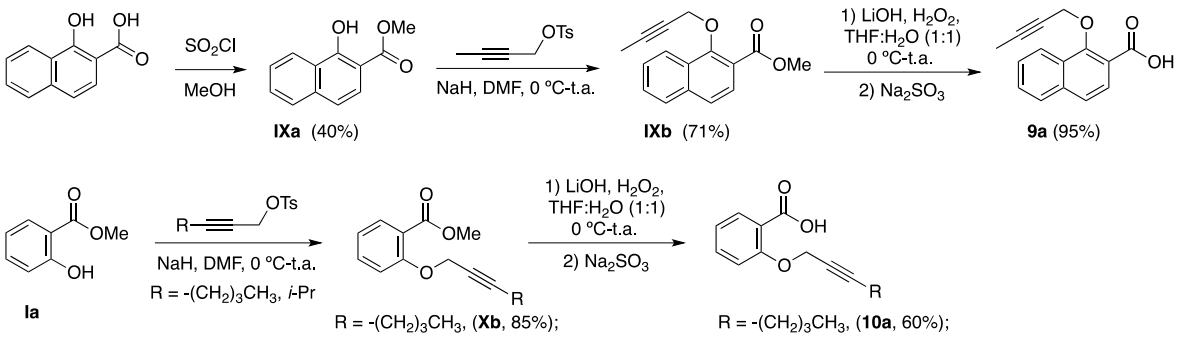
The synthesis of alkynoic acids **1a-16a** was carried out according to Schemes 1- 4.



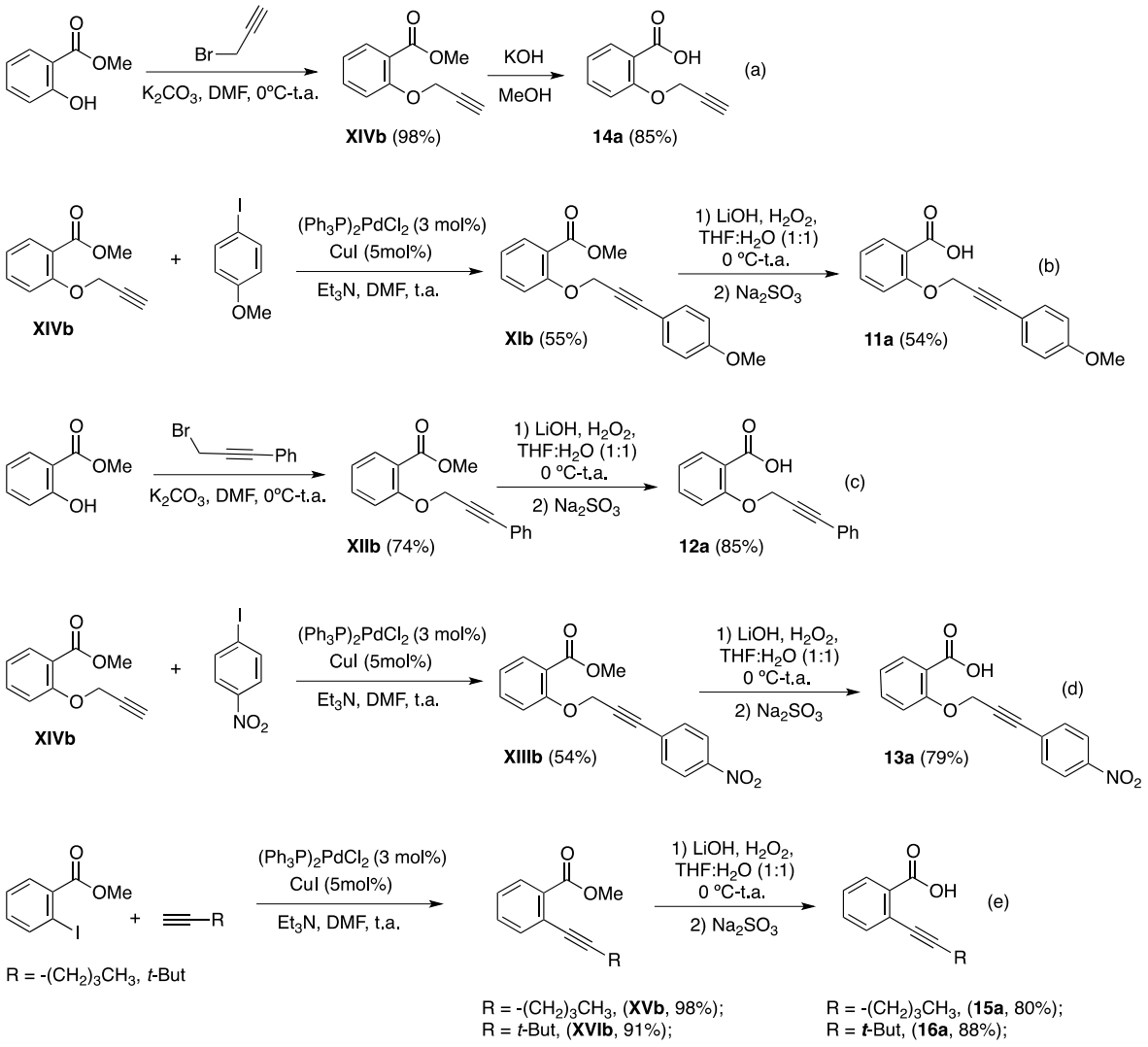
Scheme 1.



Scheme 2.



Scheme 3.



Scheme 4.

The following compounds were purchased from Aldrich and used as received: salicylic acid, 4-metoxysalicylic acid, 5-metoxysalicylic acid, 3-methylsalicylic acid, 4-chlorosalicylic

acid, 5-chlorosalicylic acid, methyl thiosalicylate, antranilic acid, 1-hydroxy-2-naphthalenecarboxylic acid, allyl bromide, 4-iodoanisole, 4-iodonitrobenzene, 1-hexyne and 3,3-dimethyl-1-butyne.

Synthesis of esters Ia-IXa:

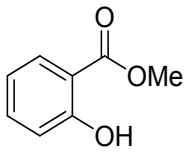
Method A:

The corresponding carboxylic acid (28.96 mmol) was dissolved in MeOH (60 mL) and H_2SO_4 (98%, 2 mL) was added dropwise to the solution. The reaction mixture was heated under reflux for 18 hours, subsequently it was cooled to 25 ºC and the solvent was removed under vacuum. The residue was diluted with water (50 mL), thereafter K_2CO_3 was added until pH = 5-6, and the aqueous solution was extracted with DCM (3 x 30 mL). Finally, the combined organic phases were dried over Na_2SO_4 and concentrated under vacuum to afford the desired compound with enough purity to be used in the next reaction without further purification.

Method B:

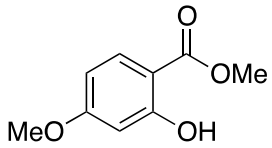
To a solution of the corresponding acid (21.87 mmol) in MeOH (35 mL) at 0 °C, $SOCl_2$ (15.86 mL, 218.75 mmol) was added dropwise over a period of 10 min. Once the addition was finished, the reaction was allowed to warm to rt, and subsequently heated to 65°C for a period of 18 hours. After this time, MeOH and the excess of $SOCl_2$ were removed under vacuum. The residue obtained was dissolved in DCM and a saturated solution of $NaHCO_3$ (40 mL) was added until no evolution of gas was observed. The aqueous solution was extracted with DCM (3 x 40 mL), and the combined organic phases were dried over Na_2SO_4 and concentrated under vacuum, to afford the desired compound with enough purity to be used in the next reaction without further purification.

Methylsalicylate (Ia).[1]



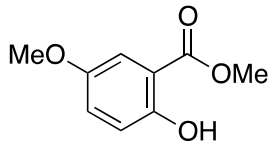
Method A. Colorless oil. Obtained: 4.04 g (99%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.77 (s, 1H), 7.84 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.46 (t, *J* = 7.3 Hz, 1H), 6.98 (d, *J* = 8.3 Hz, 1H), 6.88 (t, *J* = 7.2 Hz, 1H), 3.95 (s, 3H).

Methyl 4-methoxysalicylate (IIa).[2]



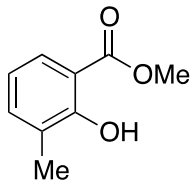
Method A. White solid. Obtained: 2.655 g (98%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.98 (s, 1H), 7.72 (d, *J* = 8.0 Hz, 1H), 6.56 – 6.32 (m, 2H), 3.90 (s, 3H), 3.81 (s, 3H).

Methyl 5-methoxysalicylate (IIIa).[3]



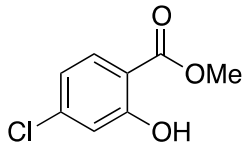
Method A. Yellowish oil. Obtained: 0.42 g (96%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.37 (s, 1H), 7.28 (d, *J* = 3.1 Hz, 1H), 7.08 (dd, *J* = 9.1, 3.2 Hz, 1H), 6.91 (d, *J* = 9.1 Hz, 1H), 3.95 (s, 3H), 3.78 (s, 3H).

Methyl 3-methylsalicylate (IVa).[4]



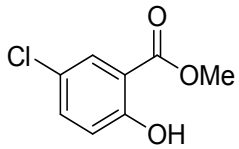
Method A. Yellowish oil. Obtained: 4.47 g (68%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.94 (s, 1H), 7.61 (dd, *J* = 8.0, 1.1 Hz, 1H), 7.24 (d, *J* = 7.3 Hz, 1H), 6.70 (t, *J* = 7.7 Hz, 1H), 3.86 (s, 3H), 2.19 (s, 3H).

Methyl 4-chlorosalicylate (Va).[5]



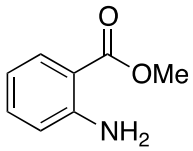
Method A. Pink oil. Obtained: 2.12 g (98%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.86 (s, 1H), 7.75 (d, *J* = 8.6 Hz, 1H), 7.08 - 6.95 (m, 1H), 6.94 - 6.76 (m, 1H), 3.95 (s, 3H). ^{13}C RMN (75 MHz, $CDCl_3$) δ 170.12 (C), 162.23 (C), 141.56 (C), 131.01 (CH), 120.00 (CH), 117.86 (CH), 111.11 (C), 52.60 (CH_3).

Methyl 5-chlorosalicylate (VIa).[6]



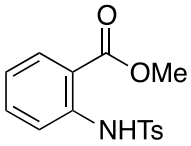
Method A. White solid, Obtained: 4.67 g (87%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.62 (s, 1H), 7.74 (d, *J* = 2.7 Hz, 1H), 7.33 (dd, *J* = 8.9, 2.7 Hz, 1H), 6.87 (d, *J* = 8.9 Hz, 1H), 3.89 (s, 3H).

Methyl anthranilate (VIIIa).[7]



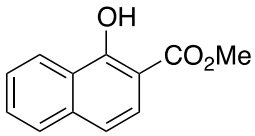
Method B. Yellowish oil. Obtained: 2.87 (95%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86 (ddd, *J* = 7.8, 1.6, 0.7 Hz, 1H), 7.26 (ddd, *J* = 8.3, 7.2, 1.6 Hz, 1H), 6.65 (t, *J* = 7.5 Hz, 1H), 5.58 (bs, 1H), 3.87 (s, 3H).

Methyl 2-{[(4-methylphenyl) sulfonyl]amino}benzoate (VIIIaa). [8]



To a solution of methyl anthranilate (**IXb**) (1.5 g, 9.92 mmol) in DCM (11 mL) pyridine (0.96 mL, 11.91 mmol) was added dropwise. The reaction mixture was stirred at 25 ºC for 1 h before a solution of 4-methylbenzene-1-sufonyl chloride (2.27 g, 11.91 mmol) in DCM (8 mL) was slowly added. After stirring the reaction mixture at 25 ºC for 24 h a saturated aqueous solution of NH_4Cl was added. The organic phase was extracted with DCM (4 x 30 mL) dried over Na_2SO_4 and concentrated under vacuum. The solid obtained was further purified by column chromatography (hexane/EtOAc: 10:1). White solid: (2.87 g, 95%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.61 (s, 1H), 7.91 (ddd, *J* = 8.0, 1.7, 0.4 Hz, 1H), 7.74(d, *J* = 8.3 Hz, 2H), 7.68 (ddd, *J* = 8.4, 1.1, 0.4 Hz, 1H), 7.41 – 7.33 (m, 1H), 7.22 (dd, *J* = 8.6, 0.7 Hz, 2H), 7.02 (ddd, *J* = 8.0, 7.3, 1.2 Hz, 1H), 3.87 (s, 3H), 2.36 (s, 3H).

Methyl 1-hydroxy-2-naphthoate (IXa).[9]



Method B (reaction time: 48 h). Light yellow solid. Obtained: 1.117 g (35%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 12.00 (s, 1H), 8.42 (d, *J* = 8.3 Hz, 1H), 7.77 (d, *J* = 8.7 Hz, 2H), 7.61 (t, *J* = 7.5 Hz, 1H), 7.53 (t, *J* = 7.5 Hz, 1H), 7.28 (d, *J* = 8.9 Hz, 1H), 4.00 (s, 3H).

Synthesis of esters Ib-XVIb:

Method A:

To a mixture of the corresponding esther (1.97 mmol) and NaH (60% in mineral oil, 2.17 mmol) in DMF (3 mL) at 0 ºC, was transferred 2-butynyl tosylate,[10] or 3-phenylpropargyl tosylate,[11] or 2-heptynyl tosylate[12] (2.07 mmol) dissolved in DMF (3 mL). The mixture was stirred from 0 ºC to 25 ºC for 24 h, then was diluted with water (5 mL) and extracted with DCM (3 x 5 mL). The combined organic phases were dried over Na_2SO_4 and concentrated

under vacuum. If necessary, the product was further purified by silica gel chromatography using mixtures of hexane/EtOAc as eluent.

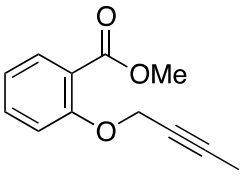
Method B:

A mixture of the corresponding esther (1.97 mmol), K_2CO_3 (3.16mmol) and propargylic bromide or 1-bromo-2-butyne[13] (2.37 mmol) in DMF (2.4 mL), was stirred from 0 ºC to 25 ºC for 24 h. Thereafter, was diluted with water (5 mL) and extracted with DCM (3 x 5 mL). The combined organic phases were dried over Na_2SO_4 and concentrated under vacuum. If necessary, the product was further purified by silica gel chromatography using mixtures of hexane/EtOAc as eluent.

Method C:

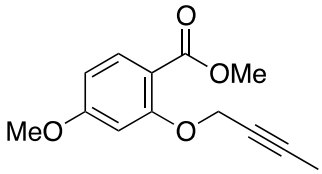
In a flask containing CuI (0.078 mmol), $(Ph_3P)_2PdCl_2$ (0.047 mmol) and 4-iodoanisol or 4-iodonitrobenzene or 1-hexyne (1.57 mmol) or 3,3-dimethylbutyne was added DMF (2.5 mL) followed by Et_3N (0.55 mL). After 10 minutes of stirring, a solution of **XVb** (1.57 mmol) in DMF (2.5 mL) was added slowly and the reaction mixture was stirred at 25 ºC for 2 hours. Thereafter, a saturated aqueous solution of NH_4Cl (10 mL) was added, the organic phase was extracted with DCM (3 x 30 mL), and the combined organic phases were dried over Na_2SO_4 and concentrated under vacuum. The oil obtained was further purified by column chromatography using mixtures of hexane/EtOAc as eluent.

Methyl 2-(2-butyn-1-yloxy)benzoate (Ib):[14]



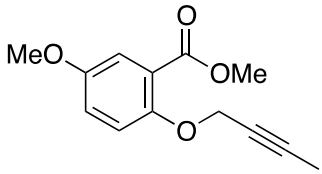
Method A. Colorless oil. Obtained: 0.4 g (99%). ^{1}H NMR (300 MHz, , $CDCl_3$) δ 7.80 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.53 – 7.41 (m, 1H), 7.13 (d, *J* = 8.4 Hz, 1H), 7.01 (t, *J* = 7.5 Hz, 1H), 4.75 (d, *J* = 2.2 Hz, 2H), 3.89 (s, 3H), 1.84 (t, *J* = 2.1 Hz, 3H).

Methyl 4-methoxy-2-(2-butyn-1-yloxy)benzoate (IIb):



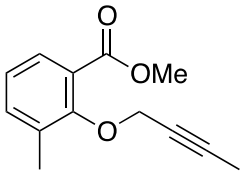
Method A. Yellow oil. Obtained: 0.3 g (65%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86 (d, *J* = 8.7 Hz, 1H), 6.65 (d, *J* = 2.1 Hz, 1H), 6.53 (dd, *J* = 8.7, 2.2 Hz, 1H), 4.73 (d, *J* = 2.2 Hz, 2H), 3.85 (s, 6H), 1.85 (t, *J* = 2.2 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 165.98 (C), 163.93 (C), 159.50 (C), 133.79 (CH), 113.02 (C), 105.64 (CH), 101.04 (CH), 84.38 (C), 73.64 (C), 57.50 (CH_3), 55.50 (CH_3), 51.73 (CH_2), 3.74 (CH_3). IR (KBr): 2949.99, 2840.21, 2228.29, 1721.19, 16015.46, 1547.68 cm^{-1}. HRMS-DART calculated for $C_{13}H_{15}O_4$ $[M+H]^+$: 235.09703; found: 235.09694.

Methyl 5-methoxy-2-(2-butyn-1-yloxy)benzoate (IIIb):



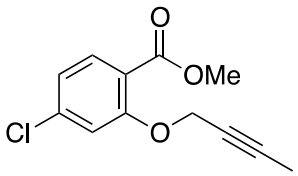
Method B. Yellowish oil. Obtained: 0.48 g (93%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.33 (d, *J* = 3.1 Hz, 1H), 7.07 (d, *J* = 9.0 Hz, 1H), 7.01 (dd, *J* = 9.0, 3.1 Hz, 1H), 4.67 (q, *J* = 2.3 Hz, 2H), 3.89 (s, 3H), 3.79 (s, 3H), 1.83 (t, *J* = 2.4 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 166.51 (C), 153.98 (C), 151.72 (C), 122.09 (C), 119.55 (CH), 117.56 (CH), 115.85 (CH), 84.13 (C), 74.29 (C), 58.97 (CH_2), 55.91 (CH_3), 52.28 (CH_3), 3.82 (CH_3). IR (film): 2950.96, 2920.37, 2837.56, 2227.97, 1727.50, 1494.69 cm^{-1}. HRMS-DART calculated for $C_{13}H_{15}O_4$ $[M+H]^+$: 235.09703; found: 235.09726.

Methyl 3-methyl-2-(2-butyn-1-yloxy)benzoate (IVb):



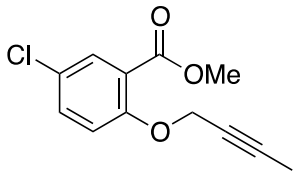
Method A. Yellow oil. Obtained: 0.25 g (63%). ^{1}H NMR (300 MHz, CDCl3) δ 7.65 (d, J = 7.8 Hz, 1H), 7.35 (d, J = 7.4 Hz, 1H), 7.07 (t, J = 7.7 Hz, 1H), 4.58 (s, 2H), 3.91 (d, J = 2.0 Hz, 3H), 2.36 (s, 3H), 1.85 (s, 3H). ^{13}C NMR (75 MHz, , CDCl3) δ 166.84 (C), 156.15 (C), 135.11 (CH), 133.42 (C), 129.16 (CH), 125.20 (C), 124.04 (CH), 83.60 (C), 74.54 (C), 62.18 (CH_2), 52.19 (CH_3), 16.43 (CH_3), 3.71 (CH_3). IR (film): 2950.34, 2921.78, 2854.92, 1722.29, 1591.94, 1460.72, 1433.24 cm^{-1}. HRMS-DART calculated for $C_{13}H_{15}O_3$ [M+H]$^{+}$: 219.10212; found: 219.10165.

Methyl 4-chloro-2-(2-butyn-1-yloxy)benzoate (Vb):



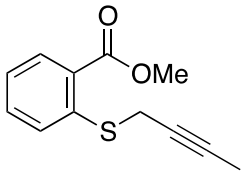
Method A. Pinkish oil. Obtained: 0.27 g (68%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.4 Hz, 1H), 7.12 (s, 1H), 7.00 (d, *J* = 8.4 Hz, 1H), 4.74 (d, *J* = 2.0 Hz, 2H), 3.88 (s, 3H), 1.86 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 165.68 (C), 158.01 (C), 139.09 (C), 132.81 (CH), 121.11 (CH), 119.16 (C), 114.80 (CH), 85.02 (C), 73.05 (C), 57.67 (CH_2), 52.14 (CH_3), 3.74 (CH_3). IR (KBr): 2951.02, 2305.14, 2229.95, 1728.43, 1709.65, 1592.93, 1507.96. 1485.22 cm^{-1}. HRMS-DART calculated for $C_{12}H_{10}ClO_3$ [M+H]$^{+}$: 239.04750; found: 239.04702.

Methyl 5-chloro-2-(2-butyn-1-yloxy)benzoate (VIb): [11]



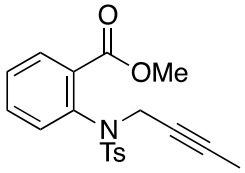
Method A. Yellowish oil. Obtained: 0.37 g (95%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.78 (d, J = 2.7 Hz, 1H), 7.43 (d, *J* = 2.7 Hz, 1H), 7.40 (d, J = 2.7 Hz, 1H), 7.08 (d, *J* = 8.9 Hz, 1H), 4.73 (q, *J* = 2.3 Hz, 2H), 3.89 (s, 3H), 1.84 (t, *J* = 2.3 Hz, 3H).

Methyl 1-(2-butyn-1-ylthio)benzoate (VIIb):



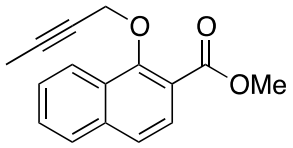
Method A. Yellowish oil. Obtained: 0.3 g (80%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.1 Hz, 1H), 7.54 – 7.43 (m, 2H), 7.19 (ddd, *J* = 7.9, 6.4, 2.3 Hz, 1H), 3.91 (s, 3H), 3.65 – 3.61 (m, 2H), 1.79 (t, *J* = 2.3 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 166.78 (C), 141.05 (C), 132.47 (CH), 131.27 (CH), 127.34 (C), 125.72 (CH), 124.15 (CH), 79.52 (C), 74.05 (C), 52.12 (CH_3), 21.22 (CH_2), 3.70 (CH_3). IR (KBr): 2952.75, 2914.16, 2848.07, 1708.34, 1585.94, 1458.18, 1435.18 cm^{-1}. HRMS-DART calculated for $C_{12}H_{13}O_2S$ $[M+H]^+$: 221.06362; found: 221.06364.

Methyl 2-[2-butyn-1-yl[(4-methylphenyl)sulfonyl]amino]benzato (VIIIb):[11]



Method A. Yellow oil. Obtained: 1.205 g (85%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88 - 7.79 (m, 1H), 7.59 (d, *J* = 8.3 Hz, 2H), 7.46 - 7.36 (m, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.20 - 7.13 (m, 1H), 4.51 (bs, 2H), 3.80 (s, 3H), 2.41 (s, 3H), 1.69 (t, *J* = 2.4 Hz, 3H).

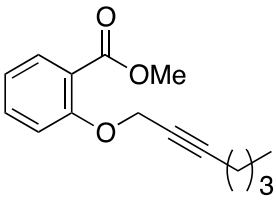
Methyl 2-(2-butyn-1-yloxy)naphthalenoate (IXb):



Method A. Yellow oil. Obtained: 0.26 g (71%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.37 (d, *J* = 8.2 Hz, 1H), 7.86 (t, *J* = 8.3 Hz, 2H), 7.69 – 7.53 (m, 3H), 4.81 (s, 2H), 3.98 (s, 3H), 1.85 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 166.67 (C), 156.00 (C), 136.70 (C), 128.97 (C), 128.36 (CH), 127.71 (CH), 126.54 (CH), 126.48 (CH), 124.18 (CH), 124.14 (CH), 120.10 (C), 84.59 (C), 74.48 (CH), 63.97 (CH_3), 52.30 (CH_2), 3.74 (CH_3). IR (film): 2948.93, 2919.44,

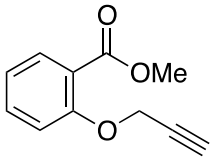
2853.68, 2232.52, 1718.77, 1624.76, 1597.03 cm^{-1}. HRMS-DART calculated for $C_{16}H_{15}O_3$ $[M+H]^+$:255.10212; found: 255.10150.

Methyl 2-(2-heptyn-1-yloxy)benzoate (Xb):[15]



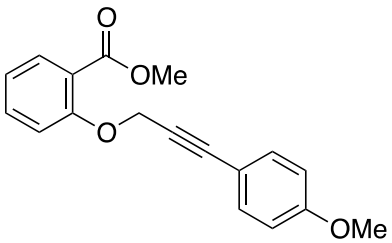
Method A. Yellow oil. Obtained: 0.82 g (85%).^{1}H NMR (300 MHz, $CDCl_3$) δ 7.80 (dd, *J* = 7.7, 1.9 Hz, 1H), 7.46 (ddd, *J* = 8.4, 7.3, 1.8 Hz, 1H), 7.14 (dd, *J* = 8.5, 1.0 Hz, 1H), 7.01 (td, *J* = 7.6, 1.0 Hz, 1H), 4.77 (t, *J* = 2.2 Hz, 2H), 3.89 (s, 3H), 2.20 (tt, *J* = 7.0, 2.2 Hz, 2H), 1.53 – 1.19 (m, 4H), 0.87 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 166.64 (C), 157.36 (C), 133.16 (CH), 131.66 (CH), 120.84 (CH), 114.52 (CH), 88.86 (C), 74.58 (C), 57.54 (CH_2), 52.03 (CH_3), 30.42 (CH_2), 21.85 (CH_2), 18.46 (CH_2), 13.53 (CH_3). IR (film): 3063.40, 3043.57, 2924.57, 2872.15, 173028, 1602.78, 1582.95, 1488.03, 1454.03,1377.53, 1285.44 cm^{-1}. HRMS-DART calculated for $C_{15}H_{19}O_3$ $[M+H]^+$: 247.13342; found: 247.13329.

2-(2-Propiniloxi)benzoate de metilo (XIVb):[16]



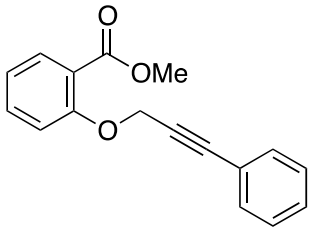
Method B. Yellow oil. Obtained: 1.87 g (98%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.75 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.48 (ddd, *J* = 8.9, 7.5, 1.7 Hz, 1H), 7.07 (d, *J* = 8.4 Hz, 1H), 6.98 (t, *J* = 7.5 Hz, 1H), 4.73 (d, *J* = 2.3 Hz, 2H), 3.82 (s, 3H), 2.46 (t, *J* = 2.3 Hz, 1H).

Methyl 2-[[3-(4-methoxyphenyl)-2-propyn-1-yl]oxy]benzoate (XIb):[11]



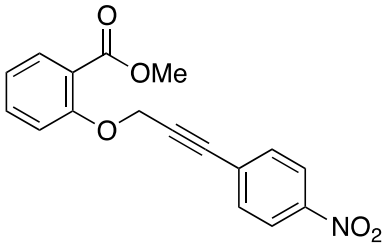
Method C. Yellow oil. Obtained: 0.35 g (55%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.52 – 7.44 (m, 1H), 7.35 (d, *J* = 8.8 Hz, 2H), 7.23 (dd, *J* = 8.6, 1.2 Hz, 1H), 7.03 (td, *J* = 7.6, 1.1 Hz, 1H), 6.82 (d, *J* = 8.8 Hz, 2H), 5.01 (s, 2H), 3.90 (s, 3H), 3.80 (s, 3H).

Methyl 2-[[3-(phenyl)-2-propyn-1-yl]oxy]benzoate (XIIb):[17]



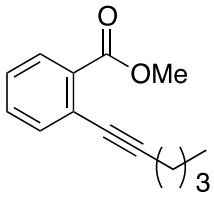
Method A. Yellow oil. Obtained: 0.39 g (74%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.7 Hz, 1H), 7.49 (t, *J* = 7.9 Hz, 1H), 7.44 – 7.20 (m, 6H), 7.04 (t, *J* = 7.5 Hz, 1H), 5.02 (s, 2H), 3.90 (s, 3H).

Methyl 2-[[3-(4-nitrophenyl)-2-propyn-1-yl]oxy]benzoate (XIIIb):[11]



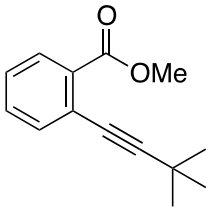
Method C. Orange oil. Obtained: 0.26 g (54%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.9 Hz, 2H), 7.84 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.54 (d, *J* = 8.9 Hz, 2H), 7.51 - 7.47 (m, 1H), 7.17 (dd, *J* = 8.4, 1.0 Hz, 1H), 7.07 (td, *J* = 7.6, 1.0 Hz, 1H), 5.04 (s, 2H), 3.90 (s, 3H).

Methyl 2-(1-hexyn-1-yl)benzoate (XVb):[18]



Method C. Yellow oil. Obtained: 0.62 g (98%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.8 Hz, 1H), 7.50 (d, *J* = 7.7 Hz, 1H), 7.41 (td, *J* = 7.5, 6.0, 1.2 Hz, 1H), 7.36 – 7.23 (m, 1H), 3.91 (s, 3H), 2.48 (t, *J* = 7.0 Hz, 2H), 1.56 (dh, *J* = 28.7, 6.7 Hz, 4H), 0.95 (t, *J* = 7.2 Hz, 3H).

Methyl 2-(3,3-dimethylbut-1-ynyl)benzoate (XVIb):[19]



Method C. Yellow oil. Obtained: 0.53 g (91%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 7.9, 0.8 Hz, 1H), 7.52 - 7.45 (m, 1H), 7.40 (td, *J* = 7.5, 1.4 Hz, 1H), 7.30 (td, *J* = 7.7, 1.5 Hz, 1H), 3.92 (s, 3H), 1.34 (s, 9H).

Synthesis of alkynoic acids 1a-16a:

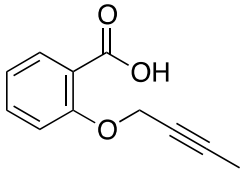
Method A:

To a solution of $LiOH{\cdot}H_2O$ (0.083 g, 1.99 mmol) in THF:H_2O (1:1, 4 mL) at 0 ºC was added H_2O_2 (30%, 1.99 mmol). This solution was dropped over a solution of the corresponding ester (0.99 mmol) in THF (2 mL) and stirred from 0 ºC to 25 ºC until the ester was totally consumed. Thereafter a solution of Na_2SO_3 (5.97 mmol) was added, and the reaction mixture was stirred for 15 minutes. The resulting solution was acidified to pH=3 and extracted with DCM (3 x 20 mL). Finally, the combined organic phases were dried over Na_2SO_4 and concentrated under vacuum. If necessary, the final alkynoic acids were further purified washing with pentane or by column chromatography.

Method B:

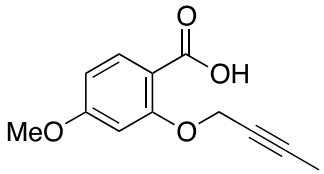
To a solution of the corresponding ester (2.62 mmol) in EtOH (20 mL), a saturated aqueous solution of KOH (30 drops) was added. The homogeneous mixture was stirred at 25 ºC for 20 h. Later on, water (30 mL) was added and the resulting solution was acidified with HCl 10% until pH = 2. The aqueous layer was extracted with DCM (4 x 30 mL), the combined organic phases were dried over Na_2SO_4 and concentrated under vacuum. The desired alkynoic acids were obtained as a white or slightly colored powder. If necessary, the final alkynoic acids were further purified by washing with pentane or by column chromatography.

2-(2-Butyn-1-yloxy)benzoic acid (1a):[11]



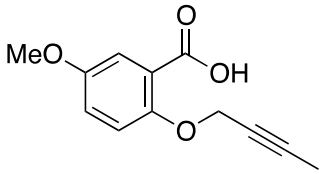
Method A. White solid. Obtained: 0.20 g (83%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.65 (s, 1H), 8.20 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.57 (td, *J* = 8.1, 1.8 Hz, 1H), 7.16 (t, *J* = 7.7 Hz, 2H), 4.91 (q, *J* = 2.2 Hz, 2H), 1.87 (t, *J* = 2.3 Hz, 3H).

4-Methoxy-2-(2-butyn-1-yloxy)benzoic acid (2a):



Method A. White solid. M. p.: 119-121°C. Obtained: 0.23 g (85%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.46 (bs, 1H), 8.14 (d, *J* = 8.7 Hz, 1H), 6.71 – 6.61 (m, 2H), 4.86 (q, *J* = 2.2 Hz, 2H), 3.88 (s, 3H), 1.88 (t, *J* = 2.2 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 165.09 (C), 164.88 (C), 157.84 (C), 135.58 (CH), 110.96 (C), 107.18 (CH), 100.07 (CH), 86.53 (C), 71.84 (C), 58.41 (CH_2), 55.76 (CH_3), 3.70 (CH_3). IR (KBr): 2919.96, 2849.42, 1662.56, 1602.99, 1503.68, 1449.76 cm^{-1}. HRMS-DART calculated for $C_{12}H_{13}O_4$ $[M+H]^+$: 221.08138; found: 221.08084.

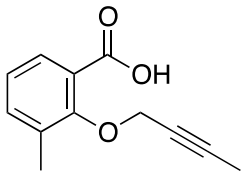
5-Methoxy-2-(2-butyn-1-yloxy)benzoic acid (3a):



Method A. White solid. M. p.: 86-87 °C. Obtained: 0.4 g (94%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.86 (bs, 1H), 7.67 (d, *J* = 2.4 Hz, 1H), 7.15 – 7.05 (m, 2H), 4.84 (q, *J* = 2.3 Hz, 2H), 3.82 (s, 3H), 1.85 (t, *J* = 2.3 Hz, 3H). ^{13}C NMR (75 MHz, CDCl3) δ 165.36 (C), 154.88 (C), 150.74 (C), 121.89 (CH), 119.21 (C), 116.34 (CH), 115.50 (CH), 86.43 (C), 72.28 (C), 59.32 (CH_2), 55.96 (CH_3), 3.72 (CH_3). IR (film): 3062.22, 2921.76, 2838.39, 1727.90, 1492.33,

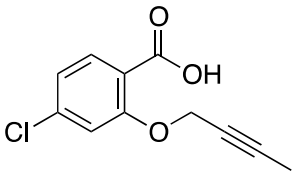
1424.48 cm^{-1}. HRMS-DART calculated for $C_{12}H_{13}O_4$ $[M+H]^+$: 221.08138; found: 221.08045.

3-Methyl-2-(2-butyn-1-yloxy)benzoic acid (4a):



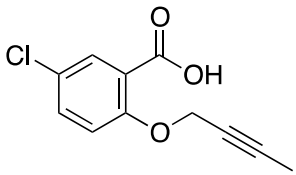
Method A. White solid. M. p.: 101-103 °C. Obtained: 0.19 g (81%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.86 (bs, 1H), 7.95 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.43 (d, *J* = 7.5 Hz, 1H), 7.19 (t, *J* = 7.7 Hz, 1H), 4.67 (q, *J* = 2.4 Hz, 2H), 2.37 (s, 3H), 1.84 (t, *J* = 2.4 Hz, 3H). ^{13}C NMR (75 MHz, CDCl3) δ 166.63 (C), 155.34 (C), 136.70 (CH), 131.95 (C), 130.45 (CH), 125.27 (CH), 123.52 (C), 86.82 (C), 72.51 (C), 62.98 (CH_2), 16.24 (CH_3), 3.62 (CH_3). IR (film): 2923.01, 2852.46, 2650.84, 2568.69, 1673.32, 1590.29, 1458.14 cm^{-1}. HRMS-DART calculated for $C_{12}H_{13}O_3$ $[M+H]^+$: 205.08647; found: 205.08593.

4-Chloro-2-(2-butyn-1-yloxy)benzoic acid (5a):



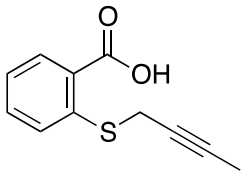
Method A. White solid. M. p.: 145-147 °C. Obtained: 0.24 g (93%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.47 (s, 1H), 8.12 (d, *J* = 9.0 Hz, 1H), 7.16 (s, 1H), 7.13 (d, *J* = 1.9 Hz, 1H), 4.90 (q, *J* = 2.3 Hz, 2H), 1.89 (t, *J* = 2.3 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 164.52 (C) , 156.79 (C), 140.73 (C), 134.82 (CH), 123.01 (CH), 116.89 (C), 114.04 (CH), 87.14 (C), 71.41 (C), 58.81 (CH_2), 3.73 (CH_3). IR (KBr): 2920.49, 2853.35, 2325.73, 1686.67, 1590.52, 1570.18 cm^{-1}. HRMS-DART calculated for $C_{11}H_{10}ClO_3$ $[M+H]^+$: 225.03185; found: 225.03079.

5-Chloro-2-(2-butyn-1-yloxy)benzoic acid (6a):[11]



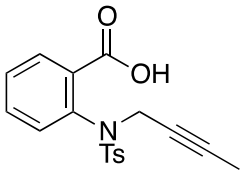
Method A. White solid. Obtained: 0.43 g (86%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.54 (s, 1H), 8.15 (d, *J* = 2.7 Hz, 1H), 7.51 (dd, *J* = 8.9, 2.8 Hz, 1H), 7.11 (d, *J* = 8.9 Hz, 1H), 4.89 (d, *J* = 2.3 Hz, 2H), 1.87 (t, *J* = 2.2 Hz, 3H).

1-(2-Butyn-1-ylthio)benzoic acid (7a):



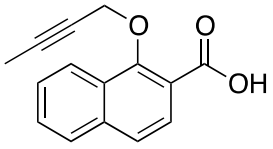
Method A. Yellowish solid. M. p.: 169-171 ºC. Obtained: 0.19 g (75%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.15 (d, *J* = 7.7 Hz, 1H), 7.52 (dt, *J* = 15.3, 7.9 Hz, 2H), 7.23 (d, *J* = 7.3 Hz, 1H), 3.65 (bs, *J* = 2.4 Hz, 2H), 1.83 – 1.78 (m, 3H). ^{13}C NMR (75 MHz, acetone-d_6) δ 167.58 (C), 142.41 (C), 133.31 (CH), 132.16 (CH), 128.29 (C), 126.60 (CH), 124.84 (CH), 79.58 (C), 75.18 (C), 21.20 (CH_2), 3.31 (CH_3). IR (KBr): 2913.54, 2849.96, 1665.22, 1563.07, 1465.76, 1411.68 cm^{-1}. HRMS-DART calculated for $C_{11}H_{11}O_2S$ $[M+H]^+$: 207.04797; found: 207.04721.

2-[2-butyn-1-yl[(4-methylphenyl)sulfonyl]amino]benzoic acid (8a):[11]



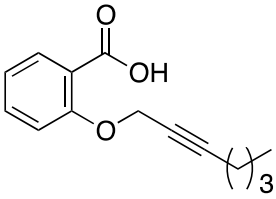
Method A. White solid. Obtained: 0.29 g (81%). ^{1}H NMR (300 MHz, acetone-d_6) δ 7.95 - 7.89 (m, 1H), 7.61 (d, *J* = 8.3 Hz, 2H), 7.54 - 7.46 (m, 2H), 7.42 - 7.35 (m, 2H), 7.15-7.09 (m, 1H), 4.54 (bs, 2H), 2.43 (s, 3H), 1.67 (t, *J* = 2.4 Hz, 3H).

2-(2-butyn-1-yloxy)naphthoic acid (9a):



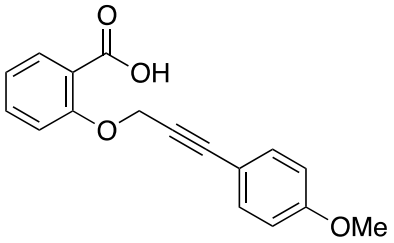
Method A. White solid. M. p.: 128-130 °C. Obtained: 0.22g (95%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.06 (bs, 1H), 8.27 (d, *J* = 8.3 Hz, 1H), 8.06 (d, *J* = 8.7 Hz, 1H), 7.88 (d, *J* = 7.4 Hz, 1H), 7.71 (d, *J* = 8.6 Hz, 1H), 7.66 – 7.56 (m, 2H), 4.90 (s, 2H), 1.85 (s, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 168.47 (C), 155.82 (C), 137.53 (C), 129.02 (CH), 128.30 (CH), 127.87 (C), 127.04 (CH), 126.85 (CH), 125.18 (CH), 123.67 (CH), 119.30 (C), 87.02 (C), 73.27 (C), 64.92 (CH_2), 3.82 (CH_3). IR (film): 2849.44, 2558.86, 2232.31, 1669.15, 1621.04, 1566.35, 1464.60 cm^{-1}. HRMS-DART calculated for $C_{15}H_{13}O_3$ $[M+H]^+$: 241.08647; found: 241.08640.

2-(2-Heptyn-1-yloxy)benzoic acid (10a):[15]



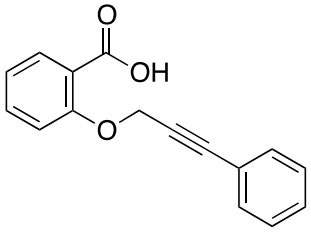
Method A. Yellow oil. Obtained: 0.46 g (60%). ^{1}H NMR (300 MHz $CDCl_3$) δ 10.75 (s, 1H), 8.20 (d, *J* = 7.8 Hz, 1H), 7.56 (t, *J* = 15.4, 7.9 Hz, 1H), 7.16 (t, *J* = 7.0 Hz, 2H), 4.93 (s, 2H), 2.22 (t, *J* = 13.4, 6.7 Hz, 2H), 1.41 (dh, *J* = 29.1, 6.8 Hz, 4H), 0.88 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$) δ 165.32 (C), 156.59 (C), 134.92 (CH), 133.98 (CH), 122.82 (CH), 118.51 (C), 113.58 (CH), 91.26 (C), 72.84 (C), 58.73 (CH_2), 30.35 (CH_2), 21.97 (CH_2), 18.53 (CH_2), 13.61 (CH_3). IR (film): 2952.85, 2924.52, 2823.93, 1676.35, 1599.84, 1577.18, 1489.34, 1459.58, 1414.25, 1315.07, 1283.90 1224.40 cm^{-1}. HRMS-DART calculated for $C_{14}H_{17}O_3$ $[M+H]^+$: 233.11777; found: 233.11748.

2-[[3-(4-Methoxyphenyl)-2-propyn-1-yl]oxy]benzoic acid (11a):[11]



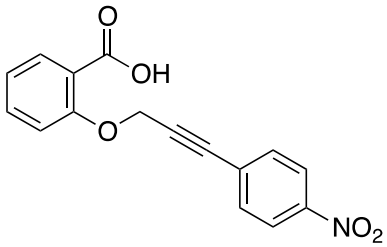
Method A. Yellow crystals. Obtained: 0.26 g (54%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.76 (bs, 1H), 8.21 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.59 (ddd, *J* = 8.9, 7.3, 1.8 Hz, 1H), 7.37 (d, *J* = 8.7 Hz, 2H), 7.17 (d, *J* = 8.4 Hz, 1H), 7.09 (t, *J* = 7.6 Hz, 1H), 6.84 (d, *J* = 8.7 Hz, 2H), 5.16 (s, 2H), 3.81 (s, 3H).

2-[[3-(Phenyl)-2-propyn-1-yl]oxy]benzoic acid (12a):[11]



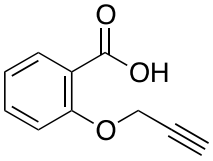
Method A. White solid. Obtained: 0.39 g (85%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.62 (bs, 1H), 8.23 (dd, *J* = 7.8, 1.6 Hz, 1H), 7.60 (td, *J* = 8.2, 7.4, 1.7 Hz, 1H), 7.48 – 7.38 (m, 2H), 7.40 – 7.27 (m, 3H), 7.27 – 7.13 (m, 2H), 5.18 (s, 2H).

2-[[3-(4-Nitrophenyl)-2-propyn-1-yl]oxy]benzoic acid (13a):[11]



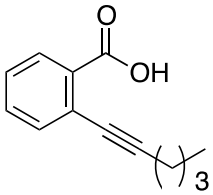
Method A. Orange solid. Obtained: 0.12 g (79%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.49 (bs, 1H), 8.27 – 8.15 (m, 3H), 7.65 – 7.55 (m, 3H), 7.24 – 7.17 (m, 2H), 5.21 (s, 2H).

2-(2-Propynyloxy)benzoic acid (14a):[20]



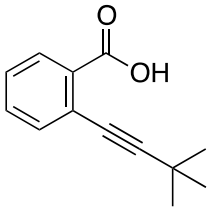
Method B. White solid. Obtained: 0.39 g (85%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 10.48 (s, 1H), 8.14 (dd, *J*= 7.8, 1.8 Hz, 1H), 7.52 (ddd, *J* = 8.3, 7.4, 1.9 Hz, 1H), 7.18 – 7.06 (m, 2H), 4.89 (d, *J* = 2.4 Hz, 2H), 2.60 (t, *J* = 2.4 Hz, 1H).

2-(1-Hexyn-1-yl)benzoic acid (15a):[21]



Method A. Yellow oil. Obtained: 0.38 g (80%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.07 (d, *J* = 7.8 Hz, 1H), 7.51 (dt, *J* = 15.0, 7.6 Hz, 2H), 7.37 (t, *J* = 7.5 Hz, 1H), 2.50 (t, *J* = 6.9 Hz, 2H), 1.57 (dh, *J* = 29.2, 6.9 Hz, 4H), 0.96 (t, *J* = 14.3, 7.2 Hz, 3H).

2-(3,3-Dimethylbut-1-ynyl)benzoic acid (16a):[20]



Method A. White solid. Obtained: 0.43 g (88%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.11 (d, *J* = 7.9 Hz, 1H), 7.56 - 7.44 (m, 2H), 7.37 (t, *J* = 7.5 Hz, 1H), 1.36 (s, 9H).

General methods for arylative cyclization:

Method A (With preformation of the arylAu(III) intermediate):

To a solution of *p*-nitroaniline (0.10 mmol) in THF (0.70 mL), was added HCl·Et_2O (1 M, 0.20 mmol, 0.20 mL) at 0°C. The mixture was stirred until a white precipitate appeared, then was cooled to -15 ºC and *tert*-butyl nitrite (0.12 mmol, 0.018 mL) was added dropwise. The

reaction mixture was stirred from -15 ºC to 0 ºC over a period of 20 min, thereafter the solution was removed under vacuum. Next, the diazonium salt was dissolved in DMSO (2 mL), and $[AuCl(SMe_2)]$[22] (0.10 mmol) was added under nitrogen. The temperature was up to 50 ºC and the mixture was heated for 4 h. Later, Li_2CO_3 (0.20 mmol) and **1a** (0.10 mmol) were added and the reaction was further heated at 50 °C for other 4 h. Finally, the solvent was removed under vacuum and the residue obtained was was further purified by silica gel chromatography using mixtures of hexane/EtOAc as eluent.

Method B (One-Pot)

To a solution of the corresponding aniline (0.10 mmol) in THF (0.70 mL), was added $HCl{\cdot}Et_2O$ (1 M, 0.20 mmol, 0.20 mL) at -0°C. The mixture was stirred until a white precipitate appeared, then was cooled to -15 ºC and *tert*-butyl nitrite (0.12 mmol, 0.018 mL) was added dropwise. The reaction mixture was stirred from -15 ºC to 0 ºC over a period of 20 min, thereafter the solution was removed under vacuum. Next, the diazonium salt was dissolved in degassed MeOH/MeCN (3:1, 3 mL), and $[AuCl(SMe_2)]$[14] (0.10 mmol), Li_2CO_3 (0.20 mmol) and the corresponding alkynoic acid (0.10 mmol) were added under nitrogen. The reaction mixture was heated at 50 ºC for 2.5 h. Finally, the solvent was removed under vacuum and the residue obtained was was further purified by silica gel chromatography using mixtures of hexane/EtOAc as eluent.

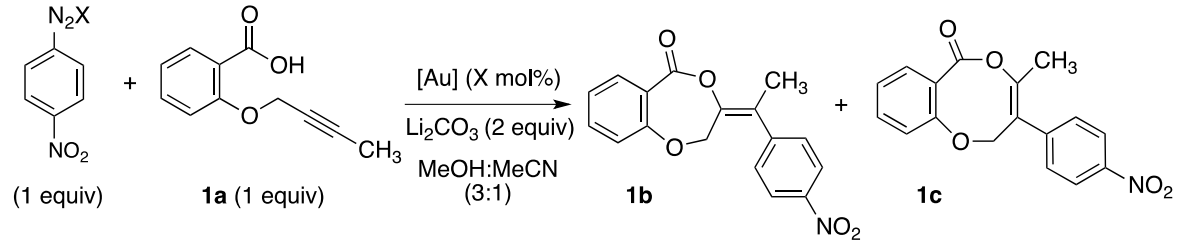
Method C (Catalytic tests in combination with $[Ru(BPy)_3][PF_6]_2$):

To a solution of *p*-nitrobenzenediazonium tetrafluoroborate (0.12 mmol) in degassed MeOH/MeCN (3:1, 3 mL), were added: $[Ru(BPy)_3][PF_6]_2$ (0.003 mmol), Me_2SAuCl (0.013 mmol), **1a** (0.13 mmol) and Li_2CO_3 (0.26 mmol). The reaction mixture was stirred at 25 °C with blue LED (25 W) for the time shown in Table 1. Then, the solvent was removed under vacuum, and the residue obtained was was further purified by silica gel chromatography.

Method D (Catalytic tests without $[Ru(BPy)_3][PF_6]_2$):

To a solution of *p*-nitrobenzenediazonium chloride (0.13 mmol) in degassed MeOH/MeCN (3:1, 3 mL), were added the gold complex (0.013 mmol), and **1a** (0.1314 mmol). The reaction mixture was stirred at 25 °C with blue LED (25 W) for the time shown in Table 1. Then, the

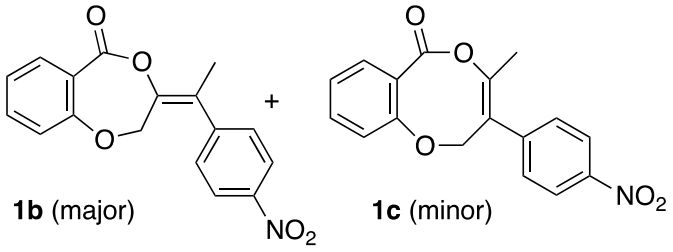
solvent was removed under vacuum, and the residue obtained was was further purified by silica gel chromatography.



Entry	X	[Cat.](mol%)	light	t, T	Yield (%)
1	Cl	$[Au(SMe_2)Cl]$ (20)	sun	16 h, 25 ºC	-
2	Cl	$[Au(PPh_3)Cl]$ (20)	sun	24 h, 25 ºC	-
3	Cl	[Au(IPr)Cl] (20)	sun	24 h, 25 ºC	-
4	Cl	$[Au(SMe_2)Cl]$ (20) Xantphos (20)	sun	24 h, 25 ºC	-
5	BF_4	$[Au(PPh_3)Cl]$ (10)	sun	20 h, 25 ºC	<5
6	Cl	$[Au(PPh_3)Cl]$ (10) $[Ru(bpy)_3](PF_6)_2$(2.5)	LED	20 h, 25 ºC	-
7	BF_4	$[Au(SMe_2)Cl]$ (10) $[Ru(bpy)_3](PF_6)_2$(2.5)	LED	20 h, 25 ºC	-
8	BF_4	$[Au(PPh_3)Cl]$ (10) $[Ru(bpy)_3](PF_6)_2$(2.5)	LED	20 h, 25 ºC	-

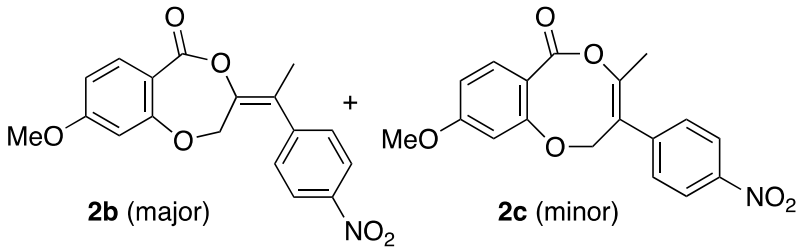
Table 1. Arylative cyclization tests with a catalytic amount of gold.

1b/1c



Method B. White solid. Obtained: 0.027 g (86%), (**1b**/**1c** = 73:26). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.31 - 8.28 (m, 1H **c**), 8.21 - 8.17 (m, 2H **c**), 8.16 - 8.11 (m, 2H **b**), 7.97 (dd, *J* = 8.0, 1.7 Hz, 1H **c**), 7.74 - 7.69 (m, 1H **c**), 7.50 - 7.43 (m, 1H **c**), 7.41 - 7.35 (m, 2H **c**), 7.32 (dd, *J* = 7.8, 1.6 Hz, 1H **b**), 7.25 - 7.20 (m, 2H **b**), 7.07 (ddd, *J* = 8.2, 7.2, 1.1 Hz, 1H **b**), 7.04 - 6.99 (m, 1H **b**), 6.91 (dd, *J* = 8.4, 0.8 Hz, 1H **b**), 4.90 (s, 2H **b**), 4.58 (s, 2H **c**), 2.10 (s, 3H **c**), 1.83 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.75 (C), 165.73 (C), 156.73 (C), 153.43 (C), 151.05 (C), 147.66 (C), 147.51 (C), 145.66 (C), 143.99 (C), 141.99 (C), 135.33 (CH), 134.74 (CH), 133.20 (CH), 131.02 (C), 130.12 (CH), 129.48 (CH), 129.22 (CH), 128.94 (CH), 128.48 (CH), 128.30 (C), 124.54 (CH), 124.05 (CH), 123.93 (CH), 122.40 (CH), 122.06 (CH), 120.36 (CH), 119.98 (C), 119.91 (CH), 117.20 (C), 68.18 (CH_2), 66.49 (CH_2), 17.87 (CH_3), 17.65 (CH_3). IR (film): 3072.41, 2918.77, 2852.39, 1735.60, 1675.08, 1598.86, 1515.40, 1477.63, 1440.59 cm^{-1}. HRMS-DART calculated for $C_{17}H_{14}NO_5$ $[M+H]^+$: 312.08720; found: 312.08652.

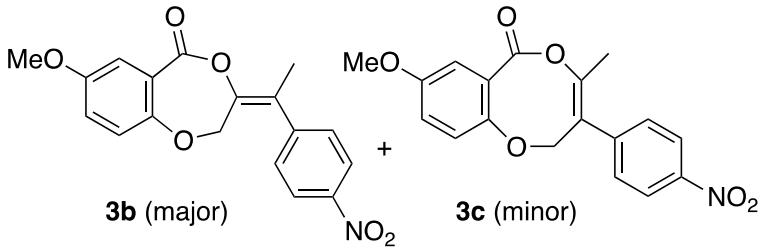
2b/**2c**



Method B. White solid. Obtained: 0.023 g (69%), (**2b**/**2c** = 71:29). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.38 - 8.34 (m, 1H **c**), 8.28 - 8.25 (m, 2H **c**), 8.24 - 8.20 (m, 2H **b**), 7.80 - 7.77 (m, 1H **c**), 7.51 - 7.48 (m, 2H **c**), 7.38 – 7.31 (m, 3H **b**), 6.68 (dd, *J* = 9.1, 2.5 Hz, 1H **c**), 6.63 (dd, *J* = 8.7, 2.5 Hz, 2H **b**), 6.52 (d, *J* = 2.5 Hz, 1H **c**), 6.45 (d, *J* = 2.4 Hz, 1H **b**), 4.94 (s, 2H **b**), 4.61 (s, 2H **c**), 3.87 (s, 3H **c**), 3.82 (s, 3H **b**), 2.17 (s, 3H **c**), 1.90 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.85 (C **b**), 165.31 (C **c**), 163.54 (C **b**), 158.98 (C **c**), 153.30 (C **b**), 153.01

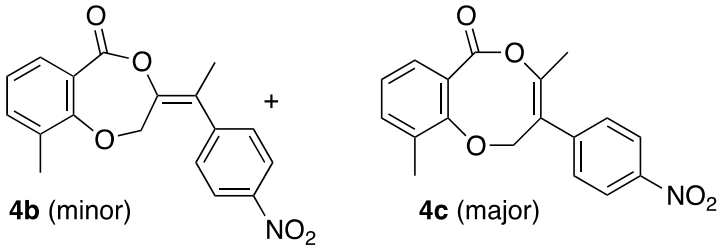
(C **b**), 147.47 (C **b**), 145.87 (C **c**), 144.05 (C **b**), 142.06 (C **c**), 136.86 (CH **c**), 132.25 (CH **b**), 129.51 (CH **b**), 129.28 (CH **c**), 128.47 (C **c**), 127.51 (C **c**), 124.52 (C **c**), 124.03 (CH **b**), 123.89 (CH **c**), 123.44 (C **c**), 120.30 (C **b**), 112.60 (C **b**), 110.46 (CH **c**), 109.12 (CH **b**), 103.89 (CH **b**), 103.05 (CH **c**), 67.82 (CH_2 **c**), 66.43 (CH_2 **b**), 55.84 (CH_3 **c**), 55.68 (CH_3 **b**), 17.89 (CH_3 **b**), 17.60 (CH_3 **2c**). IR (película): 3077.87, 2920.59, 2848.47, 1733.11, 1666.39, 1606.93, 1566.17, 1516.91, 1495.52 cm^{-1}. HRMS-DART calculated for $C_{18}H_{16}NO_6$ $[M+H]^+$: 342.09776; found: 342.09899.

3b/3c



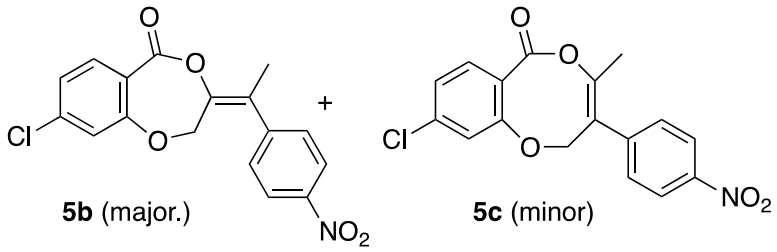
Method B. White solid. Obtained: 0.026 g (75%), (**3b/3c** = 71:29). ^1H NMR (500 MHz, $CDCl_3$) δ 8.19 - 8.15 (m, 2H **c**), 8.15 - 8.11 (m, 2H **b**), 7.35 (d, *J* = 3.2 Hz, 1H **c**), 7.34 - 7.30 (m, 2H **c**), 7.23 - 7.20 (m, 2H **b**), 7.05 (dd, *J* = 9.0, 3.2 Hz, 1H **c**), 6.95 (dd, *J* = 9.0, 3.1 Hz, 1H **b**), 6.92 (d, *J* = 9.0 Hz, 1H **c**), 6.83 (d, *J* = 9.0 Hz, 1H **b**), 6.79 (d, *J* = 3.0 Hz, 1H **b**), 4.85 (s, 2H **b**), 4.54 (s, 2H **c**), 3.77 (s, 3H **c**), 3.73 (s, 3H **b**), 2.08 (s, 3H **c**), 1.83 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.47 (C), 165.83 (C), 154.81 (C), 154.38 (C), 153.19 (C), 150.75 (C), 147.61 (C), 147.46 (C), 145.63 (C), 144.86 (C), 144.07 (C), 142.23 (C), 129.44 (CH), 129.19 (CH), 128.56 (C), 124.02 (CH), 123.91 (CH), 123.51 (CH), 121.85 (CH), 121.17 (CH), 120.73 (C), 120.35 (C), 120.11 (CH), 118.31 (C), 115.59 (CH), 113.36 (CH), 68.80 (CH_2), 66.90 (CH_2), 56.00 (CH_3), 55.94 (CH_3), 18.02 (CH_3), 17.72 (CH_3). IR (KBr): 2924.84, 2853.24, 1744.90, 1668.07, 1598.49, 1519.93, 1493.43, 1409.51 cm^{-1}. HRMS-DART calculated for $C_{18}H_{16}NO_6$ $[M+H]^+$: 342.09776; found: 342.09783.

4b/4c



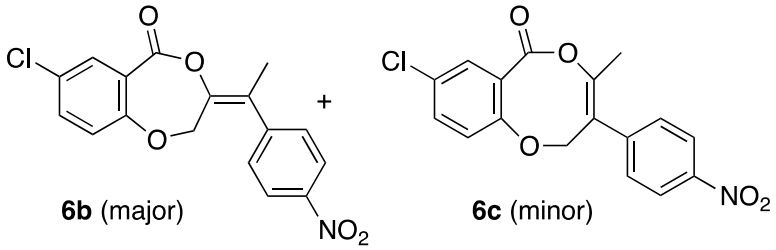
Method B. White solid. Obtained: 0.028 g (83%), (**4b**/**4c** = 47:53). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.20 - 8.16 (m, 2H **c**), 8.15 - 8.11 (m, 2H **b**), 7.76 (dd, *J* = 8.0, 1.3 Hz, 1H **c**), 7.37 - 7.29 (m, 3H **c**), 7.26 - 7.22 (m, 1H **b**), 7.16 - 7.11 (m, 3H **b**), 6.97 (t, *J* = 7.6 Hz, 1H **c**), 6.92 (t, *J* = 7.6 Hz, 1H **b**), 4.95 (s, 2H **b**), 4.61 (s, 2H **c**), 2.21 (s, 3H **c**), 2.10 (s, 3H **b**), 2.07 (s, 3H **c**), 1.79 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.09 (C), 166.31 (C), 154.56 (C), 153.29 (C), 149.06 (C), 147.59 (C), 147.47 (C), 145.76 (C), 144.15 (C), 142.21 (C), 136.18 (CH), 134.08 (CH), 132.02 (CH), 129.57 (CH), 129.49 (C), 129.21 (CH), 128.86 (C), 128.06 (C), 127.40 (CH), 124.03 (CH), 123.90 (CH), 122.27 (CH), 121.67 (CH), 120.49 (C), 120.01 (C), 118.15 (C), 68.43 (CH_2), 66.68 (CH_2), 17.82 (CH_3), 17.63 (CH_3), 17.14 (CH_3), 16.85 (CH_3). IR (película): 2955.98, 2923.48, 2858.32, 1750.82, 1687.07, 1598.66, 1521.91 cm^{-1}. HRMS-DART calculated for $C_{18}H_{15}NO_5$ $[M+H]^+$: 326.10285; found: 326.10341.

5b/5c



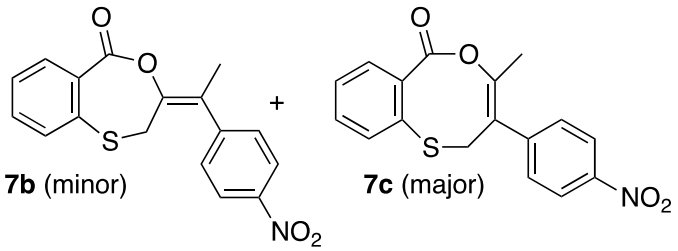
Method B. White solid. Obtained: 0.021 g (68%), (**5b**/**5c** = 88:12). ^{1}H NMR (**b**) (500 MHz, $CDCl_3$) δ 8.25 - 8.20 (m, 2H), 7.36 - 7.29 (m, 3H), 7.07 (dd, *J* = 8.3, 2.0 Hz, 1H), 7.00 (d, *J* = 2.0 Hz, 1H), 4.97 (s, 2H), 1.92 (s, 3H). ^{13}C NMR (**b**) (125 MHz, $CDCl_3$) δ 166.78 (C), 153.54 (C), 151.98 (C), 147.61 (C), 143.58 (C), 138.81 (C), 131.45 (CH), 129.46 (CH), 124.16 (CH), 122.54 (CH), 119.89 (CH), 118.73 (C), 66.66 (CH_2), 17.87 (CH_3). IR (film): 3079.58, 2921.90, 2853.69, 1735.21, 1665.26, 1596.98, 1557.50, 1516.88, 1476.47, 1406.06 cm^{-1}. HRMS-DART calculated for $C_{17}H_{13}ClNO_5$ $[M+H]^+$: 346.04822; found: 346.04770.

6b/6c



Method B. White solid. Obtained: 0.028 g (80%), (**6b/6c** = 68:32). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.22 - 8.17 (m, 2H **c**), 8.17 - 8.12 (m, 2H **b**), 7.93 (d, *J* = 2.7 Hz, 1H **c**), 7.41 (dd, *J* = 8.8, 2.7 Hz, 1H **c**), 7.38 - 7.35 (m, 2H **c**), 7.32 (dd, *J* = 8.8, 2.6 Hz, 1H **b**), 7.29 (d, *J* = 2.5 Hz, 1H **b**), 7.24 - 7.20 (m, 2H **b**), 6.97 (d, *J* = 8.8 Hz, 1H **c**), 6.85 (d, *J* = 8.8 Hz, 1H **b**), 4.89 (s, 2H **b**), 4.57 (s, 1H **c**), 2.10 (s, 3H **c**), 1.86 (s, 2H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.08 (C), 164.43 (C), 155.26 (C), 153.56 (C), 149.73 (C), 147.74 (C), 147.59 (C), 145.34 (C), 143.60 (C), 141.51 (C), 135.30 (CH), 133.72 (CH), 133.22 (CH), 129.49 (CH), 129.44 (CH), 129.17 (CH), 128.47 (C), 127.67 (C), 127.19 (C), 124.52 (C), 124.12 (CH), 123.98 (CH), 122.03 (CH), 121.44 (CH), 119.84 (C), 118.35 (C), 68.39 (CH_2), 66.69 (CH_2), 17.86 (CH_3), 17.72 (CH_3). IR (film): 3110.08, 3073.35, 2911.19, 1726.71, 1667.41, 1598.56, 1561.04, 1514.57, 1471.50 cm^{-1}. HRMS-DART calculated for $C_{17}H_{13}{}^{37}ClNO_5$ $[M+H]^+$: 348.04527; found: 348.04439.

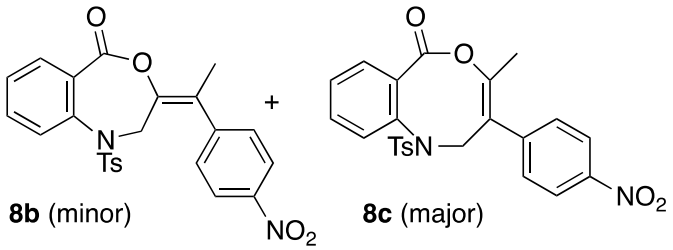
7b/7c



Method B. White solid. Obtained: 0.033 g (70%), (**7b/7c** = 57:43). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.31 - 8.27 (m, 1H **c**), 8.10 - 8.07 (m, 2H **b**), 8.07 - 8.04 (m, 2H **c**), 7.74 - 7.69 (m, 2H **b** y **c**), 7.47 - 7.27 (m, 3H **b**, 2H **c**), 7.07 - 7.00 (m, 2H **b**), 6.85 - 6.80 (m, 2H **c**), 3.89 (s, 2H **b**), 3.66 (s, 2H **c**), 1.82 (s, 3H **c**), 1.69 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.76 (C), 168.08 (C), 149.90 (C), 147.51 (C), 147.39 (C), 145.98 (C), 144.12 (C), 141.90 (C),

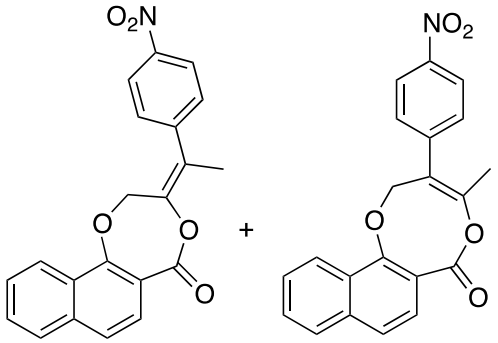
136.73 (C), 135.41 (C), 134.13 (CH), 132.75 (CH), 132.06 (CH), 131.18 (C), 131.06 (CH), 130.93 (C), 130.51 (CH), 129.56 (CH), 129.35 (CH), 128.74 (CH), 128.47 (CH), 127.40 (CH), 127.19 (CH), 124.52 (CH), 124.05 (CH), 123.95 (CH), 122.59 (C), 36.44 (CH_2), 33.79 (CH_2), 18.15 (CH_3), 17.97 (CH_3). IR (film): 3073.07, 2923.09, 2853.96, 1745.55, 1666.75, 1594.77, 1515.69, 1477.63, 1435.47 cm^{-1}. HRMS-DART calculated for $C_{17}H_{14}O_4S$ $[M+H]^+$: 328.06435; found: 328.06325.

8b/8c



Method B. White solid. Obtained: 0.035 g (76%), (**8b**/**8c** = 44:56). ^1H NMR (500 MHz, $CDCl_3$) δ 8.19 - 8.11 (m, 4H), 7.69 - 7.62 (m, 3H), 7.60 - 7.54 (m, 2H), 7.53 - 7.46 (m, 1H), 7.45 - 7.35 (m, 5H), 7.30 - 7.19 (m, 5H), 7.14 - 7.08 (m, 2H), 6.99 - 6.93 (m, 2H), 4.52 (d, *J* = 0.9 Hz, 2H), 4.44 (bs, 2H), 2.44 (s, 3H), 2.43 (s, 3H), 1.86 (t, *J* = 1.1 Hz, 3H), 1.68 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.32 (C), 166.02 (C), 153.20 (C), 147.54 (C), 145.12 (C), 144.84 (C), 144.74 (C), 143.59 (C), 141.22 (C), 135.71 (C), 134.96 (C), 134.13 (CH), 133.71 (C), 133.05 (C), 132.20 (CH), 131.77 (CH), 131.22 (CH), 130.95 (CH), 130.78 (C), 130.10 (CH), 130.08 (CH), 129.81 (C), 129.51 (CH), 129.27 (CH), 128.96 (C), 128.80 (CH), 128.00 (CH), 127.69 (CH), 127.41 (CH), 127.34 (CH), 124.08 (CH), 121.24 (C), 52.35 (CH_2), 49.41 (CH_2), 21.79 (CH_3), 21.78 (CH_3), 18.08 (CH_3). IR (KBr): 3027.61, 2923.50, 1758.78, 1672.93, 1598.56, 1520.34, 1485.03, 1445.75 cm^{-1}. HRMS-DART calculated for $C_{24}H_{21}N_2O_6S$ $[M+H]^+$: 465.11203; found: 465.11359.

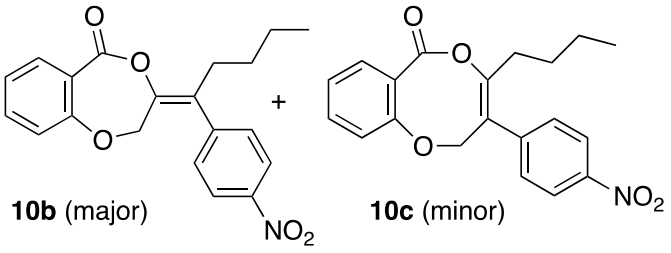
9b/9c



9b (minor) **9c** (major)

Method B. White solid. Obtained: 0.03 g (84%), (**9b/9c** = 47:53). ^{1}H NRM (500 MHz, $CDCl_3$) δ 8.32 - 8.25 (m, 2H), 8.22 - 8.17 (m, 3H), 8.08 - 8.04 (m, 2H), 7.90 (d, *J* = 8.9 Hz, 1H), 7.75 (d, *J* = 8.1 Hz, 1H), 7.72 - 7.68 (m, 1H), 7.59 (ddd, *J* = 8.1, 6.9, 1.2 Hz, 1H), 7.56 - 7.41 (m, 6H), 7.30 (d, *J* = 8.5 Hz, 1H), 7.20 - 7.16 (m, 2H), 5.13 (s, 2H), 4.80 (s, 2H), 2.11 (s, 3H), 1.82 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.08 (C), 165.98 (C), 154.42 (C), 153.50 (C), 148.17 (C), 147.65 (C), 147.41 (C), 147.19 (C), 145.73 (C), 145.08 (C), 143.97 (C), 141.84 (C), 136.80 (C), 135.79 (C), 129.73 (CH), 129.56 (CH), 129.29 (CH), 129.08 (CH), 128.55 (CH), 128.45 (CH), 127.80 (CH), 127.65 (CH), 127.08 (CH), 126.92 (CH), 125.96 (CH), 125.91 (C), 124.50 (CH), 123.99 (CH), 123.92 (CH), 123.81 (C), 123.14 (CH), 121.83 (CH), 121.81 (CH), 119.53 (C), 113.76 (C), 110.55 (C), 68.42 (CH_2), 66.81 (CH_2), 17.76 (CH_3), 17.60 (CH_3). IR (film): 2960.02, 2921.07, 2853.99, 1719.85, 1661.90, 1597.07, 1516.69 cm^{-1}. HRMS-DART calculated for $C_{21}H_{15}NO_5[M+H]^+$: 362.10285; found: 362.10137.

10b/10c

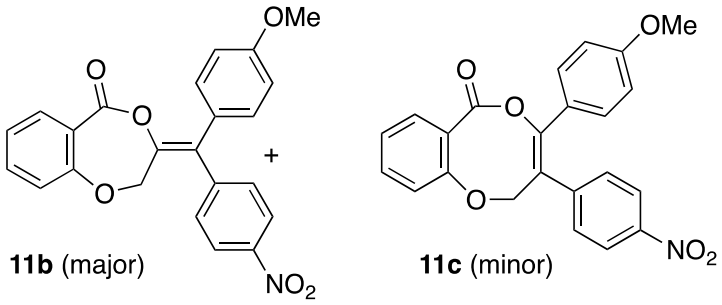


10b (major) **10c** (minor)

Method B. White solid?. Obtained: 0.0XX g (XX%), (**10b/10c** = 67:33). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.28 - 8.23 (m, 2H **c**), 8.22 - 8.17 (m, 2H **b**), 7.99 (dd, *J* = 8.0, 1.7 Hz, 1H **c**), 7.53 (ddd, *J* = 8.5, 7.2, 1.7 Hz, 1H **c**), 7.44 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H **b**), 7.39 - 7.33 (m, 2H **c**,

1 H **b**), 7.30 - 7.23 (m, 2H **b**), 7.13 (td, *J* = 7.7, 7.3, 1.1 Hz, 1H **c**), 7.08 (dt, *J* = 7.1, 1.1 Hz, 1H **b**), 7.04 (dd, *J* = 8.4, 1.0 Hz, 1H **c**), 6.97 (dd, *J* = 8.3, 0.8 Hz, 1H **b**), 4.94 (s, 2H **b**), 4.59 (s, 2H c), 2.59 (t, *J* =7.3 Hz, 2H **c**), 2.12 (t, *J* =7.6 Hz, 2H **b**), 1.34 (p, *J* =7.6 Hz, 2H **b**), 1.20-1.12 (m, 4H **c**), 0.98 (dq, *J* = 14.7, 7.4 Hz, 2H **b**), 0.79 - 0.73 (m, 3H **c**), 0.70 (t, *J* =7.3 Hz, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.16 (C), 166.01 (C), 156.65 (C), 156.53 (C), 150.98 (C), 147.66 (C), 147.50 (C), 145.10 (C), 144.69 (C), 144.13 (C), 141.55 (C), 135.25 (CH), 134.40 (CH), 133.50 (C), 133.10 (CH), 130.26 (CH), 129.60 (CH), 129.53 (CH), 124.03 (CH), 123.88 (CH), 122.49 (CH), 121.90 (CH), 120.49 (C), 120.44 (CH), 119.72 (CH), 119.63 (C), 117.66 (C), 68.54 (CH_2), 66.41 (CH_2), 30.83 (CH_2), 30.68 (CH_2), 29.59 (CH_2), 28.47 (CH_2), 22.30 (CH_2), 22.11 (CH_2), 13.77 (CH_3), 13.69 (CH_3). IR (film): 3105.87, 3074.70, 2957.10, 2927.35, 2870.68, 1735, 85, 1662.18, 1597.01, 1519.09, 1442.58 cm^{-1}. HRMS-DART calculated for $C_{20}H_{20}NO_5$ $[M+H]^+$: 354.13415; found: 354.13488.

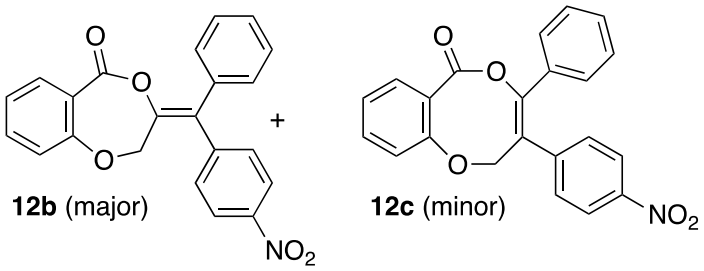
11b/11c



Method B. White solid. Obtained: 0.03 g (75%), (**11b/11c** = 79:21). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.27 - 8.23 (m, 2H **c**), 8.09 - 8.05 (m, 2H **b**), 7.95 (dd, *J* = 8.3, 1.7 Hz, 1H **c**), 7.54 (ddd, *J* = 8.5, 7.2, 1.7 Hz, 1H **c**), 7.45 - 7.35 (m, 2H **c**, 2H **b**), 7.24 - 7.19 (m, 2H **c**), 7.19 - 7.14 (m, 2H **b**), 7.13 - 7.08 (m, 2H **c**), 7.06 (td, *J* = 7.6, 1.1 Hz, 1H **b**), 6.97 - 6.94 (m, 2H **b**), 6.93 (dd, *J* = 8.3, 0.9 Hz, 1H **b**), 6.86 - 6.82 (m, 2H **c**), 6.68 - 6.62 (m, 2H **b**), 5.17 (s, 2H **b**), 4.73 (s, 2H **c**), 3.80 (s, 3H **c**), 3.73 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.36 (C), 165.33 (C), 161.02 (C), 159.83 (C), 156.67 (C), 153.55 (C), 151.25 (C), 147.80 (C), 147.19 (C), 145.42 (C), 144.73 (C), 140.92 (C), 135.30 (CH), 134.78 (CH), 133.12 (CH), 131.64 (CH), 131.19 (CH), 130.62 (CH), 130.01 (CH), 129.16 (C), 128.04 (C), 124.14 (CH), 123.82 (C), 123.75 (CH), 122.34 (CH), 122.17 (CH), 120.78 (C), 120.20 (CH), 120.06 (CH), 119.37 (C), 117.18 (C), 113.98 (CH), 113.89 (CH), 69.29 (CH_2), 68.10 (CH_2), 55.41 (CH_3). IR

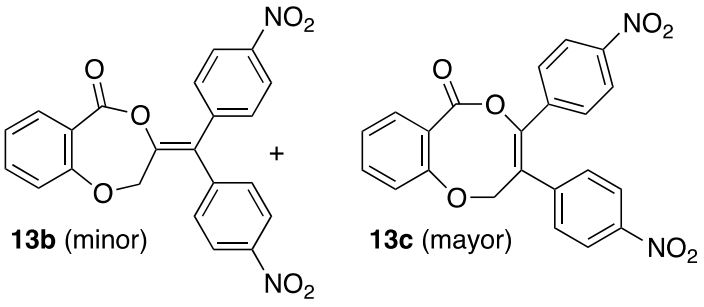
(film): 3073.51, 2931.02, 2840.71, 1738.20, 1641.62, 1600.27.98, 1572.48, 1512.93, 1479.98.47, 1442.49 cm^{-1}. HRMS-DART calculated for $C_{23}H_{18}NO_6[M+H]^+$: 404.11341; found: 404.11158.

12b/12c



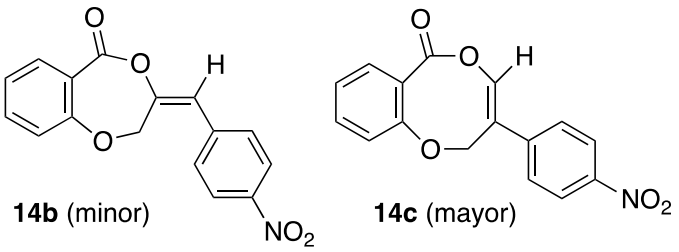
Method B. White solid. Obtained: 0.046 g (62%), (**12b/12c** = 68:32). ^1H NMR (500 MHz, $CDCl_3$) δ 8.20 - 8.15 (m, 2H **c**), 8.01 – 7.96 (m, 2H **b**), 7.87 (dd, *J* = 8.4, 1.7 Hz, 1H **c**), 7.49-7.44 (m, 1H **c**), 7.38 - 7.30 (m, 4H **c**, 1H **b**), 7.28 - 7.22 (m, 1H **b**), 7.20 - 7.16 (m, 2H **b**), 7.11 - 7.07 (m, 4H **b**), 7.07-6.98 (m, 2H **b,** 1H **c**), 6.95 - 6.86 (m, 4H **c**), 6.89 - 6.86 (m, 1H **b**), 5.11 (s, 2H **b**), 4.70 (s, 2H **c**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.14 (C), 165.08 (C), 156.67 (C), 153.61 (C), 151.18 (C), 147.79 (C), 147.30 (C), 147.09 (C), 144.23 (C), 141.86 (C), 135.80 (C), 135.35 (CH), 134.78 (CH), 133.21 (CH), 131.77 (C), 131.49 (C), 131.12 (CH), 130.27 (CH), 130.08 (CH), 130.01 (CH), 129.93 (CH), 129.02 (CH), 128.76 (CH), 128.56 (CH), 128.51 (CH), 124.08 (CH), 123.78 (CH), 122.43 (CH), 122.27 (CH), 120.87 (C), 120.63 (C), 120.18 (CH), 120.02 (CH), 117.16 (C), 69.11 (CH_2), 67.91 (CH_2). IR (film): 3069.03, 2914.60, 1741.52, 1599.84, 1514.84 cm^{-1}. HRMS-DART calculated for $C_{22}H_{16}NO_2[M+H]^+$: 374.10285; found: 374.10226.

13b/13c



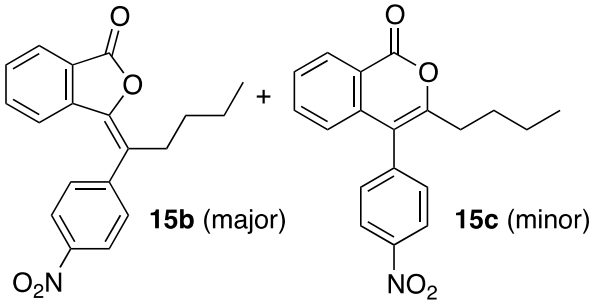
Method B. White solid. Obtained: 0.019 g (45%), (**13b/13c** = 30:70). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.30 (d, *J* = 8.8 Hz, 2H **c**), 8.19 (d, *J* = 9.0 Hz, 2H **c**), 8.14 - 8.09 (m, 2H **b**), 8.04 - 8.00 (m, 2H **b**), 7.98 (dd, *J* = 8.4, 1.7 Hz, 1H **c**), 7.57 (ddd, *J* = 8.4, 7.5, 1.7 Hz, 1H **c**), 7.51 - 7.44 (m, 4H **c**, 1H **b**), 7.39 (dd, *J* = 7.7, 1.6 Hz, 1H **b**), 7.21 – 6.99 (m, 3H **b**, 2H **c**), 7.01 - 6.99 (m, 1H **b**), 5.20 (s, 2H **b**), 4.80 (s, 2H **c**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.44 (C, **b**) 164.08 (C, **c**), 156.95 (C, **c**), 151.18 (C, **b**), 150.89 (C, **b**), 148.36 (C, **b**), 148.13 (C, **c**), 147.81 (C, **b**), 147.53 (C, **c**), 143.98 (C, **c**), 143.69 (C, **c**), 143.02 (C, **b**), 142.32 (C, **c**), 138.10 (C, **b**), 137.49 (C, **b**), 135.76 (CH, **c**), 135.04 (CH, **c**), 133.70 (CH, **b**), 131.22 (CH, **c**), 131.16 (CH, **c**), 130.01 (CH, **b**), 129.98 (CH, **b**), 129.92 (CH, **b**), 128.63 (C, **b**), 128.35 (C, **c**), 124.48 (CH, **b**), 124.17 (CH, **c**), 123.82 (CH, **b**), 123.72 (CH, **c**), 122.69 (CH, **c**), 120.16 (CH, **c**), 116.36 (CH, **c**), 68.62 (CH_2, **c**), 67.85 (CH_2, **b**). IR (film): 3075.86, 2923.53, 2853.89, 1730.06, 1598.88, 1516.20, 1478.65, 1444.30 cm^{-1}. HRMS-DART calculated for $C_{22}H_{15}N_2O_7[M+H]^+$: 419.08793; found: 419.08612.

14b/14c



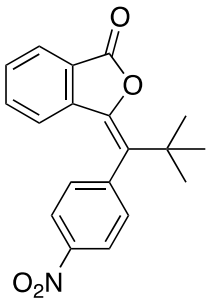
Method B. White solid. Obtained: 0.015 g (35%), (**14b/14c** = 30:70). ^{1}H RMN (500 MHz, $CDCl_3$) δ 8.29 - 8.25 (m, 2H **c**), 8.24 - 8.19 (m, 2H **b**), 8.06 - 8.03 (m, 1H **c**), 7.58 - 7.54 (m, 2H **b,** 1H **c**), 7.54 - 7.49 (m, 2H **c**), 7.41 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H **b**), 7.37 (dd, *J* = 7.8, 1.5 Hz, 1H **b**), 7.18 - 7.11 (m, 2H **c**), 7.10 (s, 1H **c**), 7.09 - 7.04 (m, 1H **c**), 7.00 (dd, *J* = 8.4, 0.8 Hz, 1H **c**), 6.76 (s, 1H **b**), 5.09 (s, 2H **b**), 4.88 (s, 1H **c**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 167.44 (C), 165.12 (C), 156.80 (C), 150.78 (C), 147.77 (C), 147.56 (C), 147.40 (C), 143.85 (CH), 141.72 (C), 140.00 (C), 135.51 (CH), 135.04 (CH), 133.25 (CH), 130.48 (CH), 129.74 (CH), 126.73 (CH), 124.37 (CH), 124.14 (CH), 122.61 (CH), 122.33 (CH), 120.25 (CH), 120.07 (C), 119.73 (CH), 119.54 (CH), 116.76 (C), 67.28 (CH_2), 63.63 (CH_2). IR (film): 2956.42, 2853.32, 1726.16, 1659.25, 1599.45, 1516.15, 1478.35 cm^{-1}. HRMS-DART calculated for $C_{16}H_{12}NO_5[M+H]^+$: 298.07155; found: 298.07111.

15b/15c



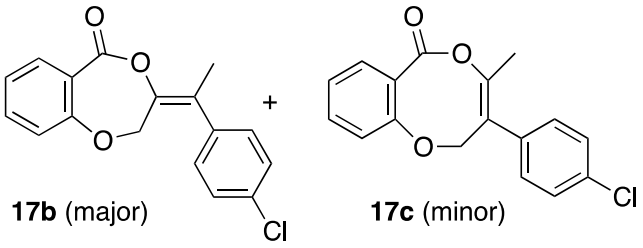
The structure of these compounds was assigned by ^{1}H NMR, ^{13}C NMR, 2D dimension analyses (COSY, HMBC, HSQC) and by comparison with the NMR reported data for similar compounds.[23] Method B. Pink solid. Obtained: 0.026 g (81%), (**15b/15c** = 72:28). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.41 - 8.31 (m, 2H **b**, 1H **c**), 7.90 (d, *J* = 7.6 Hz, 1H **b**), 7.81 – 7.76 (m, 1H **c**), 7.66 -7.58 (m, 1H **c**), 7.56 – 7.52 (m, *2*H **b**), 7.52 – 7.47 (m, 3H **c**), 7.45 (td, *J* = 8.2, 7.6, 0.7 Hz, 1 H **b**), 7.39 - 7.34 (m, 1H **b**), 6.85 (d, *J* = 8.0 Hz, 1H **c**), 6.48 (d, *J* = 8.0 Hz, 1H **b**), 2.85 – 2.71 (m, 2H **b**), 2.37 – 2.31 (m, 2H **c**), 1.68 -1.59 (m, 2H **c**), 1.45 -1.33 (m, 4H **b**), 1.30 – 1.19 (m, 2H **c**), 0.92 - 0.86 (m, 3H **b**), 0.85 – 0.79 (m, 3H **c**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.69 (C), 162.27 (C), 155.61 (C), 147.96 (C), 145.13 (C), 142.94 (C), 141.76 (C), 138.05 (C), 137.74 (C), 135.01 (CH), 134.25 (CH), 131.99 (CH), 130.39 (CH), 129.96 (C), 129.81 (CH), 128.48 (CH), 128.10 (CH), 125.77 (C), 125.72 (CH), 124.99 (C), 124.51 (CH), 124.35 (CH), 124.17 (CH), 122.47 (CH), 120.13 (C), 114.65 (C), 35.50 (CH_2), 31.36 (CH_2), 29.82 (CH_2), 29.79 (CH_2), 22.65 (CH_2), 22.39 (CH_2), 13.97 (CH_3), 13.85 (CH_3). IR (film): 2955.69, 2928.77, 2855.10, 1767.02, 1759.94, 1595.59, 1504.92, 1459.50, 1340.58, 1312.24, 1283.90 cm^{-1}. HRMS-DART calculated for $C_{19}H_{18}NO_4$ $[M+H]^+$: 324.12358; found: 324.12343.

16b



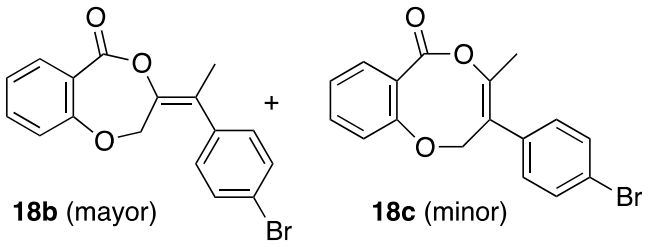
The structure of this compound was assigned by ^{1}H NMR, ^{13}C NMR, 2D dimension analyses (COSY, HMBC, HSQC). Method B. Yellow solid. Obtained: 0.023 g (71%). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.33 - 8.26 (m, 2H), 7.81 (dt, *J* = 7.7, 1.0 Hz, 1H), 7.76 - 7.69 (m, 3H), 7.38 - 7.30 (m, 3H), 7.20 (ddd, *J* = 8.4, 7.4, 1.2 Hz, 1H), 5.67 (dt, *J* = 8.1, 0.6 Hz, 1H), 1.26 (s, 9H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 166.47 (C), 147.80 (C), 145.64 (C), 142.66 (C), 139.26 (C), 134.25 (CH), 132.29 (C), 130.57 (CH), 129.54 (CH), 125.59 (CH), 124.80 (C), 124.42 (CH), 123.07 (CH), 36.88 (C), 30.72 (CH_3). IR (film): 2945, 2927, 1774, 1649, 1599, 1520, 1461, 1341, 1283.90 cm^{-1}.

17b/17c



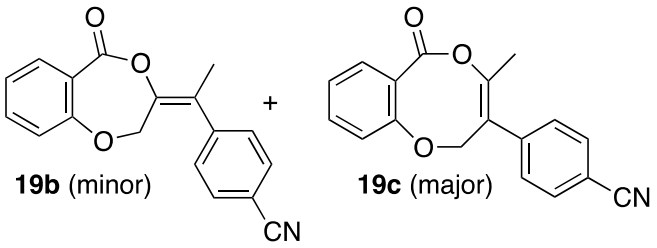
Method B. White solid. Obtained: 0.027 g (89%), (**17b/17c** = 73:27). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.93 (dd, *J* = 8.0, 1.7 Hz, 1H **c**), 7.44 (ddd, *J* = 8.8, 7.2, 1.8 Hz, 1H **c**), 7.37 - 7.32 (m, 1H **b**), 7.31 - 7.27 (m, 1H **b**, 2H **c**), 7.25 - 7.21 (m, 2H **b**), 7.13 - 7.08 (m, 2H **c**), 7.04 (ddd, *J* = 8.1, 7.2, 1.1 Hz, 1H **c**), 7.00 - 6.97 (m, 1H **b**, 1H **c**), 6.97 - 6.93 (m, 2H **b**), 6.88 (dd, *J* = 8.3, 0.9 Hz, 1H **b**), 4.86 (s, 2H **b**), 4.58 (s, 2H **c**), 2.03 (s, 3H **c**), 1.78 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.30 (C), 166.35 (C), 156.72 (C), 152.34 (C), 151.30 (C), 140.78 (C), 137.31 (C), 135.59 (C), 135.08 (CH), 134.50 (CH), 134.25 (C), 134.03 (C), 132.94 (CH), 129.95 (CH), 129.79 (CH), 129.64 (C), 129.48 (CH), 128.99 (CH), 128.85 (CH), 122.21 (CH), 121.78 (CH), 120.63 (C), 120.48 (C), 120.42 (CH), 119.95 (CH), 117.65 (C), 68.57 (CH_2), 66.95 (CH_2), 17.81 (CH_3), 17.62 (CH_3). IR (film): 2929.46, 2854.61, 2227.12, 1737.40, 1667.93, 1602.60 1477.72 cm^{-1}. HRMS-DART calculated for $C_{17}H_{14}ClO_3$ $[M+H]^+$: 301.06315; found: 301.06190.

18b/18c



Method B. Colorless oil. Obtained: 0.024 g (68%), (**18b/18c** = 77:23). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (dd, *J* = 8.1, 1.6 Hz, 1H **c**), 7.53 - 7.49 (m, 3H **c**), 7.48 - 7.44 (m, 2H **b**), 7.41 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H **b**), 7.36 (dd, *J* = 8.1, 1.6 Hz, 1H **b**), 7.13 - 7.09 (m, 3H **c**), 7.07 - 7.03 (m, 1H **b**, 1H **c**), 6.98 - 6.93 (m, 3H 1H **b**), 4.93 (s, 2H 1H **b**), 4.65 (s, 2H 1H **c**), 2.10 (s, 3H 1H **c**), 1.85 (s, 3H 1H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.27 (C, **b**), 166.32 (C, **c**), 156.72 (C, **c**), 152.32 (C, **b**), 151.29 (C, **b**), 140.76 (C, **c**), 137.79 (C, **c**), 136.07 (C, **b**), 135.08 (CH, **c**), 134.50 (CH, **c**), 132.94 (CH, **b**), 131.95 (CH, **b**), 131.81 (CH, **c**), 130.10 (CH, **b**), 129.95 (CH, **b**), 129.78 (CH, **c**), 129.65 (C, **c**), 122.40 (C, **c**), 122.21 (CH, **c**), 122.17 (C, **b**), 121.78 (CH, **b**), 120.62 (C, **b**), 120.50 (C, **b**), 120.42 (CH, **c**), 119.95 (CH, **b**), 117.64 (C, **c**), 68.56 (CH_2, **c**), 66.89 (CH_2, **b**), 17.76 (CH_3, **c**), 17.62 (CH_3, **b**). IR (film): 3069.56, 2910.11, 2853.76, 1730.11, 1670.98, 1602.95, 1568.59, 1479.28, 1440.82 cm^{-1}. HRMS-DART calculated for $C_{17}H_{14}BrO_3$ $[M+H]^+$: 345.01263; found: 345.01116.

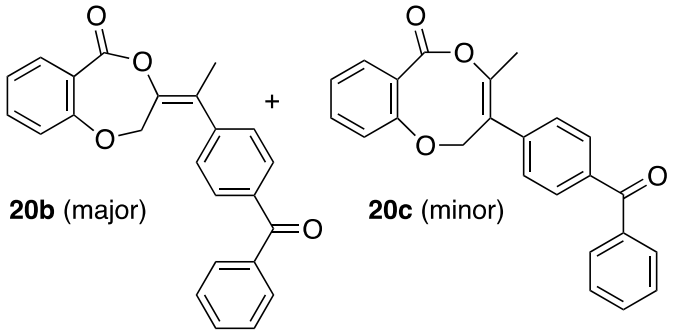
19b/19c



Method B. White solid. Obtained: 0.024 g (80%), (**19b/19c** = 67:33). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (dd, *J* = 8.1, 1.7 Hz, 1H **c**), 7.73 - 7.70 (m, 1H **c**), 7.64 - 7.60 (m, 2H **c**), 7.59 - 7.54 (m, 2H **b**), 7.46 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H **c**), 7.37 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H **b**), 7.33 - 7.29 (m, 2H **c**), 7.18 - 7.14 (m, 2H **b**), 7.08 -7.03 (m, 1H **c**), 7.03 - 6.98 (m, 2H **b**), 6.90 (dd, *J* = 8.3, 0.8 Hz, 1H **b**), 4.88 (s, 3H **b**), 4.57 (s, 2H **c**), 2.07 (s, 3H **c**), 1.81 (s, 3H **b**).

^{13}C NMR (125 MHz, $CDCl_3$) δ 167.82 (C), 165.82 (C), 156.72 (C), 153.22 (C), 151.08 (C), 143.71 (C), 142.04 (C), 141.76 (C), 135.27 (CH), 134.69 (CH), 133.14 (CH), 133.03 (CH), 132.58 (CH), 132.46 (CH), 130.07 (CH), 129.27 (CH), 129.00 (CH), 128.67 (C), 128.08 (CH), 122.35 (CH), 121.99 (CH), 120.39 (C), 120.34 (CH), 120.21 (C), 119.90 (CH), 118.54 (C), 117.25 (C), 112.14 (C), 111.97 (C), 68.21 (CH_2), 66.52 (CH_2), 17.79 (CH_3), 17.57 (CH_3). IR (film): 2920.13, 2853.43, 2228.95, 1741.88, 1667.04, 1605.63, 1570.31, 1480.27 cm^{-1}. HRMS-DART calculated for $C_{18}H_{14}NO_3$ $[M+H]^+$: 292.09737; found: 292.09620.

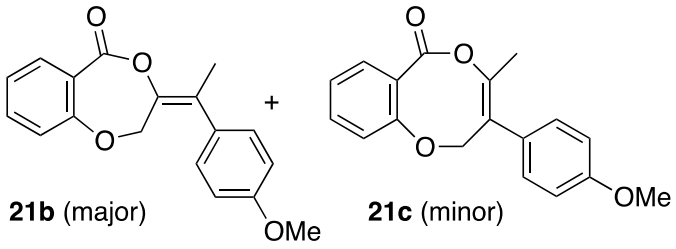
20b/20c



20b (major) **20c** (minor)

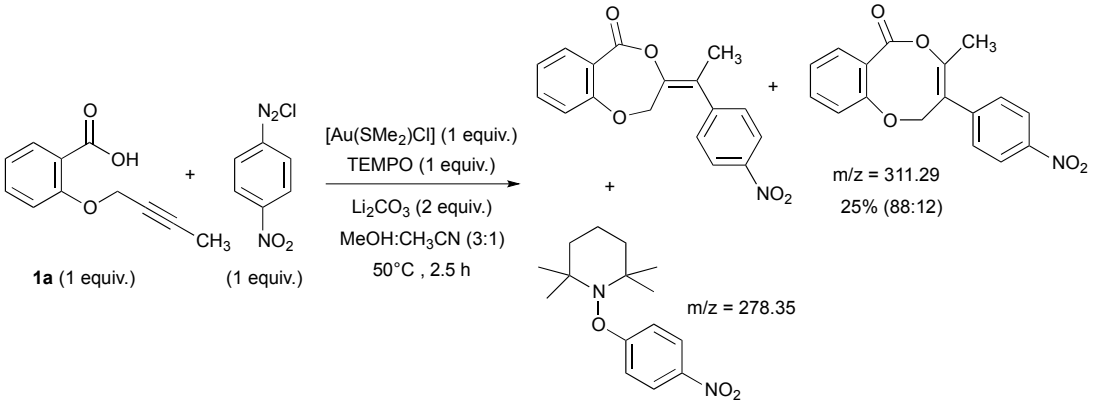
Method B. White solid. Obtained: 0.03 g (80%), (**20b/20c** = 71:29). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.87 - 7.84 (m, 1H), 7.79 - 7.68 (m, 9H), 7.56 - 7.50 (m, 2H), 7.46 - 7.38 (m, 4H), 7.35 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H), 7.30 – 7.28 (m, 2H), 7.17 - 7.12 (m, 2H), 7.04 (ddd, *J* = 8.1, 7.2, 1.1 Hz, 1H), 7.01 - 6.97 (m, 2H), 6.90 (dd, *J* = 8.3, 0.8 Hz, 1H), 4.92 (s, 2H), 4.63 (s, 2H), 2.09 (s, 3H), 1.84 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 196.30 (C), 196.13 (C), 168.17 (C), 166.21 (C), 156.75 (C), 152.74 (C), 151.27 (C), 143.98 (C), 143.08 (C), 141.40 (C), 141.23 (C), 137.67 (C), 137.43 (C), 137.28 (C), 137.17 (C), 137.08 (C), 135.12 (CH), 134.49 (CH), 132.99 (CH), 132.72 (CH), 130.92 (CH), 130.47 (CH), 130.36 (CH), 130.11 (CH), 129.96 (CH), 129.75 (C), 128.47 (CH), 128.40 (CH), 128.13 (CH), 127.31 (CH), 122.26 (CH), 121.84 (CH), 120.79 (C), 120.60 (C), 120.43 (CH), 119.99 (CH), 117.61 (C), 68.56 (CH_2), 66.83 (CH_2), 17.78 (CH_3), 17.71 (CH_3). IR (film): 2956.87, 2855,51, 1737.49, 1655.84, 1601.28, 1481.84, 1442.13 cm^{-1}. HRMS-DART calculated for $C_{24}H_{19}O_4$ $[M+H]^+$: 371.12833; found: 371.12652.

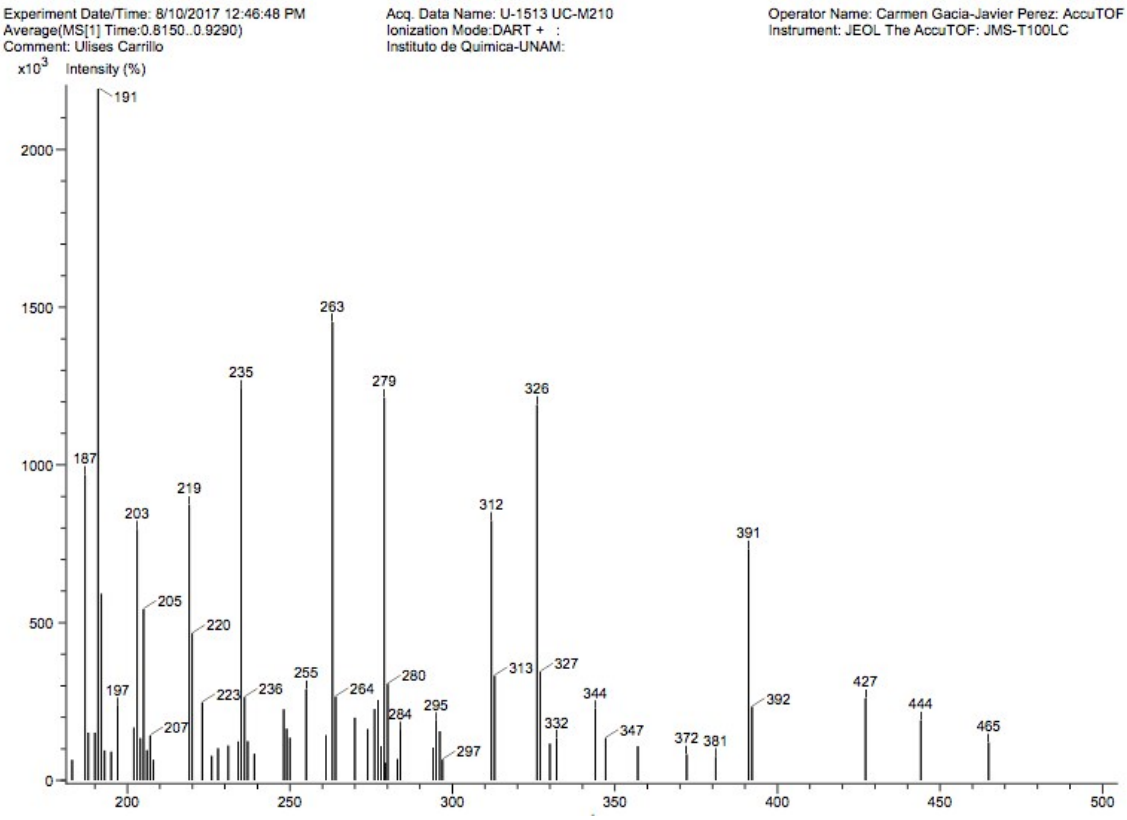
21b/21c

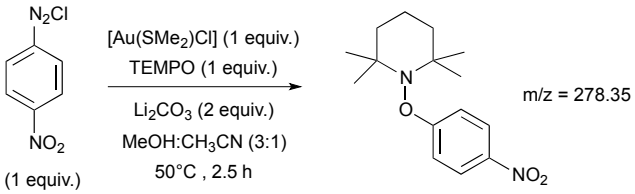


Method B. Colorless oil. Obtained: 0.021 g (70%), (**21b/21c** = 60:40). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 (dd, *J* = 8.0, 1.7 Hz, 1H **c**), 7.50 (ddd, *J* = 8.7, 7.2, 1.8 Hz, 1H **c**), 7.40 (ddd, *J* = 8.4, 7.3, 1.7 Hz, 1H **b**), 7.36 (dd, *J* = 7.7, 1.7 Hz, 1H **b**), 7.19 - 7.15 (m, 2H, **c**), 7.10 (ddd, *J* = 8.1, 7.2, 1.1 Hz, 1H **c**), 7.06 (dd, *J* = 4.7, 1.0 Hz, 1H **b**), 7.04 (dd, *J* = 3.8, 0.9 Hz, 1H **b**), 7.03 - 6.98 (m, 2H **b**), 6.95 (dd, *J* = 8.3, 0.9 Hz, 1H **b**), 6.92 - 6.88 (m, 2H **c**), 6.87 - 6.84 (m, 2H **b**), 4.94 (s, 2H **b**), 4.70 (s, 2H **c**), 3.83 (s, 3H **c**), 3.80 (s, 3H **b**), 2.10 (s, 3H **c**), 1.86 (s, 3H **b**). ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.74 (C), 166.84 (C), 159.57 (C), 159.29 (C), 156.75 (C), 151.59 (C), 151.52 (C), 139.92 (C), 134.93 (CH), 134.39 (CH), 132.79 (CH), 131.11 (C), 130.74 (C), 129.85 (CH), 129.59 (CH), 129.38 (CH), 129.32 (CH), 122.07 (CH), 121.61 (CH), 121.06 (C), 120.89 (C), 120.47 (CH), 120.03 (CH), 117.95 (C), 114.12 (CH), 113.97 (CH), 68.97 (CH_2), 67.38 (CH_2), 55.45 (CH_3), 55.45 (CH_3), 17.91 (CH_3), 17.58 (CH_3). IR (film): 2955.21, 2924.84, 2838.95, 1740.43, 1670.62, 1607.19, 1512.98, 1480.02 cm^{-1}. HRMS-DART calculated for $C_{18}H_{17}O_4$ $[M+H]^+$: 297.11268; found: 297.11180.

Mass spectra of the trapping experiments with TEMPO







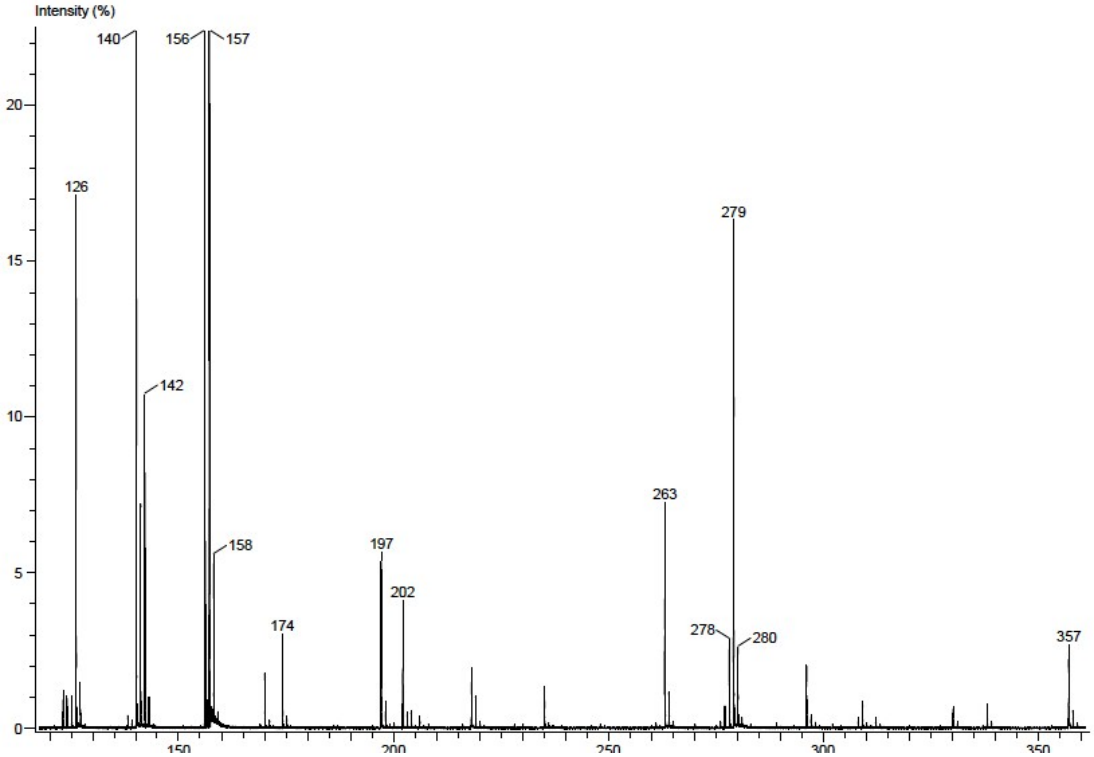
m/z = 278.35

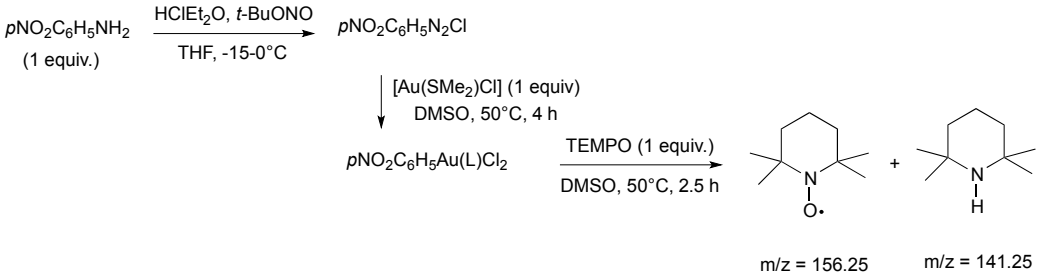
INSTITUTO DE QUIMICA, UNAM
LABORATORIO DE ESPECTROMETRIA DE MASAS

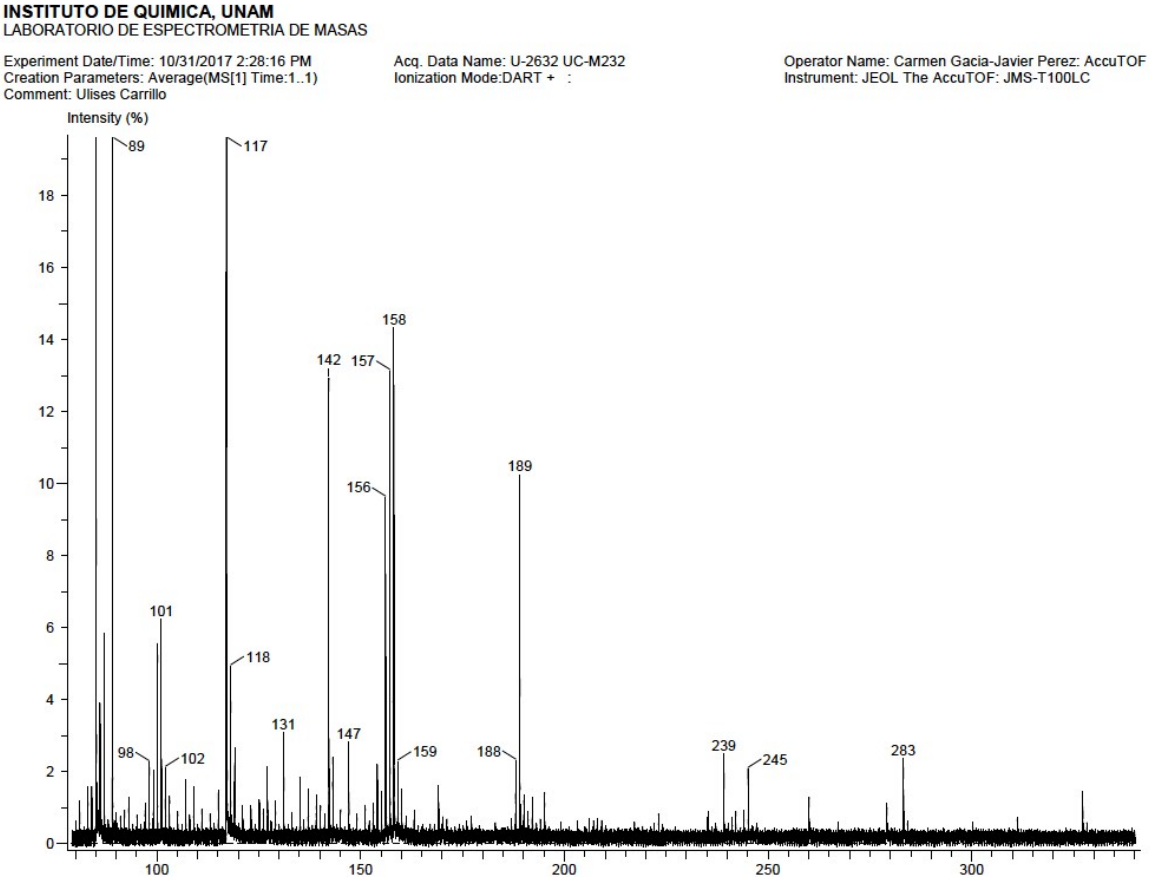
Experiment Date/Time: 10/31/2017 2:30:57 PM
Creation Parameters: Average(MS[1] Time:1..1)
Comment: Ulises Carrillo

Acq. Data Name: U-2363 UC-M231
Ionization Mode:DART + :

Operator Name: Carmen Gacia-Javier Perez: AccuTOF
Instrument: JEOL The AccuTOF: JMS-T100LC







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