Synthesis of Indenes by the Transition Metal-Mediated Carboannulation of Alkynes

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^1H and ^{13}C NMR Data	3S-21S
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Supporting Information

General. ^1H and ^{13}C NMR spectra were recorded at 300 and 75 M Hz or 400 and 100 M Hz respectively. Thin layer chromatography was performed using commercially prepared 40-mesh silica gel plates (Whatman K6F), and visualization was effected with short wavelength UV light (254 nm) and a basic KMnO_4 solution [3 g of KMnO_4 + 20 g of K_2CO_3 + 5 mL of NaOH (5%) + 300 mL of H_2O]. All melting points are uncorrected. Low resolution mass spectra were recorded on a Finnigan TSQ700 triple quadrupole mass spectrometer. High resolution mass spectra were recorded on a Kratos MS50TC double focusing magnetic sector mass spectrometer using EI at 70 eV. The IR spectra were measured on a Bio-Rad FTS-7 spectrometer on salt plates. The product characterization data, and ^1H and ^{13}C NMR spectra for compounds (**1-15**) have been reported in our previous communication.¹

General Procedure for the Synthesis of Indenes by the Palladium-Catalyzed Carboannulation of Internal Alkynes (Table 1).

For this experimental procedure, see the text.

General Procedure for the Synthesis of Indenes by the Copper(I)-Catalyzed Carboannulation of Alkynes (Table 2).

For this experimental procedure, see the text.

General Procedure for the Synthesis of Indenes by the Palladium-Catalyzed Carboannulation of Diethyl [2-(1-Alkynyl)phenyl]malonate by Organic Halides (Tables 3 and 4).

For this experimental procedure, see the text.

(1) Zhang, D.; Yum, E. K.; Liu, Z.; Larock, R. C. *Org. Lett.* **2005**, 7, 4963.

Characterization Data:

Diethyl [2-(oct-1-ynyl)phenyl]malonate (16). The indicated compound was obtained as a pale yellow oil in a 95% yield: ^1H NMR (CDCl_3) δ 0.87 (t, $J = 7.2$ Hz, 3H), 1.25-1.32 (m, 10H), 1.44 (m, 2H), 1.59 (m, 2H), 2.41 (t, $J = 7.2$ Hz, 2H), 4.21 (m, 4H), 5.30 (s, 1H), 7.24 (m, 2H), 7.41 (m, 2H); ^{13}C NMR (CDCl_3) δ 14.1, 19.6, 22.6, 28.6, 28.7, 31.4, 55.7, 61.8, 78.2, 95.9, 124.6, 127.8, 127.9, 128.4, 132.0, 134.6, 168.3; IR (CHCl_3 , cm^{-1}) 3058, 2982, 1751, 1734, 1266; HRMS calcd for $\text{C}_{21}\text{H}_{28}\text{O}_4$ 344.1988, found 344.1992.

Diethyl 2-*n*-hexyl-1*H*-indene-1,1-dicarboxylate (17). The indicated compound was obtained as a pale yellow oil in a 96% yield: ^1H NMR (CDCl_3) δ 0.91 (m, 3H), 1.25 (t, $J = 7.2$ Hz, 6H), 1.35 (m, 6H), 1.66 (m, 2H), 2.51 (m, 2H), 4.21 (m, 4H), 6.63 (t, $J = 1.8$ Hz, 1H), 7.26 (m, 3H), 7.57 (m, 1H); ^{13}C NMR (CDCl_3) δ 14.2, 14.3, 22.9, 28.1, 28.7, 29.5, 30.0, 62.1, 72.2, 120.8, 125.0, 125.4, 128.8, 130.0, 140.9, 144.7, 148.5, 168.5; IR (CHCl_3 , cm^{-1}) 3048, 2983, 1758, 1471; HRMS calcd for $\text{C}_{21}\text{H}_{28}\text{O}_4$ 334.1988, found 334.1994.

Diethyl [2-(hex-1-ynyl)phenyl]malonate (18). The indicated compound was obtained as a pale yellow oil in a 93% yield: ^1H NMR (CDCl_3) δ 0.95 (m, 3H), 1.25 (m, 6H), 1.49 (m, 2H), 1.59 (m, 2H), 2.44 (t, $J = 6.9$ Hz, 2H), 4.22 (m, 4H), 5.32 (s, 1H), 7.26 (m, 2H), 7.42 (m, 2H); ^{13}C NMR (CDCl_3) δ 13.7, 14.1, 19.2, 22.0, 30.7, 55.7, 61.8, 78.2, 95.8, 124.6, 127.8, 127.9, 128.4, 132.0, 134.7, 168.3; IR (CHCl_3 , cm^{-1}) 3057, 2982, 1753, 1733, 1266; HRMS calcd for $\text{C}_{19}\text{H}_{24}\text{O}_4$ 316.1675, found 316.1678.

Diethyl 2-*n*-butyl-1*H*-indene-1,1-dicarboxylate (19). The indicated compound was obtained as a pale yellow oil in a 92% yield: ^1H NMR (CDCl_3) δ 1.00 (t, $J = 7.2$ Hz, 3H), 1.27 (t, $J = 7.2$ Hz, 6H), 1.48 (m, 2H), 1.70 (m, 2H), 2.56 (m, 2H), 4.23 (m, 4H), 6.66 (t, $J = 1.6$ Hz, 1H), 7.18-7.33 (m, 3H), 7.61 (d, $J = 7.6$ Hz, 1H); ^{13}C NMR

(CDCl₃) δ 14.0, 14.1, 22.7, 28.3, 30.1, 61.9, 72.0, 120.6, 124.8, 125.3, 128.6, 129.7, 140.7, 144.5, 148.3, 168.3; IR (CHCl₃, cm⁻¹) 2959, 2932, 1732, 1467, 1235; HRMS calcd for C₁₉H₂₄O₄ 316.1675, found 316.1678.

Diethyl [2-(3-methoxyprop-1-ynyl)phenyl]malonate (20). The indicated compound was obtained as a pale yellow oil in an 81% yield: ¹H NMR (CDCl₃) δ 1.27 (t, *J* = 7.2 Hz, 6H), 3.47 (s, 3H), 4.23 (m, 4H), 4.36 (s, 2H), 5.29 (s, 1H), 7.29 (m, 2H), 7.49 (dd, *J* = 1.2, 7.8 Hz, 2H); ¹³C NMR (CDCl₃) δ 14.1, 55.7, 57.7, 60.4, 61.9, 84.0, 90.1, 123.2, 128.0, 128.7, 128.9, 132.5, 135.0, 168.1; IR (CHCl₃, cm⁻¹) 3054, 2928, 1749, 1713, 1266; HRMS calcd for C₁₇H₂₀O₅ 304.1311, found 304.1316.

Diethyl 2-methoxymethyl-1*H*-indene-1,1-dicarboxylate (21). The indicated compound was obtained as a pale yellow oil in a 91% yield: ¹H NMR (CDCl₃) δ 1.23 (t, *J* = 7.2 Hz, 3H), 3.41 (s, 3H), 4.20 (m, 4H), 4.43 (d, *J* = 1.6 Hz, 2H), 6.88 (d, *J* = 1.2 Hz, 1H), 7.25 (m, 3H), 7.61 (d, *J* = 7.6 Hz, 1H); ¹³C NMR (CDCl₃) δ 14.0, 58.6, 62.2, 69.6, 70.5, 121.3, 125.1, 126.0, 128.7, 132.1, 140.8, 143.3, 143.5, 167.8; IR (CHCl₃, cm⁻¹) 2984, 1733, 1464, 1244; HRMS calcd for C₁₇H₂₀O₅ 304.1311, found 304.1316.

Diethyl [2-(11-hydroxyundec-1-ynyl)phenyl]malonate (22). The indicated compound was obtained as a pale yellow oil in a 98% yield: ¹H NMR (CDCl₃) δ 1.27 (t, *J* = 7.2 Hz, 6H), 1.33-1.64 (m, 15H), 2.43 (t, *J* = 7.2 Hz, 2H), 3.62 (t, *J* = 6.6 Hz, 2H), 4.23 (m, 4H), 5.31 (s, 1H), 7.27 (m, 2H), 7.43 (m, 2H); ¹³C NMR (CDCl₃) δ 14.3, 19.7, 26.0, 28.8, 29.1, 29.3, 29.6, 29.7, 33.0, 55.9, 62.0, 63.1, 76.9, 96.1, 124.8, 128.0, 128.1, 128.6, 132.2, 134.8, 168.5; IR (CHCl₃, cm⁻¹) 3421, 3054, 2931, 1748, 1732, 1265; HRMS calcd for C₂₄H₃₄O₅ 402.2406, found 402.2413.

Diethyl 2-(9-hydroxy-1-nonyl)-1*H*-indene-1,1-dicarboxylate (23). The indicated compound was obtained as a pale yellow oil in a 79% yield: ¹H NMR (CDCl₃) δ 1.22 (t, *J* = 7.2 Hz, 6H), 1.30-1.66 (m, 15H), 2.47 (t, *J* = 7.2 Hz, 2H), 3.59 (t, *J* = 6.8

Hz, 2H), 4.17 (m, 4H), 6.60 (s, 1H), 7.15 (dt, $J = 1.2, 7.2$ Hz, 1H), 7.20 (d, $J = 7.2$ Hz, 1H), 7.26 (t, $J = 7.2$ Hz, 1H), 7.55 (d, $J = 7.6$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 25.8, 27.9, 28.5, 29.4, 29.5, 29.6, 32.8, 61.9, 63.0, 72.0, 120.6, 124.8, 125.3, 128.6, 129.7, 140.7, 144.5, 148.3, 168.5; IR (CHCl_3 , cm^{-1}) 2930, 1733, 1725, 1242; HRMS calcd for $\text{C}_{24}\text{H}_{34}\text{O}_5$ 402.2406, found 402.2413.

Diethyl [2-(11-methoxy-11-oxoundec-1-ynyl)phenyl]malonate (24). The indicated compound was obtained as a pale yellow oil in an 86% yield: ^1H NMR (CDCl_3) δ 1.26 (dt, $J = 1.2, 7.2$ Hz, 6H), 1.33-1.64 (m, 12H), 2.30 (t, $J = 7.2$ Hz, 2H), 2.43 (t, $J = 7.2$ Hz, 2H), 3.66 (s, 3H), 4.23 (m, 4H), 5.31 (s, 1H), 7.27 (m, 2H), 7.42 (t, $J = 7.8$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.1, 19.5, 24.9, 28.6, 28.9, 29.0, 29.1, 29.2, 34.0, 51.4, 55.7, 61.7, 78.2, 95.8, 124.5, 127.8, 127.9, 128.4, 132.0, 134.6, 168.2, 174.2; IR (CHCl_3 , cm^{-1}) 3056, 2934, 1734, 1266; HRMS calcd for $\text{C}_{25}\text{H}_{34}\text{O}_6$ 430.2355, found 430.2363.

Diethyl 2-(9-methoxy-9-oxo-1-nonyl)-1*H*-indene-1,1-dicarboxylate (25). The indicated compound was obtained as a pale yellow oil in an 83% yield: ^1H NMR (CDCl_3) δ 1.22 (dt, $J = 1.2, 7.2$ Hz, 6H), 1.36-1.64 (m, 12H), 2.28 (t, $J = 7.2$ Hz, 2H), 2.48 (m, 2H), 3.64 (s, 3H), 4.18 (m, 4H), 6.60 (s, 1H), 7.14-7.26 (m, 3H), 7.54 (d, $J = 7.2$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 25.0, 27.9, 28.5, 29.2, 29.3, 29.4, 29.5, 34.1, 54.5, 61.9, 72.0, 120.6, 124.8, 125.3, 128.6, 129.7, 140.7, 144.5, 148.2, 168.3, 174.4; IR (CHCl_3 , cm^{-1}) 2982, 1734, 1718, 1240; HRMS calcd for $\text{C}_{25}\text{H}_{34}\text{O}_6$ 430.2355, found 430.2362.

Diethyl [2-(3,3-diethoxyprop-1-ynyl)phenyl]malonate (26). The indicated compound was obtained as a pale yellow oil in a 75% yield: ^1H NMR (CDCl_3) δ 1.22 (m, 12H), 3.66 (m, 2H), 3.78 (m, 2H), 4.17 (m, 4H), 5.22 (s, 1H), 5.47 (s, 1H), 7.23 (dt, $J = 1.2, 7.8$ Hz, 1H), 7.22 (dt, $J = 1.2, 7.8$ Hz, 1H), 7.46 (m, 2H); ^{13}C NMR (CDCl_3) δ 14.0, 15.2, 55.5, 61.0, 61.9, 82.7, 89.5, 91.8, 122.4, 127.9, 128.8, 129.2,

132.6, 135.0, 167.0; IR (CHCl₃, cm⁻¹) 3054, 2981, 1749, 1733, 1266; HRMS calcd for C₂₀H₂₆O₆ 362.1736, found 362.17427.

Diethyl 2-diethoxymethyl-1*H*-indene-1,1-dicarboxylate (27). The indicated compound was obtained as a pale yellow oil in a 58% yield: ¹H NMR (CDCl₃) δ 1.23 (m, 12H), 3.61 (m, 2H), 3.73 (m, 2H), 4.18 (m, 4H), 5.91 (d, *J* = 1.2 Hz, 1H), 7.00 (s, 1H), 7.24 (m, 1H), 7.31 (m, 1H), 7.63 (d, *J* = 7.8 Hz, 2H); ¹³C NMR (CDCl₃) δ 13.9, 15.3, 61.9, 62.1, 70.1, 99.1, 121.8, 124.9, 126.4, 128.6, 132.7, 141.7, 143.1, 144.3, 167.9; IR (CHCl₃, cm⁻¹) 3055, 2980, 1732, 1682, 1266; HRMS calcd for C₂₀H₂₆O₆ 362.1729, found 362.1734.

Diethyl [2-(5-cyanopent-1-ynyl)phenyl]malonate (28). The indicated compound was obtained as a pale yellow oil in a 62% yield: ¹H NMR (CDCl₃) δ 1.27 (t, *J* = 7.2 Hz, 6H), 1.98 (m, 2H), 2.57 (t, *J* = 7.2 Hz, 2H), 2.63 (t, *J* = 7.2 Hz, 2H), 4.24 (m, 4H), 5.23 (s, 1H), 7.27 (dt, *J* = 1.2, 7.2 Hz, 1H), 7.33 (dt, *J* = 1.6, 7.8 Hz, 1H), 7.45 (dt, *J* = 1.2, 8.0 Hz, 2H); ¹³C NMR (CDCl₃) δ 14.1, 16.2, 18.7, 24.6, 55.9, 61.9, 80.8, 92.4, 119.2, 123.7, 128.0, 128.4, 128.7, 132.2, 134.7, 168.1; IR (CHCl₃, cm⁻¹) 2984, 2254, 1748, 1732; C₁₉H₂₁NO₄ 327.1471, found 327.1475.

Diethyl 2-(3-cyano-1-propyl)-1*H*-indene-1,1-dicarboxylate (29). The indicated compound was obtained as a pale yellow oil in a 68% yield: ¹H NMR (CDCl₃) δ 1.24 (t, *J* = 7.2 Hz, 6H), 2.04 (t, *J* = 7.2 Hz, 2H), 2.45 (t, *J* = 7.2, 2H), 2.67 (m, 2H), 4.20 (m, 4H), 6.64 (s, 1H), 7.24 (m, 3H), 7.57 (d, *J* = 7.8 Hz, 1H); ¹³C NMR (CDCl₃) δ 14.0, 16.8, 23.9, 27.6, 62.1, 71.9, 119.6, 120.9, 125.1, 125.8, 128.8, 130.9, 140.5, 143.7, 145.1, 167.9; IR (CHCl₃, cm⁻¹) 3253, 2985, 2253, 1721, 1265; HRMS calcd for C₁₉H₂₁NO₄ 327.1471, found 327.1475.

Diethyl [2-(3,3-dimethylbut-1-ynyl)phenyl]malonate (30). The indicated compound was obtained as a pale yellow oil in a 94% yield: ¹H NMR (CDCl₃) δ 1.27 (dt, *J* = 0.8, 7.2 Hz, 6H), 1.33 (d, *J* = 1.2 Hz, 9H), 4.24 (m, 4H), 5.28 (s, 1H),

7.26 (m, 2H), 7.40 (t, $J = 7.6$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.1, 28.2, 30.9, 55.9, 61.8, 104.0, 124.5, 127.8, 127.9, 128.3, 131.8, 134.8, 168.4; IR (CHCl_3 , cm^{-1}) 3053, 2970, 1749, 1736, 1265; HRMS calcd for $\text{C}_{19}\text{H}_{24}\text{O}_4$ 316.1675, found 316.1678.

Diethyl 2-*tert*-butyl-1*H*-indene-1,1-dicarboxylate (31). The indicated compound was obtained as a pale yellow oil in a 69% yield: ^1H NMR (CDCl_3) δ 1.14 (t, $J = 7.2$ Hz, 6H), 1.28 (s, 9H), 4.11 (m, 4H), 6.78 (s, 1H), 7.11 (dt, $J = 1.2, 7.6$ Hz, 1H), 7.23 (m, 2H), 7.41 (d, $J = 7.6$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 13.8, 31.2, 34.8, 61.6, 70.6, 120.6, 123.1, 125.4, 128.4, 131.2, 142.3, 144.1, 157.5, 168.8; IR (CHCl_3 , cm^{-1}) 3057, 2965, 1750, 1715, 1222; HRMS calcd for $\text{C}_{19}\text{H}_{24}\text{O}_4$ 316.1675, found 316.1678.

Diethyl [2-(trimethylsilylethynyl)phenyl]malonate (32). The indicated compound was obtained as a pale yellow oil in a 98% yield: ^1H NMR (CDCl_3) δ 0.27 (s, 9H), 1.28 (t, $J = 7.2$ Hz, 6H), 4.25 (m, 4H), 5.32 (s, 1H), 7.29 (dt, $J = 1.2, 7.2$ Hz, 1H), 7.35 (dt, $J = 1.2, 7.5$ Hz, 1H), 7.44 (dd, $J = 1.2, 7.8$ Hz, 1H), 7.49 (dd, $J = 1.2, 7.2$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 0.08, 14.3, 56.0, 62.0, 100.2, 102.6, 123.8, 128.0, 128.6, 129.0, 132.4, 135.5, 168.3; IR (CHCl_3 , cm^{-1}) 3054, 2984, 2156, 1749, 1732, 1266; HRMS calcd for $\text{C}_{18}\text{H}_{24}\text{SiO}_4$ 332.1444, found 332.1449.

Diethyl [2-(cyclohexylethynyl)phenyl]malonate (34). The indicated compound was obtained as a pale yellow oil in a 91% yield: ^1H NMR (CDCl_3) δ 1.27 (t, $J = 7.2$ Hz, 6H), 1.37 (m, 3H), 1.57 (m, 3H), 1.76 (m, 2H), 1.86 (m, 2H), 2.64 (m, 1H), 4.23 (m, 4H), 5.33 (s, 1H), 7.26 (m, 2H), 7.41 (d, $J = 7.8$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.8, 24.8, 25.9, 29.8, 32.6, 55.8, 61.8, 78.2, 99.9, 124.6, 127.8, 127.9, 128.3, 131.9, 134.7, 168.4; IR (CHCl_3 , cm^{-1}) 3054, 2933, 1749, 1733, 1265; HRMS calcd for $\text{C}_{21}\text{H}_{26}\text{O}_4$ 342.1831, found 342.1837.

Diethyl 2-cyclohexyl-1*H*-indene-1,1-dicarboxylate (35). The indicated compound was obtained as a pale yellow oil in a 92% yield: ^1H NMR (CDCl_3) δ 1.23-1.35 (m, 11H), 1.70-1.91 (m, 5H), 2.53 (m, 1H), 4.18 (m, 4H), 6.64 (s, 1H), 7.15 (dt, $J = 1.2,$

7.8 Hz, 1H), 7.20 (d, $J = 6.8$ Hz, 1H), 7.26 (dt, $J = 1.2, 7.6$ Hz, 1H), 7.54 (dd, $J = 1.2, 7.6$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 26.3, 26.9, 34.6, 38.1, 61.9, 71.9, 120.7, 124.8, 125.4, 128.6, 129.4, 140.2, 144.6, 153.9, 168.5; IR (CHCl_3 , cm^{-1}) 3019, 2929, 1733, 1216; HRMS calcd for $\text{C}_{21}\text{H}_{26}\text{O}_4$ 342.1831, found 342.1837.

Diethyl [2-(1-cyclohexenylethynyl)phenyl]malonate (36). The indicated compound was obtained as a pale yellow oil in a 90% yield: ^1H NMR (CDCl_3) δ 1.24 (t, $J = 7.2$ Hz, 6H), 1.64 (m, 4H), 2.13 (m, 2H), 2.22 (m, 2H), 4.22 (m, 4H), 5.26 (m, 1H), 6.22 (m, 1H), 7.28 (m, 2H), 7.42 (m, 2H); ^{13}C NMR (CDCl_3) δ 14.2, 21.7, 22.5, 26.0, 29.3, 56.1, 62.0, 84.4, 96.8, 120.8, 124.5, 128.0, 128.3, 128.6, 132.0, 134.8, 135.9, 168.4; IR (CHCl_3 , cm^{-1}) 3056, 2936, 1751, 1733, 1266; HRMS calcd for $\text{C}_{21}\text{H}_{24}\text{O}_4$ 340.1675, found 340.1678.

Diethyl 2-(1-cyclohexenyl)-1H-indene-1,1-dicarboxylate (37). The indicated compound was obtained as a pale yellow oil in an 85% yield: ^1H NMR (CDCl_3) δ 1.15 (t, $J = 7.2$ Hz, 6H), 1.61 (m, 2H), 1.74 (m, 2H), 2.20 (m, 2H), 2.36 (m, 2H), 4.17 (m, 4H), 6.04 (t, $J = 4.2$ Hz, 1H), 6.79 (s, 1H), 7.16 (m, 1H), 7.27 (m, 2H), 7.53 (dd, $J = 0.9, 7.5$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 13.9, 22.1, 22.8, 26.1, 26.7, 61.7, 69.7, 122.3, 123.6, 125.7, 128.3, 128.7, 129.0, 130.5, 142.2, 144.2, 147.9, 168.7; IR (CHCl_3 , cm^{-1}) 2981, 1734, 1237; HRMS calcd for $\text{C}_{21}\text{H}_{24}\text{O}_4$ 340.1675, found 340.1678.

Diethyl [2-(phenylethynyl)phenyl]malonate (38). The indicated compound was obtained as a pale yellow oil in a 98% yield: ^1H NMR (CDCl_3) δ 1.27 (t, $J = 7.2$ Hz, 6H), 4.25 (m, 4H), 5.40 (s, 1H), 7.35 (m, 5H), 7.49 (m, 1H), 7.57 (m, 3H); ^{13}C NMR (CDCl_3) δ 14.1, 56.1, 61.9, 86.9, 94.6, 122.9, 123.8, 128.0, 128.5, 128.7, 128.8, 131.6, 132.1, 135.0, 168.2; IR (CHCl_3 , cm^{-1}) 3055, 2986, 1749, 1733, 1266; HRMS calcd for $\text{C}_{21}\text{H}_{20}\text{O}_4$ 336.1362, found 336.1367.

Diethyl 2-phenyl-1H-indene-1,1-dicarboxylate (39). The indicated compound was obtained as a pale yellow oil in a 61% yield: ^1H NMR (CDCl_3) δ 1.07 (t, $J = 7.2$ Hz,

6H), 4.14 (m, 4H), 7.24-7.36 (m, 7H), 7.62 (m, 3H); ^{13}C NMR (CDCl_3) δ 13.8, 62.1, 70.9, 121.7, 124.2, 126.3, 127.4, 127.9, 128.2, 128.9, 131.5, 134.1, 142.1, 143.7, 145.7, 168.3; IR (CHCl_3 , cm^{-1}) 3019, 2988, 1734, 1217; HRMS calcd for $\text{C}_{21}\text{H}_{20}\text{O}_4$ 336.1362, found 336.1366.

Diethyl (2-[[4-(ethoxycarbonyl)phenyl]ethynyl]phenyl)malonate (40). The indicated compound was obtained as a pale yellow oil in a 63% yield: ^1H NMR (CDCl_3) δ 1.23 (t, $J = 7.2$ Hz, 6H), 1.37 (t, $J = 7.2$ Hz, 3H), 4.22 (m, 4H), 4.35 (q, $J = 7.2$ Hz, 2H), 5.33 (s, 1H), 7.32 (dt, $J = 1.2, 7.6$ Hz, 1H), 7.35 (dt, $J = 1.2, 7.6$ Hz, 1H), 7.46 (d, $J = 7.6$ Hz, 1H), 7.56 (m, 3H), 8.00 (d, $J = 7.6$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.1, 14.4, 56.1, 61.2, 62.0, 89.7, 93.8, 123.2, 127.4, 128.1, 128.8, 129.2, 129.6, 130.2, 131.5, 132.3, 135.2, 166.0, 168.0; IR (CHCl_3 , cm^{-1}) 3032, 2988, 1726, 1266; HRMS calcd for $\text{C}_{24}\text{H}_{24}\text{O}_6$ 408.1573, found 408.1580.

Diethyl 2-[4-(ethoxycarbonyl)phenyl]-1*H*-indene-1,1-dicarboxylate (41). The indicated compound was obtained as a pale yellow oil in a 65% yield: ^1H NMR (CDCl_3) δ 1.06 (t, $J = 7.2$ Hz, 6H), 1.38 (t, $J = 7.2$ Hz, 3H), 4.12 (m, 4H), 4.36 (q, $J = 7.2$ Hz, 2H), 7.24-7.40 (m, 4H), 7.65 (d, $J = 8.4$ Hz, 3H), 8.00 (m, 2H); ^{13}C NMR (CDCl_3) δ 13.8, 14.4, 61.0, 62.2, 70.8, 122.1, 124.4, 127.0, 127.1, 129.1, 129.4, 129.5, 133.6, 138.4, 142.3, 143.1, 144.5, 166.4, 168.0; IR (CHCl_3 , cm^{-1}) 3020, 2982, 1719, 1724, 1283; HRMS calcd for $\text{C}_{24}\text{H}_{24}\text{O}_6$ 408.1573, found 408.1580.

Diethyl {2-[(4-methoxyphenyl)ethynyl]phenyl}malonate (42). The indicated compound was obtained as a pale yellow oil in an 86% yield: ^1H NMR (CDCl_3) δ 1.25 (t, $J = 7.2$ Hz, 6H), 3.80 (s, 3H), 4.22 (m, 4H), 5.38 (s, 1H), 6.87 (dt, $J = 2.0, 9.2$ Hz, 2H), 7.31 (m, 2H), 7.46 (m, 3H), 7.53 (m, 1H); ^{13}C NMR (CDCl_3) δ 14.1, 55.4, 56.2, 61.9, 85.7, 94.8, 114.1, 115.0, 124.1, 128.0, 128.4, 128.6, 131.9, 133.1, 134.8, 160.0, 168.3; IR (CHCl_3 , cm^{-1}) 3056, 2985, 1728, 1264; HRMS calcd for $\text{C}_{22}\text{H}_{22}\text{O}_5$ 366.1467, found 366.1472.

Diethyl 2-(4-methoxyphenyl)-1*H*-indene-1,1-dicarboxylate (43). The indicated compound was obtained as a pale yellow oil in a 96% yield: ^1H NMR (CDCl_3) δ 1.08 (t, $J = 7.2$ Hz, 6H), 3.80 (s, 3H), 4.12 (m, 4H), 6.87 (dt, $J = 2.0, 9.2$ Hz, 2H), 7.18 (s, 1H), 7.21 (m, 1H), 7.32 (m, 2H), 7.55 (dt, $J = 2.0, 8.8$ Hz, 2H), 7.62 (d, $J = 7.6$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 13.9, 55.3, 62.0, 70.9, 113.6, 121.3, 124.1, 125.9, 126.7, 128.7, 128.9, 129.6, 141.9, 144.0, 145.3, 159.5, 168.5; IR (CHCl_3 , cm^{-1}) 3068, 2981, 1734, 1253; HRMS calcd for $\text{C}_{22}\text{H}_{22}\text{O}_5$ 366.1467, found 366.1473.

Diethyl (2-ethynylphenyl)malonate (44). The indicated compound was obtained as a pale yellow oil in an 81% yield: ^1H NMR (CDCl_3) δ 1.27 (t, $J = 7.2$ Hz, 6H), 3.32 (s, 1H), 4.25 (m, 4H), 5.32 (s, 1H), 7.29 (dt, $J = 1.2, 7.6$ Hz, 1H), 7.38 (dt, $J = 1.6, 7.6$ Hz, 1H), 7.52 (dt, $J = 1.2, 8.0$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.1, 55.5, 61.9, 81.2, 82.3, 122.6, 128.0, 128.8, 129.2, 132.8, 135.3, 168.0; IR (CHCl_3 , cm^{-1}) 3297, 3053, 2983, 1749, 1733, 1265; HRMS calcd for $\text{C}_{15}\text{H}_{16}\text{O}_4$ 260.1049, found 260.1052.

Ethyl cyano(2-iodophenyl)acetate (45). The indicated compound was obtained as a yellow oil in an 82% yield: ^1H NMR (CDCl_3) δ 1.31 (t, $J = 7.2$ Hz, 3H), 4.30 (m, 2H), 5.19 (s, 1H), 7.10 (dt, $J = 1.5, 7.8$ Hz, 1H), 7.44 (dt, $J = 1.2, 7.5$ Hz, 1H), 7.60 (dd, $J = 1.5, 7.8$ Hz, 1H), 7.90 (dd, $J = 1.2, 7.8$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.2, 48.3, 63.8, 100.0, 115.6, 129.5, 129.6, 131.1, 134.1, 140.4, 164.3; IR (CHCl_3 , cm^{-1}) 3070, 2957, 1743, 1466, 1217; HRMS calcd for $\text{C}_{11}\text{H}_{10}\text{INO}_2$ 314.9756, found 314.9760.

Ethyl cyano[2-(oct-1-ynyl)phenyl]acetate (46). The indicated compound was obtained as a pale yellow oil in a 92% yield: ^1H NMR (CDCl_3) δ 0.91 (t, $J = 6.9$ Hz, 3H), 1.26-1.37 (m, 7H), 1.45 (m, 2H), 1.60 (m, 2H), 2.44 (t, $J = 7.2$ Hz, 2H), 4.25 (m, 2H), 5.28 (s, 1H), 7.29-7.37 (m, 2H), 7.46 (m, 1H), 7.50 (m, 1H); ^{13}C NMR (CDCl_3) δ 14.2, 14.3, 19.8, 22.8, 28.7, 28.9, 31.6, 42.0, 63.4, 77.7, 97.8, 115.9, 124.3, 128.3, 128.7, 129.2, 132.0, 132.8, 165.0; IR (CHCl_3 , cm^{-1}) 3054, 2933, 2226, 1747, 1265; HRMS calcd for $\text{C}_{19}\text{H}_{23}\text{NO}_2$ 297.1729, found 297.1733.

Ethyl 1-cyano-2-*n*-hexyl-1*H*-indene-1-carboxylate (47). The indicated compound was obtained as a pale yellow oil in an 83% yield: ^1H NMR (CDCl_3) δ 0.92 (t, $J = 7.2$ Hz, 3H), 1.27-1.47 (m, 9H), 1.74 (m, 2H), 2.49 (m, 2H), 4.28 (m, 2H), 6.71 (s, 1H), 7.26 (t, $J = 7.6$ Hz, 1H), 7.30 (d, $J = 7.6$ Hz, 1H), 7.38 (d, $J = 7.6$ Hz, 1H), 7.57 (d, $J = 7.6$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 14.1, 22.6, 27.8, 28.2, 29.1, 31.7, 58.5, 63.5, 116.4, 121.5, 123.2, 126.4, 129.9, 130.8, 139.3, 144.0, 146.1, 165.4; IR (CHCl_3 , cm^{-1}) 3020, 2930, 2246, 1743, 1217; HRMS calcd for $\text{C}_{19}\text{H}_{23}\text{NO}_2$ 297.1729, found 297.1733.

Ethyl cyano[2-(cyclohexylethynyl)phenyl]acetate (48). The indicated compound was obtained as a pale yellow oil in a 76% yield: ^1H NMR (CDCl_3) δ 1.28 (t, $J = 7.2$ Hz, 3H), 1.39 (m, 3H), 1.57 (m, 3H), 1.74 (m, 2H), 1.90 (m, 2H), 2.64 (m, 1H), 4.26 (m, 2H), 5.27 (s, 1H), 7.33 (m, 2H), 7.46 (m, 1H), 7.50 (m, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 25.0, 25.9, 29.8, 32.5, 41.9, 63.2, 77.2, 101.5, 115.8, 124.1, 128.1, 128.4, 129.0, 131.7, 132.5, 164.8; IR (CHCl_3 , cm^{-1}) 3020, 2933, 2228, 1748, 1216; HRMS calcd for $\text{C}_{19}\text{H}_{21}\text{NO}_2$ 295.1572, found 295.1577.

Ethyl 1-cyano-2-cyclohexyl-1*H*-indene-1-carboxylate (49). The indicated compound was obtained as a pale yellow oil in a 78% yield: ^1H NMR (CDCl_3) δ 1.25-1.44 (m, 8H), 1.72-1.94 (m, 4H), 2.21 (m, 1H), 2.44 (m, 1H), 4.24 (m, 2H), 6.74 (m, 1H), 7.24 (dt, $J = 1.5, 7.5$ Hz, 1H), 7.29 (d, $J = 6.9$ Hz, 1H), 7.36 (dt, $J = 1.2, 7.5$ Hz, 1H), 7.52 (d, $J = 7.8$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.1, 26.2, 26.6, 26.7, 33.1, 33.7, 38.6, 58.2, 63.6, 116.7, 121.8, 123.1, 126.7, 130.0, 130.8, 139.5, 144.1, 151.3, 165.9; IR (CHCl_3 , cm^{-1}) 3020, 2932, 2250, 1710, 1217; HRMS calcd for $\text{C}_{19}\text{H}_{21}\text{NO}_2$ 295.1572, found 295.1577.

Ethyl 1-cyano-2-phenyl-1*H*-indene-1-carboxylate (50). The indicated compound was obtained as a pale yellow oil in an 86% yield: ^1H NMR (CDCl_3) δ 1.16 (t, $J = 7.2$ Hz, 3H), 4.24 (m, 2H), 7.36 (m, 2H), 7.45 (m, 5H), 7.69 (m, 3H); ^{13}C NMR

(CDCl₃) δ 13.8, 56.7, 63.7, 116.6, 122.5, 123.0, 126.0, 127.5, 129.0, 129.1, 130.3, 131.1, 131.9, 140.0, 142.9, 143.3, 165.7; IR (CHCl₃, cm⁻¹) 3020, 2984, 2250, 1740, 1217; HRMS calcd for C₁₉H₁₅NO₂ 289.1103, found 289.1108.

Ethyl (2-iodophenyl)(phenylsulfonyl)acetate (51). The indicated compound was obtained as a white solid in a 78% yield: mp 118-119 °C; ¹H NMR (CDCl₃) δ 1.15 (t, *J* = 7.2 Hz, 3H), 4.15 (m, 2H), 5.73 (s, 1H), 7.00 (dt, *J* = 1.6, 7.8 Hz, 1H), 7.33 (t, *J* = 7.5 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.58 (t, *J* = 7.2 Hz, 1H), 7.65 (d, *J* = 7.6 Hz, 2H), 7.71 (t, *J* = 8.0 Hz, 1H), 7.97 (dd, *J* = 1.5, 7.8 Hz, 1H); ¹³C NMR (CDCl₃) δ 14.0, 62.9, 103.8, 128.6, 129.1, 129.5, 131.1, 131.2, 134.5, 137.5, 140.0, 164.1; IR (CHCl₃, cm⁻¹) 3068, 2984, 1741, 1328, 1157; HRMS calcd for C₁₆H₁₅ISO₄ 329.9736, found 329.9742.

Ethyl [2-(phenylethynyl)phenyl](phenylsulfonyl)acetate (52). The indicated compound was obtained as a pale yellow oil in a 91% yield: ¹H NMR (CDCl₃) δ 1.27 (t, *J* = 7.2 Hz, 3H), 4.27 (m, 2H), 6.00 (s, 1H), 7.33-7.39 (m, 7H), 7.42-7.46 (m, 3H), 7.55 (m, 1H), 7.65 (dd, *J* = 1.2, 7.2 Hz, 2H), 7.99 (dd, *J* = 1.6, 7.2 Hz, 1H); ¹³C NMR (CDCl₃) δ 14.0, 62.8, 71.6, 86.1, 94.4, 122.5, 125.1, 128.5, 128.6, 128.7, 128.9, 129.4, 129.4, 129.5, 130.1, 131.6, 132.1, 134.1, 137.5, 164.4; IR (CHCl₃, cm⁻¹) 3056, 2985, 1740, 1265; HRMS calcd for C₂₄H₂₀SO₄ 404.1082, found 404.1088.

Ethyl 2-phenyl-1-phenylsulfonyl-1*H*-indene-1-carboxylate (53). The indicated compound was obtained as a pale yellow oil in a 36% yield: ¹H NMR (CDCl₃) δ 1.23 (t, *J* = 7.2 Hz, 3H), 4.35 (m, 2H), 6.96 (s, 1H), 7.01 (dd, *J* = 1.2, 8.4 Hz, 2H), 7.09 (t, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 6.8 Hz, 1H), 7.34-7.41 (m, 6H), 7.51 (dt, *J* = 1.6, 8.0 Hz, 2H), 7.96 (d, *J* = 7.6 Hz, 1H); ¹³C NMR (CDCl₃) δ 13.9, 63.0, 84.0, 121.7, 126.2, 126.7, 127.4, 127.9, 128.3, 128.5, 130.0, 130.2, 132.7, 133.7, 134.3, 135.4, 138.1, 142.9, 143.9, 165.8; IR (CHCl₃, cm⁻¹) 3062, 2982, 1718, 1195; HRMS calcd for C₂₄H₂₀SO₄ 404.1082, found 404.1088.

Ethyl (2-iodophenyl)acetate (54): The indicated compound was obtained as white solid in a 95% yield: mp 125-126 °C; ^1H NMR (CDCl_3) δ 1.26 (t, $J = 7.2$ Hz, 3H), 3.77 (s, 2H), 4.17 (q, $J = 7.2$ Hz, 2H), 6.94 (m, 1H), 7.28 (m, 2H), 7.82 (d, $J = 8.0$ Hz, 1H).

Ethyl [2-(phenylethynyl)phenyl]acetate (55). The indicated compound was obtained as a pale yellow oil in a 98% yield: ^1H NMR (CDCl_3) δ 1.21 (t, $J = 7.2$ Hz, 3H), 3.90 (s, 2H), 4.15 (q, $J = 7.2$ Hz, 2H), 7.26-7.34 (m, 6H), 7.52-7.55 (m, 3H); ^{13}C NMR (CDCl_3) δ 14.2, 40.4, 61.0, 87.5, 94.0, 123.3, 123.6, 127.2, 128.4, 128.5, 128.6, 130.0, 131.6, 132.1, 136.5, 171.3; IR (CHCl_3 , cm^{-1}) 3056, 2982, 1733, 1265; HRMS calcd for $\text{C}_{18}\text{H}_{16}\text{O}_2$ 264.1150, found 264.1156.

(2-Iodobenzyl)(phenyl)sulfone (56). The indicated compound was obtained as a bright colorless solid in a 63% yield: mp 131-132 °C; ^1H NMR (CDCl_3) δ 4.59 (s, 2H), 7.00 (dt, $J = 1.5, 7.8$ Hz, 1H), 7.44-7.53 (m, 3H), 7.60-7.66 (m, 3H), 7.73 (dd, $J = 0.9, 7.8$ Hz, 1H).

1-Phenylethynyl-2-(phenylsulfonylmethyl)benzene (57). The indicated compound was obtained as a pale yellow oil in a 99% yield: ^1H NMR (CDCl_3) δ 4.68 (s, 2H), 7.26-7.37 (m, 10H), 7.48 (t, $J = 7.2$ Hz, 2H), 7.58 (d, $J = 8.4$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 60.8, 86.5, 93.7, 122.6, 124.7, 128.5, 128.6, 128.7, 128.8, 128.9, 129.9, 131.4, 131.6, 132.2, 133.7, 138.1; IR (CHCl_3 , cm^{-1}) 3054, 2926, 1713, 1265; HRMS calcd for $\text{C}_{21}\text{H}_{16}\text{SO}_2$ 332.0871, found 332.0877.

Diethyl 3-[4-(ethoxycarbonyl)phenyl]-2-phenyl-1H-indene-1,1-dicarboxylate (58). The indicated compound was obtained as a pale yellow oil in an 86% yield: ^1H NMR (CDCl_3) δ 1.09 (t, $J = 7.2$ Hz, 6H), 1.37 (t, $J = 7.2$ Hz, 3H), 4.14 (m, 4H), 4.35 (q, $J = 7.2$ Hz, 2H), 7.17 (m, 5H), 7.25 (m, 1H), 7.34 (m, 2H), 7.39 (d, $J = 8.4$ Hz, 2H), 7.69 (dd, $J = 1.2, 7.6$ Hz, 1H), 8.00 (d, $J = 8.4$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 13.8, 14.4, 61.1, 62.1, 73.0, 121.1, 124.8, 126.9, 127.6, 127.7, 128.8, 129.6, 129.7,

130.3, 134.7, 139.1, 140.9, 141.8, 144.0, 144.4, 166.4, 168.0; IR (CHCl₃, cm⁻¹) 3065, 2982, 1718, 1275; HRMS calcd for C₃₀H₂₈O₆ 484.1886, found 484.1895.

Diethyl 3-[3-(ethoxycarbonyl)phenyl]-2-phenyl-1*H*-indene-1,1-dicarboxylate (59). The indicated compound was obtained as a pale yellow oil in a 74% yield: ¹H NMR (CDCl₃) δ 1.09 (t, *J* = 7.2 Hz, 6H), 1.37 (t, *J* = 7.2 Hz, 3H), 4.14 (m, 4H), 4.35 (q, *J* = 7.2 Hz, 2H), 7.16-7.28 (m, 6H), 7.34 (m, 3H), 7.44 (m, 1H), 7.71 (d, *J* = 7.2 Hz, 1H), 7.98 (dt, *J* = 1.6, 7.6 Hz, 1H), 8.10 (t, *J* = 1.2 Hz, 1H); ¹³C NMR (CDCl₃) δ 13.8, 14.4, 61.1, 62.1, 73.0, 121.1, 124.8, 126.9, 127.5, 127.7, 128.6, 128.8, 129.0, 130.3, 130.5, 130.8, 134.2, 134.6, 134.7, 140.9, 141.5, 144.0, 144.7, 166.4, 168.1; IR (CHCl₃, cm⁻¹) 3067, 2982, 1730, 1257; HRMS calcd for C₃₀H₂₈O₆ 484.1886, found 484.1892.

Diethyl 3-[2-(ethoxycarbonyl)phenyl]-2-phenyl-1*H*-indene-1,1-dicarboxylate (60). The indicated compound was obtained as a pale yellow oil in a 78% yield: ¹H NMR (CDCl₃) δ 0.82 (t, *J* = 7.2 Hz, 3H), 0.95 (t, *J* = 7.2 Hz, 3H), 1.24 (t, *J* = 7.2 Hz, 3H), 4.04 (m, 4H), 4.28 (m, 2H), 6.90 (m, 1H), 7.15 (m, 4H), 7.27 (m, 4H), 7.37 (m, 2H), 7.67 (m, 1H), 8.05 (m, 1H); ¹³C NMR (CDCl₃) δ 13.5, 13.8, 14.2, 61.5, 61.8, 62.3, 72.8, 120.6, 124.7, 126.6, 127.4, 127.7, 128.1, 128.9, 130.2, 130.8, 131.8, 131.9, 132.6, 135.2, 135.6, 139.6, 140.4, 146.0, 146.1, 167.7, 167.8, 169.1; IR (CHCl₃, cm⁻¹) 3019, 2982, 1725, 1702, 1217; HRMS calcd for C₃₀H₂₈O₆ 484.1886, found 484.1892.

Diethyl 3-(4-nitrophenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (61). The indicated compound was obtained as a pale yellow oil in an 83% yield: ¹H NMR (CDCl₃) δ 1.08 (t, *J* = 7.2 Hz, 6H), 4.15 (m, 4H), 7.23 (m, 6H), 7.36 (m, 2H), 7.49 (d, *J* = 8.8 Hz, 2H), 7.71 (d, *J* = 7.6 Hz, 1H), 8.16 (d, *J* = 8.8 Hz, 2H); ¹³C NMR (CDCl₃) δ 13.8, 62.2, 73.2, 120.8, 123.8, 125.0, 127.2, 127.9, 128.0, 129.0, 130.2, 130.6, 134.3, 140.9, 141.4, 142.9, 143.1, 143.8, 147.2, 167.7; IR (CHCl₃, cm⁻¹) 3024, 2985, 1716, 1235; HRMS calcd for C₂₇H₂₃NO₆ 457.1525, found 457.1531.

Diethyl 3-(3-nitrophenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (62). The indicated compound was obtained as a pale yellow oil in an 82% yield: ¹H NMR (CDCl₃) δ 1.09 (t, *J* = 7.2 Hz, 6H), 4.15 (m, 4H), 7.23 (m, 6H), 7.36 (m, 2H), 7.46 (d, *J* = 8.0 Hz, 1H), 7.60 (d, *J* = 7.6 Hz, 1H), 7.72 (d, *J* = 7.2 Hz, 1H), 8.13 (d, *J* = 8.4 Hz, 1H), 8.24 (s, 1H); ¹³C NMR (CDCl₃) δ 13.8, 62.2, 73.1, 120.7, 122.8, 124.4, 125.0, 127.2, 127.9, 129.0, 129.6, 130.3, 134.2, 135.9, 136.1, 140.9, 142.6, 142.9, 143.9, 148.4, 167.7; IR (CHCl₃, cm⁻¹) 3019, 2983, 1727, 1715, 1219; HRMS calcd for C₂₇H₂₃NO₆ 457.1525, found 457.1531.

Diethyl 2-phenyl-3-[4-(trifluoromethyl)phenyl]-1*H*-indene-1,1-dicarboxylate (63). The indicated compound was obtained as a pale yellow oil in an 85% yield: ¹H NMR (CDCl₃) δ 1.09 (t, *J* = 7.2 Hz, 6H), 4.15 (m, 4H), 7.23 (m, 6H), 7.35 (m, 2H), 7.45 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 8.0 Hz, 2H), 7.72 (d, *J* = 7.6 Hz, 1H); ¹³C NMR (CDCl₃) δ 13.8, 62.1, 73.1, 121.0, 122.8, 124.9, 125.5, 127.0, 127.7, 127.8, 128.9, 130.0, 130.3, 134.6, 138.2, 140.9, 141.0, 142.1, 143.6, 144.4, 168.0; IR (CHCl₃, cm⁻¹) 3006, 2982, 1732, 1247; HRMS calcd for C₂₈H₂₃F₃O₄ 480.1548, found 480.1555.

Diethyl 2-phenyl-3-[3-(trifluoromethyl)phenyl]-1*H*-indene-1,1-dicarboxylate (64). The indicated compound was obtained as a pale yellow oil in a 91% yield: ¹H NMR (CDCl₃) δ 1.09 (t, *J* = 7.2 Hz, 6H), 4.15 (m, 4H), 7.23 (m, 6H), 7.37 (m, 3H), 7.49 (d, *J* = 7.6 Hz, 1H), 7.54 (d, *J* = 7.6 Hz, 1H), 7.63 (s, 1H), 7.72 (d, *J* = 6.8 Hz, 1H); ¹³C NMR (CDCl₃) δ 13.8, 62.1, 73.0, 120.9, 124.6, 124.9, 126.4, 126.5, 127.0, 127.7, 127.8, 128.9, 129.0, 130.3, 133.0, 134.5, 135.2, 141.0, 142.1, 143.5, 144.3, 168.0; IR (CHCl₃, cm⁻¹) 3057, 2983, 1729, 1266; HRMS calcd for C₂₈H₂₃F₃O₄ 480.1548, found 480.1556.

Diethyl 2-phenyl-3-[2-(trifluoromethyl)phenyl]-1*H*-indene-1,1-dicarboxylate (65). The indicated compound was obtained as a pale yellow oil in a 53% yield: ¹H NMR (CDCl₃) δ 1.07 (m, 6H), 4.13 (m, 4H), 6.82 (m, 1H), 7.11-7.17 (m, 5H), 7.28 (m, 2H), 7.37 (d, *J* = 7.6 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 1H), 7.66-7.73

(m, 2H); ^{13}C NMR (CDCl_3) δ 13.6, 13.8, 61.9, 62.0, 72.4, 121.1, 124.0, 126.7, 126.8, 126.9, 127.4, 127.5, 128.2, 128.7, 129.4, 131.9, 132.1, 133.6, 134.3, 140.3, 141.8, 142.5, 146.4, 168.0, 168.2; IR (CHCl_3 , cm^{-1}) 3067, 2982, 1734, 1717, 1220; HRMS calcd for $\text{C}_{28}\text{H}_{23}\text{F}_3\text{O}_4$ 480.1548, found 480.1556.

Diethyl 3-(4-acetylphenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (66). The indicated compound was obtained as a pale yellow oil in a 94% yield: ^1H NMR (CDCl_3) δ 1.09 (t, $J = 7.2$ Hz, 6H), 2.59 (s, 3H), 4.14 (m, 4H), 7.20 (m, 5H), 7.28 (m, 1H), 7.35 (m, 2H), 7.43 (dt, $J = 1.8, 8.7$ Hz, 2H), 7.70 (m, 1H), 7.92 (dt, $J = 8.7$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 13.8, 26.7, 62.1, 73.0, 121.0, 124.8, 126.9, 127.6, 127.7, 128.5, 128.8, 129.9, 130.3, 134.7, 136.3, 139.5, 141.0, 142.0, 143.9, 144.4, 168.0, 197.7; IR (CHCl_3 , cm^{-1}) 2980, 1733, 1685, 1221; HRMS calcd for $\text{C}_{29}\text{H}_{26}\text{O}_5$ 454.1780, found 454.1786.

Diethyl 3-(4-chlorophenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (67). The indicated compound was obtained as a pale yellow oil in an 84% yield: ^1H NMR (CDCl_3) δ 1.08 (t, $J = 7.2$ Hz, 6H), 4.14 (m, 4H), 7.17-7.37 (m, 12H), 7.70 (d, $J = 7.2$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 62.2, 73.1, 121.2, 125.0, 127.1, 127.7, 127.9, 129.0, 130.5, 130.6, 131.2, 133.0, 133.9, 135.0, 141.1, 141.4, 143.9, 144.8, 168.3; IR (CHCl_3 , cm^{-1}) 3019, 2983, 1725, 1714, 1218; HRMS calcd for $\text{C}_{27}\text{H}_{23}\text{ClO}_4$ 446.1285, found 446.1292.

Diethyl 2-phenyl-3-(thien-2-yl)-1*H*-indene-1,1-dicarboxylate (68). The indicated compound was obtained as a pale yellow oil in a 64% yield: ^1H NMR (CDCl_3) δ 1.08 (t, $J = 7.2$ Hz, 6H), 4.14 (m, 4H), 7.00 (dd, $J = 3.6, 5.1$ Hz, 1H), 7.13 (dd, $J = 1.2, 3.6$ Hz, 1H), 7.25-7.45 (m, 8H), 7.63 (d, $J = 7.2$ Hz, 1H), 7.69 (d, $J = 7.2$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.0, 62.2, 62.3, 73.3, 121.6, 124.9, 126.6, 127.1, 127.2, 127.9, 128.0, 128.3, 130.0, 130.7, 135.3, 135.5, 138.1, 140.8, 141.4, 144.4, 168.2; IR (CHCl_3 , cm^{-1}) 3001, 2984, 1714, 1363, 1223; HRMS calcd for $\text{C}_{25}\text{H}_{22}\text{SO}_4$ 418.1239, found 418.1245.

Diethyl 2,3-diphenyl-1*H*-indene-1,1-dicarboxylate (69). The indicated compound was obtained as white crystals in a 72% yield: mp 85-87 °C; ¹H NMR (CDCl₃) δ 1.07 (t, *J* = 7.2 Hz, 6H), 4.14 (m, 4H), 7.15-7.36 (m, 13H), 7.69 (d, *J* = 7.2 Hz, 1H); ¹³C NMR (CDCl₃) δ 13.8, 61.9, 72.8, 121.3, 124.6, 126.7, 127.3, 127.6, 127.8, 128.5, 128.7, 129.6, 130.3, 134.3, 135.1, 140.6, 141.0, 144.8, 145.1, 168.3; IR (CHCl₃, cm⁻¹) 3057, 3019, 2982, 1727, 1466, 1216; HRMS calcd for C₂₇H₂₄O₄ 412.1675, found 412.1680.

Diethyl 3-(4-methylphenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (70). The indicated compound was obtained as a pale yellow oil in a 69% yield: ¹H NMR (CDCl₃) δ 1.08 (t, *J* = 7.2 Hz, 6H), 2.34 (s, 3H), 4.15 (m, 4H), 7.12-7.35 (m, 12H), 7.68 (d, *J* = 6.8 Hz, 1H); ¹³C NMR (CDCl₃) δ 14.0, 21.6, 62.1, 73.0, 121.5, 124.7, 126.8, 127.4, 127.7, 127.8, 128.7, 128.9, 129.4, 129.7, 129.8, 130.5, 130.6, 135.5, 137.7, 141.2, 145.0, 145.4, 168.6; IR (CHCl₃, cm⁻¹) 3019, 2983, 1732, 1728, 1216; HRMS calcd for C₂₈H₂₆O₄ 426.1831, found 426.1837; we have no good explanation as to why there are 18 aromatic signals in the ¹³C NMR spectrum for compound.

Diethyl 3-(3-methylphenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (71). The indicated compound was obtained as a pale yellow oil in a 74% yield: ¹H NMR (CDCl₃) δ 1.08 (t, *J* = 7.2 Hz, 6H), 2.30 (s, 3H), 4.14 (m, 4H), 7.09-7.36 (m, 12H), 7.70 (d, *J* = 7.8 Hz, 1H); ¹³C NMR (CDCl₃) δ 14.0, 21.7, 62.1, 72.9, 121.5, 124.7, 126.8, 126.9, 127.4, 127.8, 128.5, 128.6, 128.7, 128.8, 129.8, 130.3, 130.5, 134.4, 138.2, 141.2, 145.1, 145.5, 168.5; IR (CHCl₃, cm⁻¹) 3021, 2983, 1728, 1218; HRMS calcd for C₂₈H₂₆O₄ 426.1831, found 426.1837.

Diethyl 3-(2-methylphenyl)-2-phenyl-1*H*-indene-1,1-dicarboxylate (72). The indicated compound was obtained as a pale yellow oil in a 73% yield: ¹H NMR (CDCl₃) δ 1.02 (t, *J* = 7.2 Hz, 3H), 1.12 (t, *J* = 7.2 Hz, 3H), 2.06 (s, 3H), 4.12 (m, 4H), 6.97 (d, *J* = 8.0 Hz, 1H), 7.13 (m, 3H), 7.19-7.31 (m, 8H), 7.69 (d, *J* = 8.0 Hz,

1H); ^{13}C NMR (CDCl_3) δ 13.7, 13.9, 19.6, 61.8, 62.0, 72.2, 121.3, 124.1, 125.9, 126.6, 127.3, 127.6, 128.0, 128.8, 129.1, 129.7, 130.5, 134.2, 135.0, 136.7, 140.8, 140.9, 144.5, 145.9, 168.0, 168.8; IR (CHCl_3 , cm^{-1}) 3019, 2983, 1728, 1717, 1219; HRMS calcd for $\text{C}_{28}\text{H}_{26}\text{O}_4$ 426.1831, found 426.1837.

Diethyl 3-(4-methoxyphenyl)-2-phenyl-1H-indene-1,1-dicarboxylate (73). The indicated compound was obtained as a pale yellow oil in a 14% yield: ^1H NMR (CDCl_3) δ 1.08 (t, $J = 7.2$ Hz, 6H), 3.80 (s, 3H), 4.14 (m, 4H), 6.85 (d, $J = 8.8$ Hz, 2H), 7.17-7.36 (m, 10H), 7.68 (d, $J = 7.2$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 13.8, 55.2, 61.9, 72.7, 113.9, 121.2, 124.6, 126.5, 126.6, 127.1, 127.6, 128.7, 130.4, 130.8, 135.3, 139.9, 141.0, 144.4, 145.3, 159.1, 168.4; IR (CHCl_3 , cm^{-1}) 2980, 1732, 1510, 1247; HRMS calcd for $\text{C}_{28}\text{H}_{26}\text{O}_5$ 442.1780, found 442.1785.

Diethyl 2-allyl-2-[(2-phenylethynyl)phenyl]malonate (75). The indicated compound was obtained as a pale yellow oil in a 86% yield: ^1H NMR (CDCl_3) δ 1.21 (t, $J = 7.2$ Hz, 6H), 3.31 (d, $J = 7.2$ Hz, 2H), 4.16-4.30 (m, 4H), 4.92 (d, $J = 10.2$ Hz, 1H), 5.00 (d, $J = 17.1$ Hz, 1H), 5.81-5.90 (m, 1H), 7.23-7.37 (m, 6H), 7.54-7.58 (m, 3H); ^{13}C NMR (CDCl_3) δ 14.0, 39.7, 61.9, 64.1, 88.4, 95.0, 118.0, 122.9, 123.2, 127.2, 127.9, 128.2, 128.5, 128.6, 131.3, 133.9, 134.2, 139.5, 170.2; IR (CHCl_3 , cm^{-1}) 3056, 2937, 1742, 1717, 1266; HRMS calcd for $\text{C}_{24}\text{H}_{24}\text{O}_4$ 376.1675, found 376.1683.

Diethyl 3-[4-(ethoxycarbonyl)phenyl]-2-hexyl-1H-indene-1,1-dicarboxylate (77). The indicated compound was obtained as a pale yellow oil in a 61% yield: ^1H NMR (CDCl_3) δ 0.78 (t, $J = 7.2$ Hz, 3H), 1.12 (m, 6H), 1.26 (t, $J = 7.2$ Hz, 8H), 1.40 (t, $J = 7.2$ Hz, 3H), 2.58 (t, $J = 8.0$ Hz, 2H), 4.22 (m, 4H), 4.39 (q, $J = 7.2$ Hz, 2H), 6.98 (d, $J = 7.2$ Hz, 1H), 7.23 (m, 2H), 7.46 (d, $J = 8.0$ Hz, 2H), 7.62 (d, $J = 7.2$ Hz, 1H), 8.13 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.0, 14.1, 14.4, 22.6, 27.6, 29.1, 29.7, 31.4, 61.1, 62.1, 71.9, 119.8, 124.9, 126.0, 128.6, 128.9, 129.8, 129.9, 139.6, 140.1, 142.6, 143.4, 145.4, 166.5, 168.4; IR (CHCl_3 , cm^{-1}) 2981, 2930, 1730, 1273; HRMS calcd for $\text{C}_{30}\text{H}_{36}\text{O}_6$ 492.2512, found 492.2521.

Diethyl 2-hexyl-3-(4-nitrophenyl)-1*H*-indene-1,1-dicarboxylate (78). The indicated compound was obtained as a pale yellow oil in a 63% yield: ^1H NMR (CDCl_3) δ 0.78 (t, $J = 7.2$ Hz, 3H), 1.14 (m, 6H), 1.27 (t, $J = 7.2$ Hz, 8H), 2.59 (t, $J = 7.6$ Hz, 2H), 4.23 (m, 4H), 6.95 (d, $J = 6.8$ Hz, 1H), 7.26 (m, 2H), 7.56 (d, $J = 8.4$ Hz, 2H), 7.63 (d, $J = 6.8$ Hz, 1H), 8.32 (d, $J = 8.4$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.0, 22.5, 27.6, 29.2, 29.7, 31.4, 62.2, 72.0, 119.6, 124.0, 125.1, 126.3, 128.7, 129.9, 140.0, 141.5, 141.9, 144.6, 144.7, 147.4, 168.1; IR (CHCl_3 , cm^{-1}) 2981, 2930, 1732, 1243; HRMS calcd for $\text{C}_{27}\text{H}_{31}\text{NO}_6$ 465.2151, found 465.2160.

Diethyl 2-hexyl-3-(4-methoxyphenyl)-1*H*-indene-1,1-dicarboxylate (79). The indicated compound was obtained as a pale yellow oil in a 9% yield: ^1H NMR (CDCl_3) δ 0.82 (t, $J = 7.2$ Hz, 3H), 1.13-1.32 (m, 14H), 2.58 (t, $J = 8.0$ Hz, 2H), 3.87 (s, 3H), 4.21 (m, 1H), 7.00 (d, $J = 8.8$ Hz, 2H), 7.06 (d, $J = 7.2$ Hz, 1H), 7.21 (t, $J = 7.2$ Hz, 1H), 7.27 (t, $J = 7.2$ Hz, 1H), 7.32 (d, $J = 8.4$ Hz, 2H), 7.61 (d, $J = 7.2$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.1, 14.2, 22.7, 27.6, 29.1, 29.8, 31.5, 55.3, 61.9, 71.6, 114.2, 120.0, 125.6, 126.9, 127.8, 128.4, 130.0, 140.1, 142.1, 143.1, 146.2, 159.1, 168.8; IR (CHCl_3 , cm^{-1}) 3053, 2985, 2926, 1714, 1265; HRMS calcd for $\text{C}_{28}\text{H}_{34}\text{O}_5$ 450.2406, found 450.2414.

Diethyl

2-(cyclohexen-1-yl)-3-[4-(ethoxycarbonyl)phenyl]-1*H*-indene-1,1-dicarboxylate (80). The indicated compound was obtained as a pale yellow oil in an 83% yield: ^1H NMR (CDCl_3) δ 1.24 (t, $J = 7.2$ Hz, 6H), 1.42 (t, $J = 7.2$ Hz, 3H), 1.53 (m, 4H), 2.00 (m, 4H), 4.19 (m, 4H), 4.41 (t, $J = 7.2$ Hz, 2H), 5.60 (s, 1H), 7.15 (d, $J = 7.6$ Hz, 1H), 7.27 (m, 2H), 7.52 (d, $J = 8.0$ Hz, 2H), 7.60 (d, $J = 7.2$ Hz, 1H), 8.10 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.0, 14.4, 21.8, 22.9, 25.9, 29.1, 61.1, 61.9, 72.0, 120.5, 124.4, 126.3, 128.6, 129.1, 129.6, 129.7, 130.9, 132.4, 140.2, 140.7, 141.8, 144.8, 144.9, 166.6, 168.3; IR (CHCl_3 , cm^{-1}) 3055, 2983, 2934, 1716, 1269; HRMS calcd for $\text{C}_{30}\text{H}_{32}\text{O}_6$ 488.2199, found 488.2206.

Diethyl 2-(cyclohexen-1-yl)-3-(4-nitrophenyl)-1*H*-indene-1,1-dicarboxylate (81).

The indicated compound was obtained as a pale yellow oil in an 87% yield: ^1H NMR (CDCl_3) δ 1.26 (t, $J = 7.2$ Hz, 6H), 1.54 (m, 4H), 1.98 (m, 2H), 2.05 (m, 2H), 4.22 (m, 4H), 5.59 (s, 1H), 7.14 (m, 1H), 7.30 (m, 2H), 7.63 (m, 3H), 8.30 (m, 2H); ^{13}C NMR (CDCl_3) δ 14.2, 21.9, 23.0, 26.1, 29.4, 62.2, 72.2, 120.5, 123.9, 124.9, 126.9, 127.8, 128.6, 128.9, 130.3, 131.9, 132.4, 140.9, 142.7, 144.2, 146.3, 147.3, 168.1; IR (CHCl_3 , cm^{-1}) 3055, 2984, 1733, 1719, 1265; HRMS calcd for $\text{C}_{27}\text{H}_{27}\text{NO}_6$ 461.1838, found 461.1846.

Diethyl 2-(cyclohexen-1-yl)-3-[4-(acetylphenyl)phenyl]-1*H*-indene-1,1-dicarboxylate (82).

The indicated compound was obtained as a pale yellow oil in a 78% yield: ^1H NMR (CDCl_3) δ 1.24 (t, $J = 7.2$ Hz, 6H), 1.53 (m, 4H), 2.00 (m, 4H), 2.66 (s, 3H), 4.22 (m, 4H), 5.60 (s, 1H), 7.16 (d, $J = 7.6$ Hz, 1H), 7.28 (m, 2H), 7.55 (d, $J = 8.4$ Hz, 2H), 7.60 (d, $J = 7.2$ Hz, 1H), 8.02 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.1, 21.8, 22.9, 25.9, 26.7, 29.1, 61.9, 72.0, 120.5, 124.4, 126.4, 128.4, 128.6, 129.4, 131.0, 132.4, 136.2, 140.6, 140.7, 141.7, 144.7, 145.0, 168.3, 197.9; IR (CHCl_3 , cm^{-1}) 3056, 2983, 2934, 1739, 1716, 1268; HRMS calcd for $\text{C}_{29}\text{H}_{30}\text{O}_5$ 458.2093, found 458.2101.

Ethyl 1-cyano-3-[4-(ethoxycarbonyl)phenyl]-2-hexyl-1*H*-indene-1-carboxylate (83).

The indicated compound was obtained as a pale yellow oil in a 53% yield: ^1H NMR (CDCl_3) δ 1.24 (t, $J = 7.2$ Hz, 6H), 1.20-1.31 (m, 9H), 1.43 (t, $J = 7.2$ Hz, 3H), 1.60 (m, 2H), 2.48 (m, 1H), 2.58 (m, 1H), 4.28 (m, 2H), 4.41 (q, $J = 7.2$ Hz, 2H), 7.09 (d, $J = 7.6$ Hz, 1H), 7.34 (m, 2H), 7.47 (d, $J = 8.4$ Hz, 2H), 7.61 (d, $J = 7.2$ Hz, 1H), 8.18 (d, $J = 8.0$ Hz, 2H); ^{13}C NMR (CDCl_3) δ 14.0, 14.1, 14.4, 22.5, 27.6, 28.6, 29.5, 31.3, 58.3, 61.2, 63.6, 116.4, 120.9, 123.2, 127.1, 128.8, 129.8, 130.0, 130.5, 138.0, 138.9, 140.8, 144.0, 144.7, 165.6, 166.3; IR (CHCl_3 , cm^{-1}) 2983, 2930, 1741, 1715, 1266; HRMS calcd for $\text{C}_{28}\text{H}_{31}\text{NO}_4$ 445.2253, found 445.2261.

Ethyl 3-[4-(ethoxycarbonyl)phenyl]-2-phenyl-1-phenylsulfonyl-1*H*-indene-1-carboxylate (84). The indicated compound was obtained as a pale yellow oil in a 42% yield: ^1H NMR (CDCl_3) δ 1.25 (t, $J = 7.2$ Hz, 3H), 1.37 (t, $J = 7.2$ Hz, 3H), 4.35 (m, 4H), 6.91 (d, $J = 8.4$ Hz, 3H), 7.06 (d, $J = 7.2$ Hz, 2H), 7.11-7.24 (m, 7H), 7.37 (m, 2H), 7.47 (m, 1H), 7.93 (d, $J = 8.4$ Hz, 3H); ^{13}C NMR (CDCl_3) δ 13.9, 14.4, 61.2, 63.0, 85.4, 121.1, 126.3, 127.3, 127.6, 127.8, 128.2, 129.0, 129.9, 130.0, 130.1, 130.2, 130.6, 132.4, 133.7, 135.7, 137.4, 137.8, 138.8, 145.2, 146.8, 165.8, 166.2; IR (CHCl_3 , cm^{-1}) 2982, 1739, 1717, 1272; HRMS calcd for $\text{C}_{33}\text{H}_{28}\text{SO}_6$ 552.1607, found 552.1616.

Diethyl 13*H*-indeno[1,2-*l*]phenanthrene-13,13-dicarboxylate (85). The indicated compound was obtained as a pale yellow oil in a 35% yield: ^1H NMR (CDCl_3) δ 1.02 (t, $J = 7.2$ Hz, 6H), 4.10 (m, 4H), 7.41 (t, $J = 7.6$ Hz, 1H), 7.61 (m, 3H), 7.75 (m, 2H), 7.88 (d, $J = 7.6$ Hz, 1H), 8.21 (d, $J = 8.0$ Hz, 1H), 8.40 (d, $J = 7.6$ Hz, 1H), 8.74 (d, $J = 7.6$ Hz, 1H), 8.86 (m, 2H); ^{13}C NMR (CDCl_3) δ 13.8, 62.2, 68.7, 123.1, 123.3, 123.7, 124.8, 124.9, 126.5, 126.6, 126.8, 126.9, 127.0, 127.1, 128.5, 128.7, 129.1, 130.8, 131.9, 136.4, 137.5, 142.6, 142.9, 168.9; IR (CHCl_3 , cm^{-1}) 3053, 2984, 1749, 1265; HRMS calcd for $\text{C}_{27}\text{H}_{22}\text{O}_4$ 410.1518, found 410.1526.

Diethyl 3-[(*E*)-3-ethoxy-3-oxoprop-1-enyl]-2-hexyl-1*H*-indene-1,1-dicarboxylate (89). The indicated compound was obtained as a pale yellow oil in a 36% yield: ^1H NMR (CDCl_3) δ 0.89 (t, $J = 6.9$ Hz, 3H), 1.22-1.49 (m, 17H), 2.73 (m, 2H), 4.15-4.33 (m, 6H), 6.55 (d, $J = 16.5$ Hz, 1H), 7.27 (dt, $J = 0.9, 7.5$ Hz, 1H), 7.37 (dt, $J = 0.9, 7.5$ Hz, 1H), 7.56 (d, $J = 7.5$ Hz, 1H), 7.62 (d, $J = 7.2$ Hz, 1H), 7.77 (d, $J = 16.5$ Hz, 1H); ^{13}C NMR (CDCl_3) δ 14.2, 14.3, 14.5, 16.6, 22.8, 28.4, 30.1, 30.5, 31.7, 60.9, 62.4, 72.0, 120.7, 121.5, 125.4, 126.4, 128.9, 136.2, 136.9, 140.2, 142.7, 151.2, 167.3, 168.1; IR (CHCl_3 , cm^{-1}) 3054, 2985, 1727, 1718, 1265; HRMS calcd for $\text{C}_{26}\text{H}_{34}\text{O}_6$ 442.2355, found 442.2362.

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