Tandem Catalytic Carbene Addition/Bicyclization of Enynes. One-Step Synthesis of Fluorinated Bicyclic Amino Esters by Ruthenium Catalysis

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Supporting Information:

General procedure for catalytic carbene addition/cyclopropanation of enynes with N₂CHSiMe₃:

In a Schlenk tube under inert atmosphere, to a solution of the enyne (1 mmol) in degassed diethyl ether (2 mL) was added 0.57 mL (1.15 mmol) of the 2.0 M (trimethylsilyl)diazomethane solution in diethyl ether. 5 mol% of the precatalyst Cp*RuCl(COD) was then introduced. The mixture was stirred at room temperature. Reaction completion was monitored using GC or TLC techniques. Typically a 20:80 ether:pentane eluting mixture was appropriate for such a monitoring. In the case of the transformation of allyl propargyl tosylamide, the reaction is complete in 5 min. For the enynes with a fluorinated amino ester moiety, 10 min to 4 h were necessary to complete the reaction. Diastereoisomers were separated as pure compounds using standard chromatography over silica gel with an ether: pentane eluting mixture.

General procedure for catalytic carbene addition/cyclopropanation of enynes with N₂CHCO₂Et:

In a Schlenk tube under inert atmosphere, to a solution of the enyne (1 mmol) in degassed dioxane (2 mL) was added 126 μ L (1.2 mmol) of ethyldiazoacetate. The medium was heated up to the temperature of 100 °C before the introduction of 5 mol% of the precatalyst Cp*RuCl(COD). The mixture was stirred at 100 °C. Reaction completion was monitored using GC or TLC techniques. Typically a 40:60 ether:pentane eluting mixture was appropriate for such a monitoring. Diastereoisomers were separated as pure compounds using standard chromatography over silica gel with an ether:pentane eluting mixture.

Spectroscopic data for compounds 4-5 and 7-8

All bicyclic compounds were fully characterized by ¹H, ¹⁹F and ¹³C NMR techniques including HMQC and HMBC experiments. They are too hygroscopic to allow to obtain good elemental analysis. HRMS measurements were performed for the major diastereoisomer of the bicyclic compounds.

In the case of carbamate protected bicycles, after separation over silica gel chromatography of the two diastereoisomers, compounds **4a-b**, **5b** and **8b** all display the presence of two rotamers for both pure diastereoisomers. An experiment for one diastereoisomer of **4a** shows the existence of a coalescence at about 80 °C (see below the resulting coalescence experiment).

Synthesis and characterization of 4a:

4a was synthesized as mentioned above using 0.234 g (0.70 mmol) of **2a**, 400 μ L (0.80 mmol) of a 2.0 M (trimethylsilyl)diazomethane solution in ether, 1 mL of added degassed diethyl ether and 13 mg of Cp* $\text{RuCl}(\text{COD})$, yielding 0.200 g (68%) of the desired diastereoisomers in a **A**:**B** ratio of 50:50. The two diastereoisomers were separated over silica gel chromatography using a 5:95 ether:pentane eluting mixture; diastereoisomer **A** (100 mg, 34%), **B** (100 mg, 34%).

HRMS calcd for $\text{C}_{15}\text{H}_{22}\text{F}_3\text{NO}_4\text{Si}$ ($[\text{M} - \text{C}_4\text{H}_8]^+$) 365.12702, found: 365.1259.

Diastereoisomer A of 4a: (2 rotamers in a 10:14 ratio at 25 °C)

Minor rotamer:

^1H (CDCl_3 , 500 MHz, -20 °C): 6.70 (d, 1H, $^3J = 14.2$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.69 (d, 1H, $^3J = 14.2$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 4.47 (d, 1H, $^2J = 14.9$ Hz, NCHH), 3.82 (s, 3H, CO_2CH_3), 2.61 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 2.42 (d, 1H, $^2J = 14.9$ Hz, NCHH), 1.49 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 1.46 (s, 9H, $\text{NCO}_2\text{C}(\text{CH}_3)_3$), 1.16 (m, 1H, CHH cyclopropane), 0.91 (m, 1H, CH cyclopropane), 0.60 (m, 1H, CHH cyclopropane), 0.16 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 25 °C): -75.8

^{13}C { ^1H } (D_8 -toluene, 75 MHz, 25 °C): 167.2 (CO_2Me), 153.8 (NCO_2tBu), 150.2 ($\text{C}=\text{CH}(\text{TMS})$), 132.7 ($\text{C}=\text{CH}(\text{TMS})$), 80.5 ($\text{NCO}_2\text{C}(\text{CH}_3)_3$), 51.5 (CO_2CH_3), 50.3 (NCH_2), 30.1 ($\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CH}_2$), 27.7 ($\text{NCO}_2\text{C}(\text{CH}_3)_3$), 23.1 (CH_2 cyclopropane), 23.0 (C quaternary cyclopropane), 12.0 (CH cyclopropane), 0.4 ($\text{Si}(\text{CH}_3)_3$)

Major rotamer:

^1H (CDCl_3 , 500 MHz, -20 °C): 6.67 (d, 1H, $^3J = 14.1$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.66 (d, 1H, $^3J = 14.1$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 4.70 (d, 1H, $^2J = 14.7$ Hz, NCHH), 3.85 (s, 3H, CO_2CH_3), 2.61 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 2.42 (d, 1H, $^2J = 14.7$ Hz, NCHH), 1.49 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 1.44 (s, 9H, $\text{NCO}_2\text{C}(\text{CH}_3)_3$), 1.25 (m, 1H, CHH cyclopropane), 0.81 (m, 1H, CH cyclopropane), 0.60 (m, 1H, CHH cyclopropane), 0.16 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 25 °C): -74.5

^{13}C { ^1H } (D_8 -toluene, 75 MHz, 25 °C): 167.6 (CO_2Me), 153.4 (NCO_2tBu), 149.5 ($\text{C}=\text{CH}(\text{TMS})$), 132.0 ($\text{C}=\text{CH}(\text{TMS})$), 81.0 ($\text{NCO}_2\text{C}(\text{CH}_3)_3$), 51.4 (CO_2CH_3), 48.2 (NCH_2), 31.3 ($\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CH}_2$), 27.6 ($\text{NCO}_2\text{C}(\text{CH}_3)_3$), 23.6 (CH_2 cyclopropane), 23.4 (C quaternary cyclopropane), 11.8 (CH cyclopropane), 0.4 ($\text{Si}(\text{CH}_3)_3$)

Study of the coalescence of diastereoisomer A of 4a:

Heating at 80 °C a D₈-toluene solution of pure diastereoisomer **A** of compound **4a** displays a coalescence for the two rotamers observed by ¹H and ¹⁹F NMR spectroscopy:

¹H (D₈-toluene, 300 MHz, 80 °C): 6.80 (d, 1H, ³J = 14.5 Hz, HC=CH(TMS)), 5.62 (d, 1H, ³J = 14.5 Hz, HC=CH(TMS)), 4.73 (d, 1H, ²J = 15.3 Hz, NCHH), 3.51 (s, 3H, CO₂CH₃), 2.34 (m, 1H, NC(CF₃)(CO₂Me)CHH), 2.28 (d, 1H, ²J = 15.3 Hz, NCHH), 1.38 (s, 9H, CO₂C(CH₃)₃), 1.25 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.01 (m, 1H, CHH cyclopropane), 0.69 (m, 1H, CH cyclopropane), 0.23 (m, 1H, CHH cyclopropane), 0.15 (s, 9H, Si(CH₃)₃)

¹⁹F (D₈-toluene, 188 MHz, 80 °C): -74.1

Diastereoisomer B of 4a: (2 rotamers in a 10:17 ratio at 25 °C)

Minor rotamer:

¹H (CDCl₃, 300 MHz, -40 °C): 6.50 (d, 1H, ³J = 14.4 Hz, HC=CH(TMS)), 5.63 (d, 1H, ³J = 14.4 Hz, HC=CH(TMS)), 4.04 (d, 1H, ²J = 13.8 Hz, NCHH), 3.75 (s, 3H, CO₂CH₃), 3.25 (d, 1H, ²J = 13.8 Hz, NCHH), 2.73 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.67 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.45 (s, 9H, NCO₂C(CH₃)₃), 1.13 (m, 1H, CHH cyclopropane), 0.97 (m, 1H, CH cyclopropane), 0.88 (m, 1H, CHH cyclopropane), 0.15 (s, 9H, Si(CH₃)₃)

¹⁹F (CDCl₃, 188 MHz, 25 °C): -70.1

¹³C {¹H} (CDCl₃, 75 MHz, -40 °C): 168.7 (CO₂Me), 154.9 (NCO₂tBu), 149.6 (C=CH(TMS)), 133.4 (C=CH(TMS)), 81.7 (NCO₂C(CH₃)₃), 52.6 (CO₂CH₃), 49.0 (NCH₂), 30.6 (NC(CF₃)(CO₂Me)CH₂), 28.0 (NCO₂C(CH₃)₃), 22.7 (CH₂ cyclopropane), 22.0 (C quaternary cyclopropane), 13.6 (CH cyclopropane), 0.0 (Si(CH₃)₃)

Major rotamer:

¹H (CDCl₃, 300 MHz, -40 °C): 6.46 (d, 1H, ³J = 14.2 Hz, HC=CH(TMS)), 5.65 (d, 1H, ³J = 14.2 Hz, HC=CH(TMS)), 4.46 (d, 1H, ²J = 14.1 Hz, NCHH), 3.76 (s, 3H, CO₂CH₃), 2.82 (m, 1H, NC(CF₃)(CO₂Me)CHH), 2.79 (d, 1H, ²J = 14.1 Hz, NCHH), 1.48 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.40 (s, 9H, NCO₂C(CH₃)₃), 1.16 (m, 1H, CHH cyclopropane), 0.97 (m, 1H, CH cyclopropane), 0.71 (m, 1H, CHH cyclopropane), 0.13 (s, 9H, Si(CH₃)₃)

¹⁹F (CDCl₃, 188 MHz, 25 °C): -67.6

¹³C {¹H} (CDCl₃, 75 MHz, -40 °C): 168.9 (CO₂Me), 154.2 (NCO₂tBu), 149.3 (C=CH(TMS)), 133.4 (C=CH(TMS)), 82.0 (NCO₂C(CH₃)₃), 52.6 (CO₂CH₃), 49.4 (NCH₂), 33.5 (NC(CF₃)(CO₂Me)CH₂), 28.0 (NCO₂C(CH₃)₃), 24.2 (CH₂ cyclopropane), 22.5 (C quaternary cyclopropane), 13.0 (CH cyclopropane), 0.0 (Si(CH₃)₃)

Synthesis and characterization of 4b:

4b was synthesized as mentioned above using 0.180 g (0.49 mmol) of **2b**, 280 μ L (0.56 mmol) of a 2.0 M (trimethylsilyl)diazomethane solution in ether, 2 mL of added degassed diethyl ether and 9 mg of Cp*RuCl(COD), yielding 0.142 g (64%) of the desired diastereoisomers in a **A**:**B** ratio of 45:55. The two diastereoisomers were separated over silica gel chromatography using a 5:95 ether:pentane eluting mixture; diastereoisomer **A** (65 mg, 29%), **B** (78 mg, 35%).

HRMS calcd for C₁₅H₂₁F₃NO₄Si ([M - C₇H₇]⁺) 364.11920, found: 365.1174.

Diastereoisomer A of 4b: (2 rotamers in a 10:13 ratio at 25 °C)

Minor rotamer:

¹H (CDCl₃, 300 MHz, -40 °C): 7.37 (m, 5H, Ph), 6.49 (d, 1H, ³J = 14.2 Hz, HC=CH(TMS)), 5.68 (d, 1H, ³J = 14.2 Hz, HC=CH(TMS)), 5.31 (d, 1H, ²J = 11.8 Hz, NCO₂CHHPh), 4.97 (d, 1H, ²J = 11.8 Hz, NCO₂CHHPh), 4.53 (d, 1H, ²J = 14.1 Hz, NCHH), 3.24 (s, 3H, CO₂CH₃), 2.96 (d, 1H, ²J = 14.1 Hz, NCHH), 2.84 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.49 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.19 (m, 1H, CHH cyclopropane), 1.02 (m, 1H, CH cyclopropane), 0.75 (m, 1H, CHH cyclopropane), 0.18 (s, 9H, Si(CH₃)₃)

¹⁹F (CDCl₃, 188 MHz, 25 °C): -67.9

¹³C {¹H} (CDCl₃, 75 MHz, -40 °C): 168.5 (CO₂Me), 155.5 (NCO₂CH₂Ph), 149.1 (C=CH(TMS)), 135.5 (C quaternary Ph), 133.7 (C=CH(TMS)), 128.8 (C aromatic para), 128.2 (C aromatic meta), 128.1 (C aromatic ortho), 124.6 (q, CF₃, ¹J_{C-F} = 291 Hz), 68.1 (NCO₂CH₂Ph), 64.3 (q, ²J_{C-F} = 28 Hz, (F₃C)C(CO₂Me)), 52.6 (CO₂CH₃), 50.1 (NCH₂), 33.2 (NC(CF₃)(CO₂Me)CH₂), 23.8 (CH₂ cyclopropane), 22.3 (C quaternary cyclopropane), 13.3 (CH cyclopropane), 0.0 (Si(CH₃)₃)

Major rotamer:

¹H (CDCl₃, 300 MHz, -40 °C): 7.38 (m, 5H, Ph), 6.47 (d, 1H, ³J = 14.3 Hz, HC=CH(TMS)), 5.66 (d, 1H, ³J = 14.3 Hz, HC=CH(TMS)), 5.26 (d, 1H, ²J = 12.3 Hz, NCO₂CHHPh), 5.08 (d, 1H, ²J = 12.3 Hz, NCO₂CHHPh), 4.28 (d, 1H, ²J = 13.9 Hz, NCHH), 3.71 (s, 3H, CO₂CH₃), 3.16 (d, 1H, ²J = 13.9 Hz, NCHH), 2.83 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.66 (m, 1H, NC(CF₃)(CO₂Me)CHH), 1.16 (m, 1H, CHH cyclopropane), 1.02 (m, 1H, CH cyclopropane), 0.85 (m, 1H, CHH cyclopropane), 0.11 (s, 9H, Si(CH₃)₃)

¹⁹F (CDCl₃, 188 MHz, 25 °C): -69.3

¹³C {¹H} (CDCl₃, 75 MHz, -40 °C): 168.5 (CO₂Me), 155.5 (NCO₂CH₂Ph), 149.1 (C=CH(TMS)), 136.0 (C quaternary Ph), 133.7 (C=CH(TMS)), 128.8 (C aromatic para), 128.2 (C aromatic meta), 128.1 (C aromatic ortho), 124.5 (q, CF₃, ¹J_{C-F} = 294 Hz), 68.0 (NCO₂CH₂Ph), 64.3 (q, ²J_{C-F} = 28 Hz, (F₃C)C(CO₂Me)), 52.8 (CO₂CH₃), 49.3 (NCH₂), 31.3 (NC(CF₃)(CO₂Me)CH₂), 23.1 (CH₂ cyclopropane), 22.3 (C quaternary cyclopropane), 13.6 (CH cyclopropane), 0.0 (Si(CH₃)₃)

Diastereoisomer B of 4b: (2 rotamers in a 10:12 ratio at 25 °C)

Minor rotamer:

^1H (CDCl_3 , 300 MHz, $-40\text{ }^\circ\text{C}$): 7.35 (m, 5H, Ph), 6.67 (d, 1H, $^3J = 14.2\text{ Hz}$, $\text{HC}=\text{CH}(\text{TMS})$), 5.70 (d, 1H, $^3J = 14.2\text{ Hz}$, $\text{HC}=\text{CH}(\text{TMS})$), 5.22 (d, 1H, $^2J = 12.0\text{ Hz}$, NCO_2CHHPh), 5.05 (d, 1H, $^2J = 12.0\text{ Hz}$, NCO_2CHHPh), 4.78 (d, 1H, $^2J = 14.7\text{ Hz}$, NCHH), 3.38 (s, 3H, CO_2CH_3), 2.62 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 2.51 (d, 1H, $^2J = 14.7\text{ Hz}$, NCHH), 1.49 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 1.20 (m, 1H, CHH cyclopropane), 0.89 (m, 1H, CH cyclopropane), 0.62 (app. d, 1H, $^3J = 4.8\text{ Hz}$, CHH cyclopropane), 0.18 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, $25\text{ }^\circ\text{C}$): -74.6

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, $-40\text{ }^\circ\text{C}$): 167.8 (CO_2Me), 155.2 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 148.6 ($\text{C}=\text{CH}(\text{TMS})$), 135.3 (C quaternary Ph), 133.3 ($\text{C}=\text{CH}(\text{TMS})$), 128.7 (C aromatic para), 128.3 (C aromatic meta), 128.1 (C aromatic ortho), 125.0 (q, CF_3 , $^1J_{\text{C-F}} = 285\text{ Hz}$), 68.4 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 64.2 (q, $^2J_{\text{C-F}} = 27\text{ Hz}$, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 52.4 (CO_2CH_3), 49.7 (NCH_2), 30.5 ($\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CH}_2$), 23.8 (CH_2 cyclopropane), 23.5 (C quaternary cyclopropane), 11.8 (CH cyclopropane), 0.0 ($\text{Si}(\text{CH}_3)_3$)

Major rotamer:

^1H (CDCl_3 , 300 MHz, $-40\text{ }^\circ\text{C}$): 7.36 (m, 5H, Ph), 6.58 (d, 1H, $^3J = 14.3\text{ Hz}$, $\text{HC}=\text{CH}(\text{TMS})$), 5.63 (d, 1H, $^3J = 14.3\text{ Hz}$, $\text{HC}=\text{CH}(\text{TMS})$), 5.28 (d, 1H, $^2J = 12.3\text{ Hz}$, NCO_2CHHPh), 5.06 (d, 1H, $^2J = 12.3\text{ Hz}$, NCO_2CHHPh), 4.58 (d, 1H, $^2J = 14.8\text{ Hz}$, NCHH), 3.77 (s, 3H, CO_2CH_3), 2.62 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 2.56 (d, 1H, $^2J = 14.8\text{ Hz}$, NCHH), 1.49 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 1.20 (m, 1H, CHH cyclopropane), 0.89 (m, 1H, CH cyclopropane), 0.62 (app. d, 1H, $^3J = 4.8\text{ Hz}$, CHH cyclopropane), 0.13 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, $25\text{ }^\circ\text{C}$): -75.3

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, $-40\text{ }^\circ\text{C}$): 167.7 (CO_2Me), 155.0 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 148.9 ($\text{C}=\text{CH}(\text{TMS})$), 136.1 (C quaternary Ph), 133.8 ($\text{C}=\text{CH}(\text{TMS})$), 128.5 (C aromatic para), 128.3 (C aromatic meta), 128.1 (C aromatic ortho), 124.9 (q, CF_3 , $^1J_{\text{C-F}} = 286\text{ Hz}$), 67.8 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 63.9 (q, $^2J_{\text{C-F}} = 27\text{ Hz}$, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 52.6 (CO_2CH_3), 50.2 (NCH_2), 31.6 ($\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CH}_2$), 24.2 (CH_2 cyclopropane), 23.3 (C quaternary cyclopropane), 12.0 (CH cyclopropane), 0.0 ($\text{Si}(\text{CH}_3)_3$)

Synthesis and characterization of 4c:

4c was synthesized as mentioned above using 0.253 g (0.64 mmol) of **2c**, 400 μL (0.80 mmol) of a 2.0 M (trimethylsilyl)diazomethane solution in ether, 10 mL of added degassed diethyl ether and 12 mg of $\text{Cp}^*\text{RuCl}(\text{COD})$, yielding 0.226 g (73%) of the desired diastereoisomers in a **A**:**B** ratio of 67:33. The two diastereoisomers were separated over silica gel chromatography using a 20:80 ether:pentane eluting mixture; diastereoisomer **A** (151 mg, 48%), **B** (75 mg, 25%).

Diastereoisomer A of 4c:

^1H (CDCl_3 , 300 MHz, 25 °C): 7.74 (d, 2H, $^3J = 8.2$ Hz, ortho Ts), 7.27 (d, 2H, $^3J = 8.2$ Hz, meta Ts), 6.52 (d, 1H, $^3J = 14.2$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.36 (d, 1H, $^3J = 14.2$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 4.03 (d, 1H, $^2J = 14.9$ Hz, NCHH), 3.93 (s, 3H, CO_2CH_3), 2.66 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 2.60 (d, 1H, $^2J = 14.9$ Hz, NCHH), 2.40 (s, 3H, CH_3 Ts), 1.45 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 1.22 (m, 1H, CHH cyclopropane), 0.90 (m, 1H, CH cyclopropane), 0.54 (m, 1H, CHH cyclopropane), 0.10 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 25 °C): -73.9

^{13}C { ^1H } (CDCl_3 , 75 MHz, 25 °C): 168.0 (CO_2Me), 148.5 ($\text{C}=\text{CH}(\text{TMS})$), 143.6 (C quaternary Ts para), 137.2 (C quaternary Ts ipso), 132.4 ($\text{C}=\text{CH}(\text{TMS})$), 129.4 (CH Ts meta), 127.7 (CH Ts ortho), 124.4 (q, CF_3 , $^1J_{\text{C-F}} = 288$ Hz), 64.5 (q, $^2J_{\text{C-F}} = 27$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 52.9 (CO_2CH_3), 51.4 (NCH_2), 32.3 ($\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CH}_2$), 24.5 (CH_2 cyclopropane), 23.3 (C quaternary cyclopropane), 21.4 (CH_3 Ts), 11.4 (CH cyclopropane), 0.0 ($\text{Si}(\text{CH}_3)_3$)

Diastereoisomer B of 4c:

^1H (CDCl_3 , 300 MHz, 25 °C): 7.79 (d, 2H, $^3J = 8.3$ Hz, ortho Ts), 7.30 (d, 2H, $^3J = 8.3$ Hz, meta Ts), 6.17 (d, 1H, $^3J = 14.4$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.46 (d, 1H, $^3J = 14.4$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 3.89 (s, 3H, CO_2CH_3), 3.75 (d, 1H, $^2J = 13.7$ Hz, NCHH), 3.12 (d, 1H, $^2J = 13.7$ Hz, NCHH), 2.79 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 2.44 (s, 3H, CH_3 Ts), 1.70 (m, 1H, $\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CHH}$), 1.11 (m, 1H, CHH cyclopropane), 0.89 (m, 1H, CH cyclopropane), 0.82 (m, 1H, CHH cyclopropane), 0.07 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 25 °C): -69.1

^{13}C { ^1H } (CDCl_3 , 75 MHz, 25 °C): 168.7 (CO_2Me), 148.1 ($\text{C}=\text{CH}(\text{TMS})$), 143.9 (C quaternary Ts para), 136.9 (C quaternary Ts ipso), 134.1 ($\text{C}=\text{CH}(\text{TMS})$), 129.5 (CH Ts meta), 127.8 (CH Ts ortho), 124.4 (q, CF_3 , $^1J_{\text{C-F}} = 288$ Hz), 64.9 (q, $^2J_{\text{C-F}} = 27$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 53.3 (CO_2CH_3), 51.6 (NCH_2), 32.9 ($\text{NC}(\text{CF}_3)(\text{CO}_2\text{Me})\text{CH}_2$), 23.0 (CH_2 cyclopropane), 22.8 (C quaternary cyclopropane), 21.6 (CH_3 Ts), 12.9 (CH cyclopropane), 0.0 ($\text{Si}(\text{CH}_3)_3$)

Synthesis and characterization of 5b:

5b was synthesized as mentioned above using 0.310 g (0.87 mmol) of **3b**, 500 μL (1.00 mmol) of a 2.0 M (trimethylsilyl)diazomethane solution in ether, 1 mL of added degassed diethyl ether and 16 mg of $\text{Cp}^*\text{RuCl}(\text{COD})$, yielding 0.232 g (60%) of the desired diastereoisomers in a **A**:**B** ratio of 38:62. The two diastereoisomers were separated over silica gel chromatography using a 10:90 ether:pentane eluting mixture; diastereoisomer **A** (88 mg, 23%), **B** (144 mg, 37%).

HRMS calcd for $\text{C}_{21}\text{H}_{26}\text{F}_3\text{NO}_4\text{Si}$ (M^+) 441.15832, found: 441.1558.

Diastereoisomer A of 5b:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.35 (m, 5H, Ph), 6.35 (d, 1H, $^3J = 14.5$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.72 (d, 1H, $^3J = 14.5$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.16 (m, 2H, NCO_2CHHPh), 3.86 (d, 1H, $^2J = 10.2$ Hz, NCHH), 3.85 (s, 3H, CO_2CH_3), 3.63 (d, 1H, $^2J = 10.2$ Hz, NCHH), 1.85 (m, 1H, CH cyclopropane), 1.45 (m, 1H, CHH cyclopropane), 1.26 (m, 1H, CHH cyclopropane), 0.17 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -64.2 and -64.3

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, 20 °C): 164.0 (CO_2Me), 153.1 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 142.8 ($\text{C}=\text{CH}(\text{TMS})$), 135.6 ($\text{C}=\text{CH}(\text{TMS})$), 128.2 (C aromatic meta), 128.0 (C aromatic ortho), 127.4 (C aromatic para), 67.3 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 53.7 (NCH_2), 53.4 (CO_2CH_3), 16.0 (CH_2 cyclopropane), 0.0 ($\text{Si}(\text{CH}_3)_3$)

Diastereoisomer B of 5b: (2 rotamers in a 10:13 ratio at 20 °C)

Minor rotamer:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.35 (m, 5H, Ph), 6.44 (d, 1H, $^3J = 14.5$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.77 (d, 1H, $^3J = 14.5$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.18 (d, 1H, $^2J = 12.5$ Hz, NCO_2CHHPh), 5.00 (d, 1H, $^2J = 12.5$ Hz, NCO_2CHHPh), 3.96 (d, 1H, $^2J = 10.5$ Hz, NCHH), 3.65 (d, 1H, $^2J = 10.5$ Hz, NCHH), 3.40 (s, 3H, CO_2CH_3), 1.81 (m, 1H, CH cyclopropane), 1.45 (m, 1H, CHH cyclopropane), 1.26 (m, 1H, CHH cyclopropane), 0.17 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -73.0

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, 20 °C): 165.1 (CO_2Me), 153.1 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 142.9 ($\text{C}=\text{CH}(\text{TMS})$), 135.5 ($\text{C}=\text{CH}(\text{TMS})$), 135.3 (C quaternary Ph), 128.2 (C aromatic meta), 128.0 (C aromatic ortho), 127.4 (C aromatic para), 124.7 (q, CF_3 , $^1J_{\text{C-F}} = 288$ Hz), 69.8 (q, $^2J_{\text{C-F}} = 29$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 67.8 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 54.1 (NCH_2), 52.2 (CO_2CH_3), 29.5 (C quaternary cyclopropane), 28.8 (CH cyclopropane), 15.7 (CH_2 cyclopropane), 0.0 ($\text{Si}(\text{CH}_3)_3$)

Major rotamer:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.35 (m, 5H, Ph), 6.46 (d, 1H, $^3J = 14.5$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.74 (d, 1H, $^3J = 14.5$ Hz, $\text{HC}=\text{CH}(\text{TMS})$), 5.19 (d, 1H, $^2J = 12.5$ Hz, NCO_2CHHPh), 5.10 (d, 1H, $^2J = 12.5$ Hz, NCO_2CHHPh), 3.86 (d, 1H, $^2J = 10.2$ Hz, NCHH), 3.85 (s, 3H, CO_2CH_3), 3.63 (d, 1H, $^2J = 10.2$ Hz, NCHH), 1.81 (m, 1H, CH cyclopropane), 1.45 (m, 1H, CHH cyclopropane), 1.26 (m, 1H, CHH cyclopropane), 0.17 (s, 9H, $\text{Si}(\text{CH}_3)_3$)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -72.8

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, 20 °C): 165.3 (CO_2Me), 153.3 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 142.9 ($\text{C}=\text{CH}(\text{TMS})$), 135.6 (C quaternary Ph), 135.1 ($\text{C}=\text{CH}(\text{TMS})$), 128.2 (C aromatic meta), 128.0 (C aromatic ortho), 127.4 (C aromatic para), 124.3 (q, CF_3 , $^1J_{\text{C-F}} = 288$ Hz), 70.1 (q, $^2J_{\text{C-F}} = 29$ Hz,

(F₃C)C(CO₂Me)), 67.3 (NCO₂CH₂Ph), 53.5 (NCH₂), 52.6 (CO₂CH₃), 30.5 (C quaternary cyclopropane), 29.8 (CH cyclopropane), 15.5 (CH₂ cyclopropane), 0.0 (Si(CH₃)₃)

Synthesis and characterization of 5c:

5c was synthesized as mentioned above using 0.166 g (0.44 mmol) of **3c**, 260 μ L (0.52 mmol) of a 2.0 M (trimethylsilyl)diazomethane solution in ether, 4 mL of added degassed diethyl ether and 9 mg of Cp*RuCl(COD), yielding 0.120 g (59%) of the desired diastereoisomers in a **A**:**B** ratio of 38:62. The two diastereoisomers were separated over silica gel chromatography using a 20:80 ether:pentane eluting mixture; diastereoisomer **A** (43 mg, 21%), **B** (77 mg, 38%).

Diastereoisomer A of 5c:

¹H (CDCl₃, 300 MHz, 20 °C): 7.71 (d, 2H, ³J = 8.2 Hz, ortho Ts), 7.32 (d, 2H, ³J = 8.2 Hz, meta Ts), 6.39 (d, 1H, ³J = 14.5 Hz, HC=CH(TMS)), 5.76 (d, 1H, ³J = 14.5 Hz, HC=CH(TMS)), 4.12 (d, 1H, ²J = 8.9 Hz, NCHH), 3.85 (s, 3H, CO₂CH₃), 3.68 (d, 1H, ²J = 8.9 Hz, NCHH), 2.45 (s, 3H, CH₃ Ts), 1.77 (m, 1H, CH cyclopropane), 1.21 (m, 2H, CHH cyclopropane), 0.16 (s, 9H, Si(CH₃)₃)

¹⁹F (CDCl₃, 188 MHz, 20 °C): -65.2

¹³C {¹H} (CDCl₃, 75 MHz, 20 °C): 167.8 (CO₂Me), 143.5 (C quaternary Ts para), 142.4 (C=CH(TMS)), 136.7 (C quaternary Ts ipso), 135.5 (C=CH(TMS)), 129.1 (CH Ts meta), 126.9 (CH Ts ortho), 123.0 (q, CF₃, ¹J_{C-F} = 286 Hz), 72.7 (q, ²J_{C-F} = 25 Hz, (F₃C)C(CO₂Me)), 57.0 (NCH₂), 53.0 (CO₂CH₃), 31.8 (CH cyclopropane), 27.6 (C quaternary cyclopropane), 21.2 (CH₃ Ts), 15.5 (CH₂ cyclopropane), 0.0 (Si(CH₃)₃)

Diastereoisomer B of 5c:

¹H (CDCl₃, 300 MHz, 20 °C): 7.80 (d, 2H, ³J = 8.2 Hz, ortho Ts), 7.33 (d, 2H, ³J = 8.2 Hz, meta Ts), 6.32 (d, 1H, ³J = 14.4 Hz, HC=CH(TMS)), 5.71 (d, 1H, ³J = 14.4 Hz, HC=CH(TMS)), 3.93 (s, 3H, CO₂CH₃), 3.46 (d, 1H, ²J = 8.4 Hz, NCHH), 3.36 (d, 1H, ²J = 8.4 Hz, NCHH), 2.45 (s, 3H, CH₃ Ts), 1.83 (m, 1H, CH cyclopropane), 1.45 (m, 1H, CHH cyclopropane), 1.24 (m, 1H, CHH cyclopropane) 0.09 (s, 9H, Si(CH₃)₃)

¹⁹F (CDCl₃, 188 MHz, 20 °C): -72.1

¹³C {¹H} (CDCl₃, 75 MHz, 20 °C): 165.6 (CO₂Me), 143.9 (C quaternary Ts para), 142.9 (C=CH(TMS)), 135.8 (C=CH(TMS)), 135.3 (C quaternary Ts ipso), 129.3 (CH Ts meta), 127.8 (CH Ts ortho), 124.4 (q, CF₃, ¹J_{C-F} = 288 Hz), 72.1 (q, ²J_{C-F} = 29 Hz, (F₃C)C(CO₂Me)), 53.8 (NCH₂), 53.1 (CO₂CH₃), 30.4 (C quaternary cyclopropane), 29.4 (CH cyclopropane), 21.3 (CH₃ Ts), 15.1 (CH₂ cyclopropane), 0.0 (Si(CH₃)₃)

Synthesis and characterization of 7:

In a Schlenk tube under inert atmosphere, to a solution of 0.300g of enyne **6** (0.77 mmol) in degassed dioxane (1 mL) was added 0.9 mL (1.80 mmol) of the 2.0 M (trimethylsilyl)diazomethane solution in hexanes. 14 mg of the precatalyst Cp*RuCl(COD) was then introduced. The mixture was stirred at 60 °C. Reaction completion was monitored using GC. 0.132 g of **7** (36%) was isolated after silica gel column chromatography with a 10:90 ether:pentane eluting mixture.

¹H (CDCl₃, 300 MHz, 25 °C): 7.84 (d, 2H, ³J = 8.3 Hz, ortho Ts), 7.29 (d, 2H, ³J = 8.3 Hz, meta Ts), 6.29 (d, 1H, ³J = 14.6 Hz, HC=CH(TMS)), 5.56 (d, 1H, ³J = 14.6 Hz, HC=CH(TMS)), 4.06 (dd, 1H, ²J = 15.0 Hz, ³J = 7.5 Hz, NCHH), 3.84 (s, 3H, CO₂CH₃), 2.87 (d, ²J = 15.5 Hz, 1H, NC(CF₃)(CO₂Me)CHH), 2.29 (d, 1H, ²J = 15.0 Hz, ³J = 9.5 Hz, NCHH), 2.41 (s, 3H, CH₃ Ts), 1.71 (d, ²J = 15.5 Hz, 1H, NC(CF₃)(CO₂Me)CHH), 1.45 (m, 1H, CH cyclopropane), 1.02 (dd, J = 7.7 Hz, J = 4.7 Hz, 1H, CH cyclopropane), 0.51 (dd, J = 4.8 Hz, J = 4.7 Hz, 1H, CH cyclopropane), 0.12 (s, 9H, Si(CH₃)₃)

Synthesis and characterization of 8b:

8b was synthesized as mentioned above using 0.331 g (0.93 mmol) of **3b**, 117 μL (1.11 mmol) of ethyldiazoacetate, 1 mL of degassed dioxane and 18 mg of Cp*RuCl(COD), yielding 0.250 g (60%) of the desired diastereoisomers in a **A**:**B** ratio of 42:58. The two diastereoisomers were separated over silica gel chromatography using a 20:80 ether:pentane eluting mixture; diastereoisomer **A** (105 mg, 25%), **B** (145 mg, 35%).

HRMS calcd for C₂₁H₂₂F₃NO₆ (M⁺) 441.13992, found: 441.1387.

Diastereoisomer A of 8b:

¹H (CDCl₃, 300 MHz, 20 °C): 7.37 (m, 5H, Ph), 6.65 (d, 1H, ³J = 15.8 Hz, HC=CH(CO₂Et)), 5.85 (d, 1H, ³J = 15.8 Hz, HC=CH(CO₂Et)), 5.17 (m, 2H, NCO₂CH₂Ph), 4.20 (q, 2H, ³J = 7.1 Hz, CO₂CH₂CH₃), 3.98 (d, 1H, ²J = 10.0 Hz, NCHH), 3.89 (d, 1H, ²J = 10.0 Hz, NCHH), 3.77 (s, 3H, CO₂CH₃), 2.18 (m, 1H, CH cyclopropane), 1.47 (m, 1H, CHH cyclopropane), 1.30 (m, 1H, CHH cyclopropane), 1.28 (t, 3H, ³J = 7.1 Hz, CO₂CH₂CH₃)

¹⁹F (CDCl₃, 188 MHz, 20 °C): -64.2

¹³C {¹H} (CDCl₃, 75 MHz, 20 °C): 167.1 (CO₂Me), 165.9 (CO₂Et), 155.3 (NCO₂CH₂Ph), 147.0 (C=CH(CO₂Et)), 135.7 (C quaternary Ph), 128.5 (C aromatic meta), 128.3 (C aromatic ortho), 128.2 (C aromatic para), 123.2 (q, CF₃, ¹J_{C-F} = 285 Hz), 120.4 (C=CH(CO₂Et)), 73.2 (q, ²J_{C-F} = 31 Hz, (F₃C)C(CO₂Me)), 67.9 (NCO₂CH₂Ph), 60.6 (CO₂CH₂CH₃), 53.5 (CO₂CH₃), 53.0 (NCH₂), 33.5 (CH cyclopropane), 26.9 (C quaternary cyclopropane), 16.6 (CH₂ cyclopropane), 14.2 (CO₂CH₂CH₃)

Diastereoisomer B of 8b: (2 rotamers in a 10:12 ratio at 20 °C)

Minor rotamer:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.34 (m, 5H, Ph), 6.70 (d, 1H, $^3J = 15.8$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 5.88 (d, 1H, $^3J = 15.8$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 5.18 (d, 1H, $^2J = 11.9$ Hz, NCO_2CHHPh), 5.00 (d, 2H, $^2J = 11.9$ Hz, NCO_2CHHPh), 4.21 (q, 2H, $^3J = 7.2$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 4.00 (d, 1H, $^2J = 10.4$ Hz, NCHH), 3.84 (d, 1H, $^2J = 10.4$ Hz, NCHH), 3.38 (s, 3H, CO_2CH_3), 2.15 (m, 1H, CH cyclopropane), 1.62 (m, 1H, CHH cyclopropane), 1.30 (t, 3H, $^3J = 7.2$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 1.27 (m, 1H, CHH cyclopropane)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -73.1

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, 20 °C): 165.9 (CO_2Et), 165.1 (CO_2Me), 153.3 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 146.3 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 135.1 (C quaternary Ph), 128.6 (C aromatic meta), 128.4 (C aromatic ortho), 128.2 (q, CF_3 , $^1J_{\text{C-F}} = 287$ Hz), 128.0 (C aromatic para), 120.4 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 70.0 (q, $^2J_{\text{C-F}} = 28$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 68.3 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 60.6 ($\text{CO}_2\text{CH}_2\text{CH}_3$), 52.7 (CO_2CH_3), 51.7 (NCH_2), 31.6 (CH cyclopropane), 28.5 (C quaternary cyclopropane), 16.4 (CH_2 cyclopropane), 14.2 ($\text{CO}_2\text{CH}_2\text{CH}_3$)

Major rotamer:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.36 (m, 5H, Ph), 6.70 (d, 1H, $^3J = 15.8$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 5.84 (d, 1H, $^3J = 15.8$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 5.15 (s, 2H, $\text{NCO}_2\text{CH}_2\text{Ph}$), 4.20 (q, 2H, $^3J = 7.1$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 3.91 (d, 1H, $^2J = 9.8$ Hz, NCHH), 3.85 (s, 3H, CO_2CH_3), 3.82 (d, 1H, $^2J = 9.8$ Hz, NCHH), 2.15 (m, 1H, CH cyclopropane), 1.70 (m, 1H, CHH cyclopropane), 1.30 (m, 1H, CHH cyclopropane), 1.30 (t, 3H, $^3J = 7.2$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -73.0

^{13}C $\{^1\text{H}\}$ (CDCl_3 , 75 MHz, 20 °C): 165.8 (CO_2Et), 164.9 (CO_2Me), 153.5 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 146.3 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 135.7 (C quaternary Ph), 128.5 (C aromatic meta), 128.4 (C aromatic ortho), 128.2 (q, CF_3 , $^1J_{\text{C-F}} = 287$ Hz), 128.0 (C aromatic para), 120.3 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 70.0 (q, $^2J_{\text{C-F}} = 28$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 67.9 ($\text{NCO}_2\text{CH}_2\text{Ph}$), 60.6 ($\text{CO}_2\text{CH}_2\text{CH}_3$), 53.2 (CO_2CH_3), 51.0 (NCH_2), 32.8 (CH cyclopropane), 29.6 (C quaternary cyclopropane), 16.3 (CH_2 cyclopropane), 14.2 ($\text{CO}_2\text{CH}_2\text{CH}_3$)

Synthesis and characterization of 8c:

8c was synthesized as mentioned above using 0.170 g (0.45 mmol) of **3c**, 60 μL (0.57 mmol) of ethyldiazoacetate, 2 mL of degassed dioxane and 9 mg of $\text{Cp}^*\text{RuCl}(\text{COD})$, yielding 0.161 g (80%) of the desired diastereoisomers in a **A**:**B** ratio of 31:69. The two diastereoisomers were separated over silica gel chromatography using a 30:70 ether:pentane eluting mixture; diastereoisomer **A** (50 mg, 25%), **B** (111 mg, 55%).

HRMS calcd for $\text{C}_{18}\text{H}_{19}\text{F}_3\text{NO}_4\text{S}$ ($[\text{M} - \text{C}_2\text{H}_3\text{O}_2]^+$) 402.09869, found: 402.0970.

Diastereoisomer A of 8c:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.72 (d, 2H, $^3J = 8.2$ Hz, ortho Ts), 7.32 (d, 2H, $^3J = 8.2$ Hz, meta Ts), 6.66 (d, 1H, $^3J = 15.9$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 5.88 (d, 1H, $^3J = 15.9$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 4.28 (d, 1H, $^2J = 8.6$ Hz, NCHH), 4.21 (q, 2H, $^3J = 7.1$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 3.84 (s, 3H, CO_2CH_3), 3.72 (d, 1H, $^2J = 8.6$ Hz, NCHH), 2.45 (s, 3H, CH_3 Ts), 2.10 (m, 1H, CH cyclopropane), 1.40 (m, 1H, CHH cyclopropane), 1.30 (t, 3H, $^3J = 7.1$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 1.23 (m, 1H, CHH cyclopropane)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -64.9

^{13}C { ^1H } (CDCl_3 , 75 MHz, 20 °C): 167.3 (CO_2Me), 165.8 (CO_2Et), 145.8 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 144.8 (C quaternary Ts para), 136.9 (C quaternary Ts ipso), 129.5 (CH Ts meta), 127.3 (CH Ts ortho), 123.1 (q, CF_3 , $^1J_{\text{C-F}} = 286$ Hz), 120.7 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 73.0 (q, $^2J_{\text{C-F}} = 30$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 60.6 ($\text{CO}_2\text{CH}_2\text{CH}_3$), 54.6 (NCH $_2$), 53.5 (CO_2CH_3), 34.2 (CH cyclopropane), 26.6 (C quaternary cyclopropane), 21.5 (CH_3 Ts), 16.0 (CH_2 cyclopropane), 14.2 ($\text{CO}_2\text{CH}_2\text{CH}_3$)

Diastereoisomer B of 8c:

^1H (CDCl_3 , 300 MHz, 20 °C): 7.83 (d, 2H, $^3J = 8.2$ Hz, ortho Ts), 7.35 (d, 2H, $^3J = 8.2$ Hz, meta Ts), 6.63 (d, 1H, $^3J = 15.9$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 5.77 (d, 1H, $^3J = 15.9$ Hz, $\text{HC}=\text{CH}(\text{CO}_2\text{Et})$), 4.19 (q, 2H, $^3J = 7.1$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 3.95 (s, 3H, CO_2CH_3), 3.59 (d, 1H, $^2J = 8.3$ Hz, NCHH), 3.45 (d, 1H, $^2J = 8.3$ Hz, NCHH), 2.46 (s, 3H, CH_3 Ts), 2.16 (m, 1H, CH cyclopropane), 1.63 (m, 1H, CHH cyclopropane), 1.19 (t, 3H, $^3J = 7.1$ Hz, $\text{CO}_2\text{CH}_2\text{CH}_3$), 1.16 (m, 1H, CHH cyclopropane)

^{19}F (CDCl_3 , 188 MHz, 20 °C): -72.2

^{13}C { ^1H } (CDCl_3 , 75 MHz, 20 °C): 164.6 (CO_2Et), 164.2 (CO_2Me), 144.6 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 143.5 (C quaternary Ts para), 134.2 (C quaternary Ts ipso), 128.7 (CH Ts meta), 127.2 (CH Ts ortho), 127.2 (q, CF_3 , $^1J_{\text{C-F}} = 288$ Hz), 119.6 ($\text{C}=\text{CH}(\text{CO}_2\text{Et})$), 71.0 (q, $^2J_{\text{C-F}} = 29$ Hz, $(\text{F}_3\text{C})\text{C}(\text{CO}_2\text{Me})$), 59.6 ($\text{CO}_2\text{CH}_2\text{CH}_3$), 52.5 (CO_2CH_3), 50.3 (NCH $_2$), 31.1 (CH cyclopropane), 28.4 (C quaternary cyclopropane), 20.6 (CH_3 Ts), 14.6 (CH_2 cyclopropane), 13.2 ($\text{CO}_2\text{CH}_2\text{CH}_3$)

Structural data for minor diastereoisomer of 5c

Crystal data for minor diastereoisomer A of 5c: $\text{C}_{20}\text{H}_{26}\text{F}_3\text{NO}_4\text{SSi}$, $M = 461.57$, white needles, monoclinic, space group $\text{P}2_1/c$, $a = 14.5342(4)$ Å, $b = 11.9275(3)$ Å, $c = 14.7603(3)$ Å, $\beta = 117.704(1)^\circ$, $V = 2265.5(1)$ Å 3 , $Z = 4$, $D_x = 1.353$ mg.m $^{-3}$, $\lambda(\text{Mo-K}\alpha) = 0.71073$ Å, $\mu = 2.46$

cm^{-1} , $T = 120 \text{ K}$, 5182 independent reflections, $R_{\text{int}} = 0.000$, $R = 0.098$. The structure was solved with SIR-97 (Altomare & al., 1998) which reveals the non hydrogen atoms of the molecule. After anisotropic refinement, many hydrogen atoms may be found with a Fourier Difference. The whole structure was refined with SHELXL97 (Sheldrick, 1997) by the full-matrix least-square techniques. CCDC 241321 contains the supplementary crystallographic data for this structure. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

Figure: minor diastereoisomer of **5c**