Supporting Information for

Copper-Catalyzed Radical 1, 2-Carbotrifluoromethylselenolation of Alkenes
under Ambient Conditions


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1. General information

All reactions were carried out under argon atmosphere using Schlenk techniques unless otherwise noted. Reagents were purchased at the highest commercial quality and used without further purification, unless otherwise stated. \(3a\) and \(3e\) was purchased from J&K. \(3b\) was purchased from Admas. \(3c\) was purchased from TCI. \(3d\) was purchased from Macklin. Analytical thin layer chromatography (TLC) was performed on precoated silica gel 60 GF254 plates. Flash column chromatography was performed using Tsingdao silica gel (60, particle size 0.040–0.063 mm). Visualization on TLC was achieved by use of UV light (254 nm), iodine, or basic KMnO₄ indicator. NMR spectra were recorded on Bruker DRX-400 and DPX-600 spectrometers at 400 or 600 MHz for \(^1\)H NMR, 100 or 150 MHz for \(^{13}\)C NMR, and 376 MHz for \(^{19}\)F NMR, respectively, in CDCl₃ with tetramethylsilane (TMS) as an internal standard. \((\text{NMe}_4)\text{SeCF}_3\) was synthesized according to the literature.¹ The chemical shifts were expressed in ppm and coupling constants were given in Hz. Data for \(^1\)H NMR were recorded as follows: chemical shift (ppm), multiplicity (s, singlet; d, doublet; t, triplet; q, quarter; p, pentet, m, multiplet; br, broad), coupling constant (Hz), integration. Data for \(^{13}\)C NMR were reported in terms of chemical shift (δ, ppm). EPR spectra were recorded on Bruker EMX⁺⁺-10/12. Mass spectrometric data were obtained using Bruker Apex IV RTMS.
2. The synthesis of substrates, (Me₄N)SeCF₃ and L8

Most of alkenes were purchased from commercial sources. The alkenes 1b, 1c, 1d, 1e, were synthesized according to the reported literature and the spectra were the same as that reported in literature.

(Me₄N)SeCF₃ was synthesized according to the reported literature. An oven-dried, 50-mL Schlenk flask equipped with a magnetic stirrer and a stopcock was flushed with Argon. To a suspension of (preferred) red selenium (1.58 g, 20.0 mmol) in 25 mL glyme, Me₃SiCF₃ (3.104 mL, 21.0 mmol) was added using an Eppendorf pipette. The reaction mixture was cooled to −78 °C using a dry ice bath. NMe₄F (1.86 g, 20.0 mmol) was added in one portion under a strong Argon flow and with vigorous stirring. The temperature was held for approximately 1 h and then allowed to warm to room temperature overnight. The color of the suspension changed during this period from dark red to gray. The solution was decanted and the remaining solid was dried in vacuo. The gray residue was extracted with two portions of 5 mL MeCN. The combined solution was moved solvent by reduced pressure distillation and (Me₄N)SeCF₃ was dried in vacuo in an average

![Chemical structures and reactions](https://example.com/structures.png)
yield of 60%. The spectra of 2 was the same as that reported in literature.

**L8** was synthesized according to the reported literature.\(^6\)

![Chemical Structure](image)

(1) Synthesis of l-methylpyrrolidine-2-carboxylic acid.

A solution of pyrrolidine-2-carboxylic acid (5.4 g, 46.96 mmol), aqueous formaldehyde solution (37%-40%, 1 mL), catalytic CH\(_3\)COOH and Pd/C (1 g, 10% weight) in MeOH (100 mL) was stirred under H\(_2\) (1 atm) for 2 h. The completion of reaction was monitored by LC-MS. The l-methylpyrrolidine-2-carboxylic acid was removed by filtration, and the filtrate was concentrated to give 5.8 g of the desired product, which was directly used for the next step without further purification.

(2) Synthesis of **L8**.

To a solution of l-methylpyrrolidine-2-carboxylic acid (0.37 g, 2.9 mmol) in DCM (10.0 mL) at 0 °C was added isobutyl chloroformate (0.42 mL, 3.2 mmol) and triethylamine (0.45 mL, 3.2 mmol). After stirring for 20 min at 0 °C, aniline (0.95 g, 3.2 mmol) was added, and the reaction was warmed to rt and stirred overnight. The pure product (**L8**) was isolated by flash column chromatography (petroleum ether/ethyl acetate = 4:1) in an average yield of 35%.

The spectra of **L8** was the same as that reported in literature.\(^6\)
3. Typical procedure for Carbotrifluoromethylselenolation of Alkenes

Into a 10 mL sealed tube were added alkene 1 (0.2 mmol), (Me₄N)SeCF₃ (66 mg, 0.3 mmol), ICF₂CO₂Et (150 mg, 0.6 mmol), Cu₂O (2.9 mg, 0.02 mmol), L₈ (11.6 mg, 0.03 mmol), Cs₂CO₃ (65 mg, 0.2 mmol) and anhydrous 1,4-dioxane (3 mL) under argon atmosphere. The tube was sealed and the reaction mixture was stirred at room temperature for 48 h. After the completion of reaction, the pure product was isolated by flash column chromatography.

**ethyl 4-([1,1'-biphenyl]-4-yl)-2,2-difluoro-4-((trifluoromethyl)thio)butanoate (4)**

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 4 (81.1 mg, 90%) as a slightly green liquid. ¹H NMR (400 MHz, CDCl₃) (ppm) 7.68 – 7.53 (m, 4H), 7.54 – 7.34 (m, 5H), 4.91 (dd, J = 10.9, 4.1 Hz, 1H), 4.08 – 3.96 (m, 2H), 3.33 – 3.16 (m, 1H), 3.16 – 2.85 (m, 1H), 1.25 (t, J = 7.2 Hz, 3H); ¹⁹F NMR (376 MHz, CDCl₃) (ppm) -33.66 (s, 3F), -102.12 (dt, J = 264.5, 13.5 Hz, 1F), -105.87 (ddd, J = 264.5, 17.6, 14.7 Hz, 1F); ¹³C NMR (101 MHz, CDCl₃) (ppm) 163.5 (C-F, 2JCF = 32.0 Hz), 163.2 (C-F, 2JCF = 32.0 Hz), 162.9 (C-F, 2JCF = 32.0 Hz), 141.4, 140.1, 136.8, 128.9, 128.1, 127.7, 127.6, 127.0, 127.8 (C-F, 1JCF = 332.4 Hz), 124.5 (C-F, 1JCF = 332.4 Hz), 121.2 (C-F, 1JCF = 332.4 Hz), 117.9 (C-F, 1JCF = 332.4 Hz), 116.9 (C-F, 1JCF = 254.0 Hz), 114.44 (C-F, 1JCF = 254.0 Hz), 114.42 (C-F, 1JCF = 254.0 Hz), 111.9 (C-F, 1JCF = 254.0 Hz), 63.1, 41.9 (C-F, 2JCF = 23.8 Hz), 41.7 (C-F, 2JCF = 23.8 Hz), 41.4 (C-F, 2JCF = 23.8 Hz), 38.7, 13.7; HRMS (ESI) m/z: [M–H]- Calcd for C₁₉H₁₆O₂F₅Se 451.0241; Found 451.0246.
ethyl 2,2-difluoro-4-(2-methoxyphenyl)-4-((trifluoromethyl)selenyl)butanoate (5)

![Structure of compound 5]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 5 (71.2 mg, 88%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.34 – 7.29 (m, 1H), 7.27 – 7.16 (m, 3H), 5.07 (dd, $J$ = 11.5, 3.3 Hz, 1H), 4.05 – 3.73 (m, 2H), 3.49 – 3.19 (m, 1H), 3.13 – 2.88 (m, 1H), 2.45 (s, 3H), 1.22 (t, $J$ = 7.2 Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -34.11 (s, 3F), -101.93 (dt, $J$ = 262.7, 12.7 Hz, 1F), -106.64 (ddd, $J$ = 262.6, 18.6, 14.9 Hz, 1F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 163.5 (C-F), $^2J$$_{C-F}$ = 32.1 Hz), 163.2 (C-F), $^2J$$_{C-F}$ = 32.1 Hz), 162.9 (C-F), $^2J$$_{C-F}$ = 32.1 Hz), 135.8, 135.1, 131.1, 128.4, 126.8, 126.6, 127.8 (C-F), $^1J$$_{C-F}$ = 332.7 Hz), 124.7 (C-F), $^1J$$_{C-F}$ = 332.7 Hz), 121.4 (C-F), $^1J$$_{C-F}$ = 332.7 Hz), 118.1 (C-F), $^1J$$_{C-F}$ = 332.7 Hz), 116.9 (C-F), $^1J$$_{C-F}$ = 254.1 Hz), 114.43 (C-F), $^1J$$_{C-F}$ = 254.1 Hz), 114.4.0 (C-F), $^1J$$_{C-F}$ = 254.1 Hz), 111.9 (C-F), $^1J$$_{C-F}$ = 254.1 Hz), 63.0, 42.0 (C-F), $^2J$$_{C-F}$ = 23.7 Hz), 41.8 (C-F), $^2J$$_{C-F}$ = 23.7 Hz), 41.5 (C-F), $^2J$$_{C-F}$ = 23.7 Hz), 34.6, 19.1, 13.6; HRMS (ESI) m/z: [M+Na]$^+$ Calcd for C$_{14}$H$_{15}$O$_3$F$_5$NaSe 428.9999; Found 428.9996.

ethyl 2,2-difluoro-4-(3-methoxyphenyl)-4-((trifluoromethyl)selenyl)butanoate (6)

![Structure of compound 6]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 6 (70.6 mg, 86%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.28 (t, $J$ = 7.8 Hz, 1H), 6.93 (d, $J$ = 7.8 Hz, 1H), 6.89 – 6.81 (m, 2H), 4.80 (dd, $J$ = 10.8, 4.1 Hz, 1H), 4.14 – 3.96 (m, 2H), 3.83 (s, 3H), 3.27 – 3.07 (m, 1H), 3.05 – 2.87 (m, 1H), 1.25 (t, $J$ = 7.2 Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.86 (s, 3F), -102.24 (dt, $J$ = 264.7, 13.6 Hz, 1F), -105.95 (ddd, $J$ = 264.8, 17.5, 14.8 Hz, 1F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 163.5 (C-F), $^2J$$_{C-F}$ = 32.1 Hz), 163.2 (C-F), $^2J$$_{C-F}$ = 32.1 Hz), 159.9, 139.4, 130.0, 127.8 (C-F), $^1J$$_{C-F}$ = 332.4 Hz), 124.5 (C-F), $^1J$$_{C-F}$ = 332.4 Hz), 121.2 (C-F), $^1J$$_{C-F}$ = 332.4 Hz), 119.8, 117.9 (C-F), $^1J$$_{C-F}$ = 332.4 Hz).
Hz), 116.9 (C-F, \( J_{C-F} = 253.9 \) Hz), 114.39 (C-F, \( J_{C-F} = 253.9 \) Hz), 114.37 (C-F, \( J_{C-F} = 253.9 \) Hz), 113.8, 113.4, 111.9 (C-F, \( J_{C-F} = 253.9 \) Hz), 63.0, 55.2, 42.0 (C-F, \( J_{C-F} = 23.7 \) Hz), 41.7 (C-F, \( J_{C-F} = 23.7 \) Hz), 41.5 (C-F, \( J_{C-F} = 23.7 \) Hz), 38.9, 13.6; HRMS (ESI) \( m/z: \) [M+Na]\(^+\) Calcd for C\(_{14}\)H\(_{15}\)O\(_3\)F\(_5\)NaSe 428.9999; Found 428.9997.

**ethyl 2,2-difluoro-4-(4-methoxyphenyl)-4-((trifluoromethyl)selanyl)butanoate (7)**

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 7 (70.4 mg, 86%) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (ppm) 7.24 (d, \( J = 8.7 \) Hz, 2H), 6.85 (d, \( J = 8.7 \) Hz, 2H), 4.82 (dd, \( J = 11.0, 4.0 \) Hz, 1H), 4.14 – 3.95 (m, 2H), 3.79 (s, 3H), 3.25 – 3.04 (m, 1H), 3.02 – 2.77 (m, 1H), 1.22 (t, \( J = 7.2 \) Hz, 3H); \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.78 (s, 3F), -102.07 (dt, \( J = 264.3, 13.4 \) Hz, 1F), -106.11 (ddd, \( J = 264.3, 18.0, 14.3 \) Hz, 1F); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) (ppm) 163.5 (C-F, \( J_{C-F} = 32.1 \) Hz), 163.2 (C-F, \( J_{C-F} = 32.1 \) Hz), 162.9 (C-F, \( J_{C-F} = 32.1 \) Hz), 159.6, 129.5, 128.9, 127.9 (C-F, \( J_{C-F} = 332.5 \) Hz), 124.6 (C-F, \( J_{C-F} = 332.5 \) Hz), 121.3 (C-F, \( J_{C-F} = 332.5 \) Hz), 118.0 (C-F, \( J_{C-F} = 332.5 \) Hz), 117.0 (C-F, \( J_{C-F} = 253.9 \) Hz), 114.46 (C-F, \( J_{C-F} = 253.9 \) Hz), 114.44 (C-F, \( J_{C-F} = 253.9 \) Hz), 114.3, 111.9 (C-F, \( J_{C-F} = 253.9 \) Hz), 63.0, 55.3, 42.0 (C-F, \( J_{C-F} = 23.8 \) Hz), 41.8 (C-F, \( J_{C-F} = 23.8 \) Hz), 41.5 (C-F, \( J_{C-F} = 23.8 \) Hz), 38.7, 13.6; HRMS (ESI) \( m/z: \) [M+Na]\(^+\) Calcd for C\(_{14}\)H\(_{15}\)O\(_3\)F\(_5\)NaSe 428.9999; Found 429.0002.

**ethyl 2,2-difluoro-4-(4-phenoxyphenyl)-4-((trifluoromethyl)selanyl)butanoate (8)**

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 8 (77.1 mg, 82%) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (ppm) 7.39 – 7.31 (m, 2H), 7.31 – 7.23 (m, 2H), 7.17 – 7.09 m, 1H), 7.05 – 6.98 (m, 2H), 6.97 – 6.9 (m, 2H), 6.97 – 6.9 (m, 2H), 6.97 – 6.9 (m,
4.84 (dd, J = 10.8, 4.1 Hz, 1H), 4.18 – 3.96 (m, 2H), 3.26 – 3.04 (m, 1H), 3.04 – 2.79 (m, 1H), 1.26 (t, J = 7.2 Hz, 3H); ^1^H NMR (376 MHz, CDCl$_3$) (ppm) -33.69 (s, 3F), -102.47 (dt, J = 264.8, 13.8 Hz, 1F), -105.36 (dt, J = 264.8, 15.6 Hz, 1F); ^1^C NMR (101 MHz, CDCl$_3$) (ppm), 163.5 (C-F, ^2^J$_{C-F}$ = 32.1 Hz), 163.2 (C-F, ^2^J$_{C-F}$ = 32.1 Hz), 162.9 (C-F, ^2^J$_{C-F}$ = 32.1 Hz), 157.6, 156.4, 132.3, 129.9, 129.1, 123.8, 122.8 (q, J = 332.5 Hz), 127.8 (C-F, ^1^J$_{C-F}$ = 332.5 Hz), 124.5 (C-F, ^1^J$_{C-F}$ = 332.5 Hz), 121.2 (C-F, ^1^J$_{C-F}$ = 332.5 Hz), 119.3, 118.7, 117.9 (C-F, ^1^J$_{C-F}$ = 332.5 Hz), 116.9 (C-F, ^1^J$_{C-F}$ = 253.9 Hz), 114.42 (C-F, ^1^J$_{C-F}$ = 253.9 Hz), 114.41 (C-F, ^1^J$_{C-F}$ = 253.9 Hz), 111.9 (C-F, ^1^J$_{C-F}$ = 253.9 Hz), 63.1, 41.9 (C-F, ^2^J$_{C-F}$ = 23.7 Hz), 41.7 (C-F, ^2^J$_{C-F}$ = 23.7 Hz), 41.4 (C-F, ^2^J$_{C-F}$ = 23.7 Hz), 38.5 (C-F, ^2^J$_{C-F}$ = 23.7 Hz), 13.7; HRMS (ESI) m/z: [M+Na]$^+$ Calcd for C$_{19}$H$_{17}$O$_3$F$_5$NaSe 491.0155; Found 491.0154.

ethyl 4-(4-(tert-butyl)phenyl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (9)

\[
\begin{align*}
\text{SeCF}_3 \\
\text{CF}_2\text{CO}_2\text{Et}
\end{align*}
\]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 9 (72.3 mg, 83%) as a slightly green liquid. ^1^H NMR (400 MHz, CDCl$_3$) (ppm) 7.37 (d, J = 8.4 Hz, 2H), 7.27 (d, J = 8.4 Hz, 2H), 4.83 (dd, J = 11.0, 3.9 Hz, 1H), 4.06 – 3.76 (m, 2H), 3.33 – 3.09 (m, 1H), 3.07 – 2.84 (m, 1H), 1.32 (s, 9H), 1.20 (t, J = 7.2 Hz, 3H); ^1^F NMR (376 MHz, CDCl$_3$) (ppm) -33.84 (s, 3F), -101.43 (dt, J = 264.1, 13.6 Hz, 1F), -106.61 (dd, J = 264.1, 19.6, 13.7 Hz, 1F); ^1^C NMR (101 MHz, CDCl$_3$) (ppm) 163.5 (C-F, ^2^J$_{C-F}$ = 32.1 Hz), 163.2 (C-F, ^2^J$_{C-F}$ = 32.1 Hz), 162.9 (C-F, ^2^J$_{C-F}$ = 32.1 Hz), 151.7, 134.4, 127.4, 127.9 (C-F, ^1^J$_{C-F}$ = 332.3 Hz), 125.9, 124.6 (C-F, ^1^J$_{C-F}$ = 332.3 Hz), 121.3 (C-F, ^1^J$_{C-F}$ = 332.3 Hz), 118.0 (C-F, ^1^J$_{C-F}$ = 332.3 Hz), 116.9 (C-F, ^1^J$_{C-F}$ = 253.8 Hz), 114.41 (C-F, ^1^J$_{C-F}$ = 253.8 Hz), 114.39 (C-F, ^1^J$_{C-F}$ = 253.8 Hz), 111.9 (C-F, ^1^J$_{C-F}$ = 253.8 Hz), 62.9, 42.1 (C-F, ^2^J$_{C-F}$ = 23.9 Hz), 41.9 (C-F, ^2^J$_{C-F}$ = 23.9 Hz), 41.6 (C-F, ^2^J$_{C-F}$ = 23.9 Hz), 13.7; HRMS (ESI) m/z: [M+Na]$^+$ Calcd for C$_{19}$H$_{17}$O$_3$F$_5$NaSe 491.0155; Found 491.0154.
ethyl 4-(4-chlorophenyl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (10)

\[
\begin{align*}
&\text{Cl} \\
&\text{SeCF}_3 \\
&\text{CF}_2\text{CO}_2\text{Et}
\end{align*}
\]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 10 (52.2 mg, 63%) as a colourless liquid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (ppm) 7.35 – 7.23 (m, 4H), 4.80 (dd, \(J = 10.7, 4.2 \text{ Hz}, 1\text{H}\)), 4.17 – 3.96 (m, 2H), 3.19 – 2.73 (m, 2H), 1.26 (t, \(J = 7.2 \text{ Hz}, 3\text{H}\)); \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.63 (s, 3F), -102.88 (dt, \(J = 265.4, 14.2 \text{ Hz}, 1\text{F}\)), -105.34 (dt, \(J = 265.8, 15.8 \text{ Hz}, 1\text{F}\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) (ppm) 63.2, 41.6, 41.4, 38.1, 13.7; HRMS (ESI) \(m/z\): [M+Na]\(^+\) Calcd for C\(_{17}\)H\(_{21}\)O\(_2\)F\(_5\)NaSe 455.0519; Found 455.0518.

ethyl 4-(3-bromophenyl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (11)

\[
\begin{align*}
&\text{Br} \\
&\text{SeCF}_3 \\
&\text{CF}_2\text{CO}_2\text{Et}
\end{align*}
\]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 11 (74.1 mg, 81%) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (ppm) 7.53 – 7.48 (m, 1H), 7.48 – 7.42 (m, 1H), 7.32 – 7.18 (m, 2H), 4.78 (dd, \(J = 10.6, 4.3 \text{ Hz}, 1\text{H}\)), 4.25 – 3.99 (m, 2H), 3.23 – 2.82 (m, 2H), 1.29 (t, \(J = 7.2 \text{ Hz}, 3\text{H}\)); \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.64 (s, 3F), -102.64 (dt, \(J = 265.8, 14.0 \text{ Hz}, 1\text{F}\)), -105.48 (dt, \(J = 265.8, 15.9 \text{ Hz}, 1\text{F}\)); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) (ppm) 63.4 (C-F, \(^2\)J\(_{C\text{-F}} = 32.0 \text{ Hz}\)), 163.4 (C-F, \(^2\)J\(_{C\text{-F}} = 32.0 \text{ Hz}\)), 162.8 (C-F, \(^2\)J\(_{C\text{-F}} = 32.0 \text{ Hz}\)), 162.7 (C-F, \(^2\)J\(_{C\text{-F}} = 32.0 \text{ Hz}\)), 161.8 (C-F, \(^2\)J\(_{C\text{-F}} = 32.0 \text{ Hz}\)), 116.8 (C-F, \(^1\)J\(_{C\text{-F}} = 325.6 \text{ Hz}\)), 114.3 (C-F, \(^1\)J\(_{C\text{-F}} = 325.6 \text{ Hz}\)), 111.8 (C-F, \(^1\)J\(_{C\text{-F}} = 325.6 \text{ Hz}\)), 110.8 (C-F, \(^1\)J\(_{C\text{-F}} = 254.6 \text{ Hz}\)), 63.2, 41.6, 41.4 (C-F, \(^2\)J\(_{C\text{-F}} = 25.6 \text{ Hz}\)), 41.1 (C-F, \(^2\)J\(_{C\text{-F}} = 23.6 \text{ Hz}\)), 38.1, 13.7; HRMS (ESI) \(m/z\): [M+Na]\(^+\) Calcd for C\(_{13}\)H\(_{12}\)O\(_2\)Cl\(_3\)F\(_5\)NaSe 432.9503; Found 432.9503.
ethyl 4-(3-cyanophenyl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (12)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 12 (67.3 mg, 84%) as a slightly green liquid. ¹H NMR (400 MHz, CDCl₃) (ppm) 7.69 – 7.65 (m, 1H), 7.64 – 7.58 (m, 2H), 7.49 (t, J = 7.8 Hz, 1H), 4.86 (dd, J = 10.3, 4.6 Hz, 1H), 4.25 – 4.12 (m, 2H), 3.16 – 2.84 (m, 2H), 1.31 (t, J = 7.2 Hz, 3H); ¹³C NMR (101 MHz, CDCl₃) (ppm) 163.3 (C-F, ²J_C-F = 31.9 Hz), 162.9 (C-F, ²J_C-F = 31.9 Hz), 162.6 (C-F, ²J_C-F = 31.9 Hz), 140.6, 132.1, 132.0, 131.1, 129.9, 127.4 (C-F, ¹J_C-F = 332.3 Hz), 124.1 (C-F, ¹J_C-F = 332.3 Hz), 120.8 (C-F, ¹J_C-F = 332.3 Hz), 118.0, 117.5 (C-F, ¹J_C-F = 332.3 Hz), 116.7 (C-F, ¹J_C-F = 253.6 Hz), 114.2 (C-F, ¹J_C-F = 253.6 Hz), 113.2, 111.7 (C-F, ¹J_C-F = 253.6 Hz), 63.4, 41.1 (C-F, ²J_C-F = 23.7 Hz), 40.8 (C-F, ²J_C-F = 23.7 Hz), 40.6 (C-F, ²J_C-F = 23.7 Hz), 37.6, 13.7; HRMS (ESI) m/z: [M+Na]⁺ Calcd for C₁₃H₁₂O₂BrF₅NaSe 476.8998; Found 476.8998.

ethyl 2,2-difluoro-4-(4-nitrophenyl)-4-((trifluoromethyl)selanyl)butanoate (13)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 13 (74.1 mg, 88%) as a slightly green liquid. ¹H NMR (400 MHz, CDCl₃) (ppm)
8.22 (d, J = 8.8 Hz, 2H), 7.54 (d, J = 8.8 Hz, 2H), 4.91 (dd, J = 10.2, 4.7 Hz, 1H), 4.19 (q, J = 7.1 Hz, 2H), 3.24 – 2.78 (m, 2H), 1.30 (t, J = 7.1 Hz, 3H); 19F NMR (376 MHz, CDCl3) (ppm) -33.41 (s, 3F), -104.03 – -104.49 (m, 2F); 13C NMR (101 MHz, CDCl3) (ppm) 163.3 (C-F, 2J_C-F = 31.9 Hz), 162.9 (C-F, 2J_C-F = 31.9 Hz), 162.6 (C-F, 2J_C-F = 31.9 Hz), 147.6, 146.2, 128.6, 124.2, 127.3 (C-F, 1J_C-F = 332.5 Hz), 124.0 (C-F, 1J_C-F = 332.5 Hz), 120.7 (C-F, 1J_C-F = 332.5 Hz), 117.4 (C-F, 1J_C-F = 332.5 Hz), 116.7 (C-F, 1J_C-F = 253.8 Hz), 114.2 (C-F, 1J_C-F = 253.8 Hz), 111.7 (C-F, 1J_C-F = 253.8 Hz), 63.4, 41.0 (C-F, 2J_C-F = 23.6 Hz), 40.8 (C-F, 2J_C-F = 23.6 Hz), 40.5 (C-F, 2J_C-F = 23.6 Hz), 37.6, 13.7; HRMS (ESI) m/z: [M−H] Calcd for C13H11O4NF5Se 419.9779; Found 419.9778.

ethyl 2,2-difluoro-4-(naphthalen-2-yl)-4-((trifluoromethyl)selanyl)butanoate (14)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 14 (74.3 mg, 87%) as a slightly green liquid. 1H NMR (400 MHz, CDCl3) (ppm) 7.89 – 7.73 (m, 4H), 7.57 – 7.46 (m, 2H), 7.46 – 7.39 (m, 1H), 5.00 (dd, J = 10.8, 3.9 Hz, 1H), 3.81 (q, J = 7.1 Hz, 2H), 3.38 – 3.14 (m, 1H), 3.02 (qd, J = 14.6, 4.1 Hz, 1H), 1.08 (t, J = 7.2 Hz, 3H); 19F NMR (376 MHz, CDCl3) (ppm) -33.65 (s, 3F), -101.97 (dt, J = 264.8, 13.4 Hz, 1F), -105.99 (ddd, J = 264.8, 17.2, 15.2 Hz, 1F); 13C NMR (101 MHz, CDCl3) (ppm) 163.5 (C-F, 2J_C-F = 32.1 Hz), 163.2 (C-F, 2J_C-F = 32.1 Hz), 162.9 (C-F, 2J_C-F = 32.1 Hz), 135.1, 133.0, 133.0, 129.0, 127.9, 127.7, 126.8, 126.7, 125.0, 127.8 (C-F, 1J_C-F = 332.0 Hz), 124.5 (C-F, 1J_C-F = 332.0 Hz), 121.2 (C-F, 1J_C-F = 332.0 Hz), 117.9 (C-F, 1J_C-F = 332.0 Hz), 117.0 (C-F, 1J_C-F = 254.1 Hz), 114.46 (C-F, 1J_C-F = 254.1 Hz), 114.44 (C-F, 1J_C-F = 254.1 Hz), 111.9 (C-F, 1J_C-F = 254.1 Hz), 63.0, 41.8 (C-F, 2J_C-F = 23.8 Hz), 41.5 (C-F, 2J_C-F = 23.8 Hz), 41.3 (C-F, 2J_C-F = 23.8 Hz), 39.3, 13.5; HRMS (ESI) m/z: [M+Na]+ Calcd for C17H15O2F5NaSe 449.0046; Found 449.0046.

ethyl 4-(benzo[d][1,3]dioxol-5-yl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (15)
The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 15 (80.4 mg, 95%) as a colourless liquid. \(^1\)H NMR (400 MHz, CDCl\textsubscript{3}) (ppm) 6.85 – 6.73 (m, 3H), 5.99 (s, 2H), 4.80 (dd, \(J = 10.9, 4.1\) Hz, 1H), 4.24 – 4.03 (m, 2H), 3.23 – 3.01 (m, 1H), 3.01 – 2.77 (m, 1H), 1.29 (t, \(J = 7.2\) Hz, 3H); \(^1\)F NMR (376 MHz, CDCl\textsubscript{3}) (ppm) -33.79 (s, 3F), -102.62 (dt, \(J = 264.8, 13.9\) Hz, 1F), -105.72 (ddd, \(J = 264.8, 16.4, 15.4\) Hz, 1F); \(^{13}\)C NMR (101 MHz, CDCl\textsubscript{3}) (ppm) 163.5 (C-F, \(^2J_{C-F} = 32.1\) Hz), 163.2 (C-F, \(^2J_{C-F} = 32.1\) Hz), 162.8 (C-F, \(^2J_{C-F} = 32.1\) Hz), 148.0, 147.7, 131.5, 127.8 (C-F, \(^1J_{C-F} = 332.5\) Hz), 124.5 (C-F, \(^1J_{C-F} = 332.5\) Hz), 121.3, 121.2 (C-F, \(^1J_{C-F} = 332.5\) Hz), 117.9 (C-F, \(^1J_{C-F} = 332.5\) Hz), 116.9 (C-F, \(^1J_{C-F} = 252.0\) Hz), 114.39 (C-F, \(^1J_{C-F} = 252.0\) Hz), 114.38 (C-F, \(^1J_{C-F} = 252.0\) Hz), 111.9 (C-F, \(^1J_{C-F} = 252.0\) Hz), 108.4, 107.8, 101.4, 63.1, 42.0 (C-F, \(^2J_{C-F} = 23.7\) Hz), 41.8 (C-F, \(^2J_{C-F} = 23.7\) Hz), 41.5 (C-F, \(^2J_{C-F} = 23.7\) Hz), 39.1, 13.7; HRMS (ESI) \(m/z\): [M+Na]\(^+\) Calcd for C\textsubscript{14}H\textsubscript{13}O\textsubscript{4}F\textsubscript{5}NaSe 442.9791; Found 442.9791.

ethyl-2,2-difluoro-4-(14-methyl-15-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-3-yl)-4-((trifluoromethyl)selanyl)butanoate (16)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 5:1) to afford 16 (103.0 mg, 93%, dr = 1:1, major of the diastereomeric mixture) as a colourless liquid. \(^1\)H NMR (400 MHz, CDCl\textsubscript{3}) (ppm) 7.25 (d, \(J = 8.2\) Hz, 1H + 1H), 7.11 – 7.05 (m, 1H + 1H), 7.05 – 7.00 (m, 1H + 1H), 4.77 (dd, \(J = 10.8, 4.0\) Hz, 1H + 1H), 4.14 – 3.86 (m, 2H + 2H), 3.27 – 3.04 (m, 1H + 1H), 3.04 – 2.80 (m, 3H + 3H), 2.51 (dd, \(J = 18.7, 8.6\) Hz, 1H + 1H), 2.45 – 2.33 (m, 1H + 1H), 2.32 – 2.22 (m, 1H + 1H), 2.21 – 1.87 (m, 4H + 4H), 1.77 – 1.33 (m, 6H + 6H), 1.22 (td,
$J = 7.1, 1.0 \text{ Hz, } 3H + 3H), 0.91 (s, 3H + 3H)$; $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.82 (s, 3F), -33.83 (s, 3F), -101.88 - -103.36 (m, 1F + 1F), -104.94 - -106.47 (m, 1F + 1F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 220.6, 163.60 (C-F, $^2J_{C-F} = 32.2$ Hz), 163.55 (C-F, $^2J_{C-F} = 32.2$ Hz), 163.27 (C-F, $^2J_{C-F} = 32.2$ Hz), 163.23 (C-F, $^2J_{C-F} = 32.2$ Hz), 162.95 (C-F, $^2J_{C-F} = 32.2$ Hz), 162.91 (C-F, $^2J_{C-F} = 32.2$ Hz), 140.2, 137.28, 137.26, 135.1, 128.12, 128.05, 127.9 (C-F, $^1J_{C-F} = 332.5$ Hz), 125.99, 125.97, 124.9, 124.6 (C-F, $^1J_{C-F} = 332.5$ Hz), 121.3 (C-F, $^1J_{C-F} = 332.5$ Hz), 118.0 (C-F, $^1J_{C-F} = 332.5$ Hz), 117.1 - 111.7 (m), 63.0, 50.5, 47.9, 44.3, 42.03 (C-F, $^2J_{C-F} = 23.6$ Hz), 41.97 (C-F, $^2J_{C-F} = 23.6$ Hz), 41.80 (C-F, $^2J_{C-F} = 23.6$ Hz), 41.73 (C-F, $^2J_{C-F} = 23.6$ Hz), 41.57 (C-F, $^2J_{C-F} = 23.6$ Hz), 41.50 (C-F, $^2J_{C-F} = 23.6$ Hz), 38.8, 37.9, 35.8, 31.5, 29.3, 29.2, 26.4, 26.3, 25.6, 21.5, 13.8, 13.7; HRMS (ESI) $m/z$: [M+Na]$^+$ Calcd for C$_{25}$H$_{29}$O$_3$F$_5$NaSe 575.1094; Found 575.1094.

**ethyl 4-(benzofuran-3-yl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (17)**

\[
\begin{align*}
&\text{F}_3\text{CSe} \\
&\text{CF}_2\text{CO}_2\text{Et}
\end{align*}
\]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 17 (44.0 mg, 53%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.71 - 7.66 (m, 1H), 7.65 (s, 1H), 7.55 - 7.50 (m, 1H), 7.42 - 7.31 (m, 2H), 5.09 (dd, $J = 10.8, 4.1$ Hz, 1H), 4.05 - 3.93 (m, 1H), 3.93 - 3.80 (m, 1H), 3.39 - 3.20 (m, 1H), 3.17 - 2.99 (m, 1H), 1.11 (t, $J = 7.2$ Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.81 (s, 3F), -102.70 (dt, $J = 265.1, 13.2$ Hz, 1F), -106.29 (ddd, $J = 265.1, 17.9, 14.5$ Hz, 1F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 163.4 (C-F, $^2J_{C-F} = 32.1$ Hz), 163.1 (C-F, $^2J_{C-F} = 32.1$ Hz), 162.8 (C-F, $^2J_{C-F} = 32.1$ Hz), 155.6, 142.9, 127.6 (C-F, $^1J_{C-F} = 332.2$ Hz), 125.2, 125.1, 124.3 (C-F, $^1J_{C-F} = 332.2$ Hz), 123.1, 121.0 (C-F, $^1J_{C-F} = 332.2$ Hz), 119.9, 117.9, 117.7 (C-F, $^1J_{C-F} = 332.2$ Hz), 116.8 (C-F, $^1J_{C-F} = 253.5$ Hz), 114.33 (C-F, $^1J_{C-F} = 253.5$ Hz), 114.31 (C-F, $^1J_{C-F} = 253.5$ Hz), 112.0, 111.8 (C-F, $^1J_{C-F} = 253.5$ Hz), 63.1, 41.1 (C-F, $^2J_{C-F} =
24.2 Hz), 40.8 (C-F, $^{2}J_{C-F} = 24.2$ Hz), 40.6 (C-F, $^{2}J_{C-F} = 24.2$ Hz), 28.9, 13.4; HRMS (ESI) $m/z$: [M+Na]$^+$ Calcd for C_{15}H_{13}O_{3}F_{5}NaSe 438.9842; Found 438.9847.

**ethyl 2,2-difluoro-4-(quinolin-3-yl)-4-((trifluoromethyl)selanyl)butanoate (18)**

![Chemical Structure](image)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 18 (58.0 mg, 68%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 8.92 (d, $J = 2.0$ Hz, 1H), 8.15 – 8.03 (m, 2H), 7.82 (d, $J = 8.2$ Hz, 1H), 7.78 – 7.70 (m, 1H), 7.65 – 7.53 (m, 1H), 5.04 (dd, $J = 10.6, 4.3$ Hz, 1H), 3.98 (q, $J = 7.1$ Hz, 2H), 3.34 – 3.15 (m, 1H), 3.14 – 2.94 (m, 1H), 1.18 (t, $J = 7.1$ Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.37 (s, 3F), -103.06 (dt, $J = 266.2, 14.2$ Hz, 3F), -104.94 (dt, $J = 266.2, 15.6$ Hz, 3F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 163.4 (C-F, $^{1}J_{C-F} = 31.9$ Hz), 163.0 (C-F, $^{1}J_{C-F} = 31.9$ Hz), 162.7 (C-F, $^{1}J_{C-F} = 31.9$ Hz), 149.9, 147.7, 134.4, 131.3, 130.2, 129.3, 127.8, 127.6 (C-F, $^{1}J_{C-F} = 333.3$ Hz), 127.5, 127.2, 124.2 (C-F, $^{1}J_{C-F} = 333.3$ Hz), 120.9 (C-F, $^{1}J_{C-F} = 333.3$ Hz), 117.6 (C-F, $^{1}J_{C-F} = 333.3$ Hz), 116.8 (C-F, $^{1}J_{C-F} = 252.6$ Hz), 114.3 (C-F, $^{1}J_{C-F} = 252.6$ Hz), 111.8 (C-F, $^{1}J_{C-F} = 252.6$ Hz), 63.3, 41.2 (C-F, $^{2}J_{C-F} = 23.8$ Hz), 41.0 (C-F, $^{2}J_{C-F} = 23.8$ Hz), 36.1, 13.6; HRMS (ESI) $m/z$: [M+H]$^+$ Calcd for C$_{16}$H$_{15}$O$_{2}$NF$_{5}$Se 428.0183; Found 428.0178.

**ethyl 2,2-difluoro-4,4-diphenyl-4-((trifluoromethyl)selanyl)butanoate (19)**

![Chemical Structure](image)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 19 (78.1 mg, 86%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.52 – 7.44 (m, 4H), 7.42 – 7.31 (m, 6H), 3.96 (q, $J = 7.2$ Hz, 2H), 3.86 (t, $J = 14.7$ Hz, 2H), 1.24 (t, $J = 7.2$ Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -32.56 (s, 3F), -98.75 (t, $J = 14.7$ Hz, 2F); $^{13}$C
NMR (101 MHz, CDCl3) (ppm) 163.5 (C-F, \(^2J_{\text{C-F}} = 32.3\) Hz), 163.2 (C-F, \(^2J_{\text{C-F}} = 32.3\) Hz), 162.8 (C-F, \(^2J_{\text{C-F}} = 32.3\) Hz), 141.2, 129.1, 128.0, 127.8 (C-F, \(^1J_{\text{C-F}} = 334.3\) Hz), 124.5 (C-F, \(^1J_{\text{C-F}} = 334.3\) Hz), 121.2 (C-F, \(^1J_{\text{C-F}} = 334.3\) Hz), 117.8 (C-F, \(^1J_{\text{C-F}} = 334.3\) Hz), 117.3 (C-F, \(^1J_{\text{C-F}} = 254.3\) Hz), 114.8 (C-F, \(^1J_{\text{C-F}} = 254.3\) Hz), 112.2 (C-F, \(^1J_{\text{C-F}} = 254.3\) Hz), 63.0, 58.83 (C-F, \(^3J_{\text{C-F}} = 2.6\) Hz), 59.80 (C-F, \(^3J_{\text{C-F}} = 2.6\) Hz), 59.77 (C-F, \(^3J_{\text{C-F}} = 2.6\) Hz), 46.6 (C-F, \(^2J_{\text{C-F}} = 23.1\) Hz), 46.4 (C-F, \(^2J_{\text{C-F}} = 23.1\) Hz), 46.2 (C-F, \(^2J_{\text{C-F}} = 23.1\) Hz), 13.6; HRMS (ESI) \(m/z\): [M+Na]\(^+\) Calcd for C\(_{19}\)H\(_{17}\)O\(_2\)F\(_5\)NaSe 475.0206; Found 475.0206.

ethyl 2,2-difluoro-3-methyl-4-phenyl-4-((trifluoromethyl)selanyl)butanoate (20)

![Chemical Structure](image)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 20 (45.1 mg, 58%, dr = 14:1, major of the diastereomeric mixture) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl3) (ppm) 7.39 – 7.26 (m, 5H), 4.74 (d, \(J = 6.8\) Hz, 1H), 4.16 – 3.97 (m, 2H), 3.11 – 2.76 (m, 1H), 1.32 (d, \(J = 7.0\) Hz, 3H), 1.27 (t, \(J = 7.2\) Hz, 3H); \(^19\)F NMR (376 MHz, CDCl3) (ppm) -33.55 (s, 3F), -106.90 (dd, \(J = 261.1, 12.5\) Hz, 1F), -111.61 (dd, \(J = 261.2, 14.8\) Hz, 1F); \(^13\)C NMR (101 MHz, CDCl3) (ppm) 163.7 (C-F, \(^2J_{\text{C-F}} = 32.3\) Hz), 163.4 (C-F, \(^2J_{\text{C-F}} = 32.3\) Hz), 163.1 (C-F, \(^2J_{\text{C-F}} = 32.3\) Hz), 140.0, 128.6, 128.5, 128.1, 127.3 (C-F, \(^1J_{\text{C-F}} = 331.5\) Hz), 124.0 (C-F, \(^1J_{\text{C-F}} = 331.5\) Hz), 120.7 (C-F, \(^1J_{\text{C-F}} = 331.5\) Hz), 118.4 (C-F, \(^1J_{\text{C-F}} = 255.0\) Hz), 117.4 (C-F, \(^1J_{\text{C-F}} = 331.5\) Hz), 115.90 (C-F, \(^1J_{\text{C-F}} = 255.0\) Hz), 115.89 (C-F, \(^1J_{\text{C-F}} = 255.0\) Hz), 113.4 (C-F, \(^1J_{\text{C-F}} = 255.0\) Hz), 63.0, 47.2, 44.2 (C-F, \(^2J_{\text{C-F}} = 22.0\) Hz), 44.0 (C-F, \(^2J_{\text{C-F}} = 22.0\) Hz), 43.8 (C-F, \(^2J_{\text{C-F}} = 22.0\) Hz), 13.7, 12.15 (C-F, \(^3J_{\text{C-F}} = 4.5\) Hz), 12.10 (C-F, \(^3J_{\text{C-F}} = 4.5\) Hz), 12.06 (C-F, \(^3J_{\text{C-F}} = 4.5\) Hz); HRMS (ESI) \(m/z\): [M+Na]\(^+\) Calcd for C\(_{14}\)H\(_{15}\)O\(_2\)F\(_3\)NaSe 413.0050; Found 413.0047.

ethyl 2,2-difluoro-2-(2-phenyl-2-((trifluoromethyl)selanyl)cyclohexyl)acetate (21)
The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 21 (47.2 mg, 55%, dr > 20:1, major of the diastereomeric mixture) as a slightly green liquid. 

\[ \text{The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 21 (47.2 mg, 55%, dr > 20:1, major of the diastereomeric mixture) as a slightly green liquid.} \]

\[ \begin{align*}
\text{1H NMR (400 MHz, CDCl}_3\text{) (ppm)} & \quad \text{7.61 (d, } J = 7.6 \text{ Hz, 2H), 7.34 – 7.20 (m, 3H), 3.96 – 3.82 (m, 1H), 3.82 – 3.70 (m, 1H), 3.49 – 3.34 m, 1H), 2.74 – 2.62 (m, 1H), 2.36 (d, } J = 14.6 \text{ Hz, 1H), 2.30 – 2.12 (m, 2H), 2.02 – 1.93 (m, 1H), 1.91 – 1.77 (m, 1H), 1.77 – 1.66 (m, 1H), 1.66 – 1.51 (m, 1H), 1.16 (t, } J = 7.2 \text{ Hz, 3H);} \\
\text{19F NMR (376 MHz, CDCl}_3\text{) (ppm)} & \quad -31.35 (s, 3F), -95.85 (d, } J = 266.1 \text{ Hz, 3F), -102.86 (dd, } J = 266.1, 26.2 \text{ Hz, 3F);} \\
\text{13C NMR (101 MHz, CDCl}_3\text{) (ppm)} & \quad 163.8 (\text{C-F, } J_{\text{C-F}} = 32.6 \text{ Hz), 163.5 (\text{C-F, } J_{\text{C-F}} = 32.6 \text{ Hz), 163.1 (\text{C-F, } J_{\text{C-F}} = 32.6 \text{ Hz), 141.1, 129.0, 127.9, 127.6, 127.1 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 123.8 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 120.5 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 118.8 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 117.2 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 116.3 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 116.1 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 113.6 (\text{C-F, } J_{\text{C-F}} = 333.0 \text{ Hz), 62.8, 62.81 – 62.71 (m, 1H), 46.5 (\text{C-F, } J_{\text{C-F}} = 22.0 \text{ Hz), 46.3 (\text{C-F, } J_{\text{C-F}} = 22.0 \text{ Hz), 46.1 (\text{C-F, } J_{\text{C-F}} = 22.0 \text{ Hz), 31.84 (\text{C-F, } J_{\text{C-F}} = 5.8 \text{ Hz), 31.79 (\text{C-F, } J_{\text{C-F}} = 5.8 \text{ Hz), 23.55 (\text{C-F, } J_{\text{C-F}} = 9.4 \text{ Hz), 23.46 (\text{C-F, } J_{\text{C-F}} = 9.4 \text{ Hz), 22.6, 20.67 (\text{C-F, } J_{\text{C-F}} = 0.9 \text{ Hz), 20.66 (\text{C-F, } J_{\text{C-F}} = 0.9 \text{ Hz), 13.5;} \text{ HRMS (ESI) } m/z: [M+Na]^+ \text{ Calcd for } C_{17}H_{19}O_2F_5NaSe 453.0363;} \text{ Found 453.0360.} \]
\end{align*} \]

ethyl 4-(9H-carbazol-9-yl)-2,2-difluoro-4-((trifluoromethyl)selanyl)butanoate (22)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 22 (41.1 mg, 44%) as a slightly green liquid. 

\[ \text{The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 22 (41.1 mg, 44%) as a slightly green liquid.} \]

\[ \begin{align*}
\text{1H NMR (400 MHz, CDCl}_3\text{) (ppm)} & \quad 8.11 (d, } J = 7.7 \text{ Hz, 1H), 8.05 (d, } J = 7.7 \text{ Hz, 1H), 7.61 – 7.43 (m, 4H), 7.42 – 7.30 (m, 2H), 6.81 (dd,} \\
\end{align*} \]
$J = 11.2, 3.6$ Hz, 1H), 4.01 - 3.80 (m, 1H), 3.68 - 3.57 (m, 1H), 3.56 - 3.43 (m, 1H), 3.25 - 3.03 (m, 1H), 0.88 (t, $J = 7.2$ Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -32.62 (s, 3F), -102.33 (ddd, $J = 268.9, 12.5, 10.0$ Hz, 1F), -108.89 (ddd, $J = 268.9, 20.8, 12.2$ Hz, 1F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 162.4 (C-F, $^2$J$_{C-F} = 31.5$ Hz), 162.1 (C-F, $^2$J$_{C-F} = 31.5$ Hz), 161.8 (C-F, $^2$J$_{C-F} = 31.5$ Hz), 139.6, 137.8, 126.7, 125.9, 125.3, 123.3, 127.8 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 124.5 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 121.1 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 117.8 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 121.2, 121.0, 120.9, 120.3, 116.3 (C-F, $^1$J$_{C-F} = 254.7$ Hz), 111.4, 109.2, 63.1, 48.54 (C-F, $^3$J$_{C-F} = 7.4$ Hz), 48.47 (C-F, $^3$J$_{C-F} = 7.4$ Hz), 41.2 (C-F, $^2$J$_{C-F} = 24.8$ Hz), 41.0 (C-F, $^2$J$_{C-F} = 24.8$ Hz), 40.7 (C-F, $^2$J$_{C-F} = 24.8$ Hz), 13.2; HRMS (ESI) $m/z$: [M+Na]$^+$ Calcd for C$_{19}$H$_{16}$O$_2$NF$_5$NaSe 488.0159; Found 488.0154.

5-benzyl 1-ethyl 2,2-difluoro-4-((trifluoromethyl)selanyl)pentanedioate (23)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 23 (53.3 mg, 53%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.44 - 7.28 (m, 5H), 5.19 (d, $J = 2.7$ Hz, 2H), 4.31 (q, $J = 7.1$ Hz, 2H), 4.14 (dd, $J = 10.5, 3.7$ Hz, 1H), 3.23 - 3.01 (m, 1H), 2.88 - 2.61 (m, 1H), 1.34 (t, $J = 7.2$ Hz, 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.37 (s, 3F), -105.44 - -105.85 (m, 2F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 170.0, 163.3 (C-F, $^2$J$_{C-F} = 32.0$ Hz), 163.0 (C-F, $^2$J$_{C-F} = 32.0$ Hz), 162.7 (C-F, $^2$J$_{C-F} = 32.0$ Hz), 134.7, 128.6, 128.3, 127.1 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 123.8 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 120.5 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 117.2 (C-F, $^1$J$_{C-F} = 332.2$ Hz), 116.6 (C-F, $^1$J$_{C-F} = 252.9$ Hz), 114.1 (C-F, $^1$J$_{C-F} = 252.9$ Hz), 111.6 (C-F, $^1$J$_{C-F} = 252.9$ Hz), 68.2, 63.4, 38.3 (C-F, $^2$J$_{C-F} = 24.0$ Hz), 38.1 (C-F, $^2$J$_{C-F} = 24.0$ Hz), 37.8 (C-F, $^2$J$_{C-F} = 24.0$ Hz), 33.7, 13.8; HRMS (ESI) $m/z$: [M+Na]$^+$ Calcd for C$_{15}$H$_{15}$O$_4$F$_5$NaSe 456.9948; Found 456.9939.
ethyl \((R, S)-4\)\-(\text{tert-butyl})-2,2\-difluoro-6-\((\text{trifluoromethyl})\text{selanyl})\text{undeca-4,5-dienoate (24)}\)

\[
\begin{align*}
\text{F}_3\text{CSe} & \quad \text{Bu} \\
\text{CF}_2\text{CO}_2\text{Et} & \quad \text{C}_9\text{H}_{11}
\end{align*}
\]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 24 (50.2 mg, 56%) as a slightly green liquid. \^H NMR (400 MHz, CDCl\textsubscript{3}) (ppm) 4.44 – 4.15 (m, 2H), 3.05 – 2.71 (m, 2H), 2.48 – 2.18 (m, 2H), 1.57 – 1.44 (m, 2H), 1.43 – 1.27 (m, 7H), 1.11 (s, 9H), 0.96 – 0.87 (m, 3H); \(^{19}\)F NMR (376 MHz, CDCl\textsubscript{3}) (ppm) -33.27 (s, 3F), -100.91 (dt, \(J = 266.8, 13.9 \text{ Hz}, 1\text{F}\)), -103.58 (ddd, \(J = 266.8, 18.1, 15.0 \text{ Hz}, 1\text{F}\)); \(^{13}\)C NMR (101 MHz, CDCl\textsubscript{3}) (ppm) 202.0, 163.8 (C-F, \(^2\)\(J_{\text{C-F}} = 32.7 \text{ Hz}\)), 163.5 (C-F, \(^2\)\(J_{\text{C-F}} = 32.7 \text{ Hz}\)), 163.1 (C-F, \(^2\)\(J_{\text{C-F}} = 32.7 \text{ Hz}\)), 128.0 (C-F, \(^1\)\(J_{\text{C-F}} = 333.9 \text{ Hz}\)), 124.7 (C-F, \(^1\)\(J_{\text{C-F}} = 333.9 \text{ Hz}\)), 121.4 (C-F, \(^1\)\(J_{\text{C-F}} = 333.9 \text{ Hz}\)), 118.1 (C-F, \(^1\)\(J_{\text{C-F}} = 333.9 \text{ Hz}\)), 117.6 (C-F, \(^1\)\(J_{\text{C-F}} = 251.7 \text{ Hz}\)), 115.08 (C-F, \(^1\)\(J_{\text{C-F}} = 251.7 \text{ Hz}\)), 115.06 (C-F, \(^1\)\(J_{\text{C-F}} = 251.7 \text{ Hz}\)), 112.6 (C-F, \(^1\)\(J_{\text{C-F}} = 251.7 \text{ Hz}\)), 105.43 (C-F, \(^3\)\(J_{\text{C-F}} = 5.2 \text{ Hz}\)), 105.40 (C-F, \(^3\)\(J_{\text{C-F}} = 5.2 \text{ Hz}\)), 105.38 (C-F, \(^3\)\(J_{\text{C-F}} = 5.2 \text{ Hz}\)), 105.35 (C-F, \(^3\)\(J_{\text{C-F}} = 5.2 \text{ Hz}\)), 93.8, 62.9, 36.6, 34.6, 33.2 (C-F, \(^2\)\(J_{\text{C-F}} = 24.3 \text{ Hz}\)), 32.9 (C-F, \(^2\)\(J_{\text{C-F}} = 24.3 \text{ Hz}\)), 32.7 (C-F, \(^2\)\(J_{\text{C-F}} = 24.3 \text{ Hz}\)), 31.2, 28.5, 27.8, 22.4, 13.9, 13.8; HRMS (ESI) \(m/z\): [M+Na]\(^+\) Calcd for C\textsubscript{18}H\textsubscript{27}O\textsubscript{2}F\textsubscript{5}NaSe 473.0989; Found 473.0985.

ethyl 4-\((1,1'\)-biphenyl\)-4-yl)-2,2-difluoro-4-\((\text{trifluoromethyl})\text{thio})\text{butanoate (25)}\)

\[
\begin{align*}
\text{SCF}_3 & \quad \text{Ph} \\
\text{CF}_2\text{CO}_2\text{Et} & \quad \text{Ph}
\end{align*}
\]

Using NMe\textsubscript{4}SCF\textsubscript{3}\(^7\) as the nucleophile: The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 25 (62.1 mg, 77%) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl\textsubscript{3}) (ppm) 7.67 – 7.56 (m, 4H), 7.52 – 7.36 (m, 5H), 4.71 (dd, \(J = 9.6, 5.0 \text{ Hz}, 1\text{H}\)), 4.15 – 3.97 (m, 2H), 3.16 – 2.77 (m, 2H), 1.26 (t, \(J = 7.2 \text{ Hz}, 3\text{H}\)); \(^{19}\)F NMR (376 MHz, CDCl\textsubscript{3}) (ppm) -40.25 (s, 3F), -102.25 (dt, \(J = 266.3, 13.9 \text{ Hz}, 1\text{F}\)), -105.42 (dd, \(J = 266.3, 5.2 \text{ Hz}\)).
17.4, 14.3 Hz, 1F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 163.4 (C-F, $^2$$J_{C$-$F}$ = 32.1 Hz), 163.1 (C-F, $^2$$J_{C$-$F}$ = 32.1 Hz), 162.8 (C-F, $^2$$J_{C$-$F}$ = 32.1 Hz), 141.6, 140.1, 136.9, 134.5 (C-F, $^1$$J_{C$-$F}$ = 308.1 Hz), 131.4 (C-F, $^1$$J_{C$-$F}$ = 308.1 Hz), 128.9, 128.4 (C-F, $^1$$J_{C$-$F}$ = 308.1 Hz), 128.1, 127.7, 127.6, 127.0, 125.3 (C-F, $^1$$J_{C$-$F}$ = 308.1 Hz), 116.7 (C-F, $^1$$J_{C$-$F}$ = 253.5 Hz), 114.18 (C-F, $^1$$J_{C$-$F}$ = 253.5 Hz), 114.16 (C-F, $^1$$J_{C$-$F}$ = 253.5 Hz), 111.7 (C-F, $^1$$J_{C$-$F}$ = 253.5 Hz), 63.1, 43.9 – 42.3 (m), 41.5 (C-F, $^2$$J_{C$-$F}$ = 23.9 Hz), 41.3 (C-F, $^2$$J_{C$-$F}$ = 23.9 Hz), 41.1 (C-F, $^2$$J_{C$-$F}$ = 23.9 Hz), 13.7; HRMS (ESI) m/z: [M+Na]$^+$ Calcd for C$_{19}$H$_{17}$O$_2$F$_5$NaS 427.0762; Found 427.0763.

(1-([1,1'-biphenyl]-4-yl)-3,3-dichloro-4,4,4-trifluorobutyl)(trifluoromethyl)sulfane (26)

Using NMe$_4$SCF$_3$ as the nucleophile: The product mixture was purified by silica gel column chromatography (petroleum ether) to afford 26 (53.2 mg, 61%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.70 – 7.59 (m, 4H), 7.54 – 7.44 (m, 4H), 7.44 – 7.34 (m, 1H), 4.99 (dd, $J$ = 8.7, 3.8 Hz, 1H), 3.20 (dd, $J$ = 15.1, 8.7 Hz, 1H), 3.09 (dd, $J$ = 15.1, 3.9 Hz, 1H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -40.22 (s, 3F), -79.83 (s, 3F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 141.6, 140.1, 137.6, 134.4 (C-F, $^1$$J_{C$-$F}$ = 309.4 Hz), 131.3 (C-F, $^1$$J_{C$-$F}$ = 309.4 Hz), 128.8, 128.3 (C-F, $^1$$J_{C$-$F}$ = 309.4 Hz), 128.2, 127.8, 127.7, 127.0, 126.2 (C-F, $^1$$J_{C$-$F}$ = 282.2 Hz), 125.2 (C-F, $^1$$J_{C$-$F}$ = 309.4 Hz), 123.4 (C-F, $^1$$J_{C$-$F}$ = 282.2 Hz), 120.6 (C-F, $^1$$J_{C$-$F}$ = 282.2 Hz), 117.8 (C-F, $^1$$J_{C$-$F}$ = 282.2 Hz), 83.7 (C-F, $^2$$J_{C$-$F}$ = 35.1 Hz), 83.4 (C-F, $^2$$J_{C$-$F}$ = 35.1 Hz), 83.0 (C-F, $^2$$J_{C$-$F}$ = 35.1 Hz), 82.7 (C-F, $^2$$J_{C$-$F}$ = 35.1 Hz), 46.3, 44.7; HRMS (ESI) m/z: [M+H]$^+$ Calcd for C$_{17}$H$_{13}$Cl$_2$F$_6$S 433.0014; Found 432.9992.
4. Typical procedure for Carbotrifluoromethylselenolation of Alkenes (Scope of Radical Precursors)

Into a 10 mL sealed tube were added alkene 1 (0.2 mmol), (NMe₄)SeCF₃ (66.6 mg, 0.3 mmol), other Radical Precursors (0.6 mmol), Cu₂O (2.9 mg, 0.02 mmol), L₈ (11.6 mg, 0.03 mmol), Cs₂CO₃ (65 mg, 0.2 mmol) and anhydrous 1,4-dioxane (3 mL) under argon atmosphere. The tube was sealed and the reaction mixture was stirred at room temperature for 48 h. After the completion of reaction, the pure product was isolated by flash column chromatography.

(1-([1,1'-biphenyl]-4-yl)-3,3,4,4,5,5,6,6,6-nonafluorohexyl)(trifluoromethyl)selenane (27)

The product mixture was purified by silica gel column chromatography (petroleum ether) to afford 27 (95.3 mg, 87%) as a white solid. ¹H NMR (400 MHz, CDCl₃) (ppm) 7.64 – 7.52 (m, 4H), 7.49 – 7.38 (m, 4H), 7.38 – 7.30 (m, 1H), 5.01 (dd, \( J = 10.6, 3.8 \text{ Hz}, 1H \)), 3.29 – 3.10 (m, 1H), 3.10 – 2.90 (m, 1H); ¹⁹F NMR (376 MHz, CDCl₃) (ppm) -33.9 (s, 3F), -81.0 (t, \( J = 9.3 \text{ Hz}, 3F \)), -111.17 – -115.35 (m, 2F), -124.25 – -124.70 (m, 2F), -125.80 – -126.15 (m, 2F); ¹³C NMR (101 MHz, CDCl₃) (ppm) 141.6, 140.1, 136.9, 128.8, 127.9, 127.7, 127.6, 127.0, 127.8 (C-F, \( ^{1}JC-F = 333.1 \text{ Hz}, 124.5 \text{ (C-F, } ^{1}JC-F = 333.1 \text{ Hz}), 121.2 \text{ (C-F, } ^{2}JC-F = 333.1 \text{ Hz}) \)), 117.9 (C-F, \( ^{1}JC-F = 333.1 \text{ Hz}), 120.4 – 105.0 (m, 4C), 38.3 (C-F, \( ^{2}JC-F = 20.9 \text{ Hz} \)), 38.1 (C-F, \( ^{2}JC-F = 20.9 \text{ Hz} \)), 37.8 (C-F, \( ^{2}JC-F = 20.9 \text{ Hz} \)), 37.6; HRMS (ESI) \( m/z \): [M–H] Calcd for C₁₉H₁₁F₁₂Se 546.9840; Found 546.9843.

(3,3,4,4,5,5,6,6,6-nonafluoro-1-(naphthalen-2-yl)hexyl)(trifluoromethyl)selenane (28)
The product mixture was purified by silica gel column chromatography (petroleum ether) to afford **28** (88.1 mg, 84%) as a white solid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.95 – 7.81 (m, 4H), 7.60 – 7.52 (m, 2H), 7.49 (dd, $J = 8.5$, 1.9 Hz, 1H), 5.18 (dd, $J = 10.6$, 3.9 Hz, 1H), 3.42 – 3.21 (m, 1H), 3.21 – 2.97 (m, 1H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.90 (s, 3F), -81.02 – -81.14 (m, 3F), -111.23 – -115.07 (m, 2F), -124.25 – -124.60 (m, 2F), -125.82 – -126.18 (m, 2F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 135.3, 133.2, 133.1, 129.3, 128.0, 127.8, 127.7 (C-F, $^1$J$_{C-F} = 333.2$ Hz), 126.8, 126.3, 124.5, 124.4 (C-F, $^1$J$_{C-F} = 333.2$ Hz), 121.2 (C-F, $^1$J$_{C-F} = 333.2$ Hz), 117.9 (C-F, $^1$J$_{C-F} = 333.2$ Hz), 120.4 – 106.3 (m, 4C), 38.1, 38.0 (C-F, $^2$J$_{C-F} = 20.9$ Hz), 37.9 (C-F, $^2$J$_{C-F} = 20.9$ Hz), 37.8 (C-F, $^2$J$_{C-F} = 20.9$ Hz); HRMS (ESI) m/z: [M–H]$^-$ Calcd for C$_{17}$H$_9$F$_{12}$Se 520.9683; Found 520.9681.

**[(8R,9S,13S,14S)-13-methyl-3-(3,3,4,4,5,5,6,6,6-nonafluoro-1-((trifluoromethyl)selanyl)hexyl)-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (29)]**

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford **29** (93.0 mg, 72%, dr = 1:1, major of the diastereomeric mixture) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.27 (d, $J = 8.1$ Hz, 1H + 1H), 7.11 (d, $J = 8.1$ Hz, 1H + 1H), 7.05 (s, 1H + 1H), 4.91 (dd, $J = 10.6$, 3.7 Hz, 1H + 1H), 3.27 – 2.78 (m, 4H + 4H), 2.59 – 2.47 (m, 1H + 1H), 2.45 – 2.36 (m, 1H + 1H), 2.35 – 2.23 (m, 1H + 1H), 2.22 – 1.89 (m, 4H + 4H), 1.72 – 1.38 (m, 6H + 6H), 0.92 (s, 3H + 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -34.08 (s, 3F + 3F), -80.99 – -81.17 (m, 3F + 3F), -111.21 – -115.61 (m, 2F + 2F), -124.28 – -124.61 (m, 2F + 2F), -125.80
-126.15 (m, 2F + 2F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 220.6, 140.4, 137.5, 135.3, 135.2, 127.9 (C-F, $^1J_{C\text{-}F} = 332.1$ Hz), 127.8, 127.6, 126.2, 124.6 (C-F, $^1J_{C\text{-}F} = 332.1$ Hz), 124.3, 124.2, 121.3 (C-F, $^1J_{C\text{-}F} = 332.1$ Hz), 118.0 (C-F, $^1J_{C\text{-}F} = 332.1$ Hz), 120.2 – 105.3 (m), 50.5, 47.9, 44.3, 38.20 (t, $J = 20.7$), 38.33 (C-F, $^2J_{C\text{-}F} = 20.7$ Hz), 38.27 (C-F, $^2J_{C\text{-}F} = 20.7$ Hz), 38.11 (C-F, $^2J_{C\text{-}F} = 20.7$ Hz), 38.07 (C-F, $^2J_{C\text{-}F} = 20.7$ Hz), 37.9, 37.86 (C-F, $^2J_{C\text{-}F} = 20.7$ Hz), 37.80 (C-F, $^2J_{C\text{-}F} = 20.7$ Hz), 37.6, 35.8, 31.5, 29.2, 26.3, 25.5, 21.5, 13.8; HRMS (ESI) $m/z$: [M+H]$^+$ Calcd for C$_{25}$H$_{25}$OF$_{12}$Se 649.0874; Found 649.0885.

(1-([1,1'-biphenyl]-4-yl)-3,3-dichloro-4,4,4-trifluorobutyl)(trifluoromethyl)selane (30)

The product mixture was purified by silica gel column chromatography (petroleum ether) to afford 30 (73.2 mg, 76%) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.66 – 7.53 (m, 4H), 7.48 – 7.40 (m, 4H), 7.40 – 7.32 (m, 1H), 5.18 (dd, $J = 10.0, 2.9$ Hz, 1H), 3.37 (dd, $J = 15.1, 10.0$ Hz, 1H), 3.17 (dd, $J = 15.1, 2.9$ Hz, 1H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.66 (s, 3F), -79.77 (s, 3F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 141.4, 140.0, 137.4, 128.8, 128.1, 127.8, 127.7, 127.9, 126.2 (C-F, $^1J_{C\text{-}F} = 282.4$ Hz), 124.6 (C-F, $^1J_{C\text{-}F} = 332.7$ Hz), 123.4 (C-F, $^1J_{C\text{-}F} = 282.4$ Hz), 121.3 (C-F, $^1J_{C\text{-}F} = 332.7$ Hz), 120.6 (C-F, $^1J_{C\text{-}F} = 282.4$ Hz), 118.0 (C-F, $^1J_{C\text{-}F} = 332.7$ Hz), 117.8 (C-F, $^1J_{C\text{-}F} = 282.4$ Hz), 84.3 (C-F, $^2J_{C\text{-}F} = 50.0$ Hz), 84.0 (C-F, $^2J_{C\text{-}F} = 50.0$ Hz), 83.6 (C-F, $^2J_{C\text{-}F} = 35.0$ Hz), 83.3 (C-F, $^2J_{C\text{-}F} = 35.0$ Hz), 46.6, 40.9; HRMS (ESI) $m/z$: [M–H]$^-$ Calcd for C$_{17}$H$_{11}$Cl$_2$F$_6$Se 478.9313; Found 478.9311.

(3,3-dichloro-4,4,4-trifluoro-1-(naphthalen-2-yl)butyl)(trifluoromethyl)selane (31)
The product mixture was purified by silica gel column chromatography (petroleum ether) to afford 31 (73.1 mg, 80%) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (ppm) 7.97 – 7.76 (m, 4H), 7.64 – 7.43 (m, 3H), 5.36 (dd, \(J = 10.0, 3.0\) Hz, 1H), 3.50 (dd, \(J = 15.1, 10.0\) Hz, 1H), 3.27 (dd, \(J = 15.1, 3.0\) Hz, 1H); \(^1\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.66 (s, 3F), -79.76 (s, 3F); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) (ppm) 135.8, 133.3, 133.1, 129.3, 128.0, 127.8, 126.9, 126.8, 126.7, 125.1, 127.9 (C-F, \(^1\)J\(_{C-F} = 332.8\) Hz), 124.6 (C-F, \(^1\)J\(_{C-F} = 332.8\) Hz), 121.3 (C-F, \(^1\)J\(_{C-F} = 332.8\) Hz), 118.0 (C-F, \(^1\)J\(_{C-F} = 332.8\) Hz), 126.2 (C-F, \(^1\)J\(_{C-F} = 282.5\) Hz), 123.4 (C-F, \(^1\)J\(_{C-F} = 282.5\) Hz), 120.6 (C-F, \(^1\)J\(_{C-F} = 282.5\) Hz), 117.8 (C-F, \(^1\)J\(_{C-F} = 282.5\) Hz), 84.4 (C-F, \(^2\)J\(_{C-F} = 35.1\) Hz), 84.0 (C-F, \(^2\)J\(_{C-F} = 35.1\) Hz), 83.7 (C-F, \(^2\)J\(_{C-F} = 35.1\) Hz), 83.3 (C-F, \(^2\)J\(_{C-F} = 35.1\) Hz), 46.5, 41.5; HRMS (ESI) \(m/z\): [M–H]\(^-\) Calcd for \(C_{15}H_9Cl_2F_6Se\) 452.9156; Found 452.9153.

3-(3,3-dichloro-4,4,4-trifluoro-1-((trifluoromethyl)selanyl)butyl)-14-methyl-6,7,8,9,11,12,13,14,16,17-decahydro-15\(^H\)-cyclopenta[\(a\)]phenanthren-15-one (32)

![Structure](image)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 32 (105.0 mg, 90%, dr = 1:1, diastereomeric mixture) as a slightly green liquid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) (ppm) 7.29 (d, \(J = 8.0\) Hz, 1H + 1H), 7.20 – 7.13 (m, 1H + 1H), 7.12 – 7.05 (m, 1H + 1H), 5.10 (dd, \(J = 9.9, 2.9\) Hz, 1H + 1H), 3.36 (dd, \(J = 15.1, 9.9\) Hz, 1H + 1H), 3.16 (dd, \(J = 15.1, 3.0\) Hz, 1H + 1H), 3.00 – 2.86 (m, 2H + 2H), 2.53 (dd, \(J = 18.7, 8.6\) Hz, 1H + 1H), 2.47 – 2.38 (m, 1H + 1H), 2.36 – 2.25 (m, 1H + 1H), 2.24 – 1.92 (m, 4H + 4H), 1.76 – 1.40 (m, 6H + 6H), 0.94 (s, 3H + 3H); \(^1\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.81 (s, 3F), -33.82 (s, 3F), -79.78 (s, 3F + 3F); \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) (ppm) 220.6, 140.3, 137.4, 135.8, 135.7, 128.2, 128.0, 126.1, 125.0, 124.8, 128.0 (C-F, \(^1\)J\(_{C-F} = 332.9\) Hz), 126.2 (C-F, \(^1\)J\(_{C-F} = 282.2\) Hz), 124.7 (C-F, \(^1\)J\(_{C-F} = 332.9\) Hz),
123.4 (C-F, \(^1J_{C\text{-}F} = 282.2\) Hz), 121.3 (C-F, \(^1J_{C\text{-}F} = 332.9\) Hz), 120.6 (C-F, \(^1J_{C\text{-}F} = 282.2\) Hz), 118.0 (C-F, \(^1J_{C\text{-}F} = 332.9\) Hz), 117.8 (C-F, \(^1J_{C\text{-}F} = 282.2\) Hz), 84.4 (C-F, \(^2J_{C\text{-}F} = 34.9\) Hz), 84.0 (C-F, \(^2J_{C\text{-}F} = 34.9\) Hz), 83.7 (C-F, \(^2J_{C\text{-}F} = 34.9\) Hz), 83.3 (C-F, \(^2J_{C\text{-}F} = 34.9\) Hz), 50.5, 47.9, 46.7, 46.6, 44.3, 41.0, 37.9, 35.8, 31.5, 29.2, 26.3, 25.5, 21.5, 13.8; HRMS (ESI) \(m/z\): [M–H]\(^{-}\) Calcd for C\(_{23}\)H\(_{23}\)OCl\(_2\)F\(_6\)Se 579.0201; Found 579.0203.

tert-butyl 4-([1,1'-biphenyl]-4-yl)-2,2-dimethyl-4-((trifluoromethyl)selanyl)butanoate (33)

![33]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 33 (41.1 mg, 43%) as a slightly green liquid. \(^1H\) NMR (400 MHz, CDCl\(_3\)) (ppm) 7.61 – 7.49 (m, 4H), 7.48 – 7.37 (m, 4H), 7.37 – 7.29 (m, 1H), 4.74 (dd, \(J = 9.1, 5.5\) Hz, 1H), 2.61 – 2.31 (m, 2H), 1.36 (s, 9H), 1.15 (s, 3H), 1.01 (s, 3H); \(^19\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.71 (s, 3F); \(^13\)C NMR (101 MHz, CDCl\(_3\)) (ppm) 175.9, 140.8, 140.4, 140.0, 128.8, 128.3, 128.1 (C-F, \(^1J_{C\text{-}F} = 332.2\) Hz), 127.4, 127.4, 127.0, 124.8 (C-F, \(^1J_{C\text{-}F} = 332.2\) Hz), 121.5 (C-F, \(^1J_{C\text{-}F} = 332.2\) Hz) 118.2 (C-F, \(^1J_{C\text{-}F} = 332.2\) Hz), 80.5, 46.2, 44.2, 43.5, 27.8, 26.5, 25.3; HRMS (ESI) \(m/z\): [M–H]\(^{-}\) Calcd for C\(_{23}\)H\(_{26}\)O\(_2\)F\(_3\)Se 471.1056; Found 471.1055.

tert-butyl 2,2-dimethyl-4-(naphthalen-2-yl)-4-((trifluoromethyl)selanyl)butanoate (34)

![34]

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 34 (36.3 mg, 40%) as a slightly green liquid. \(^1H\) NMR (400 MHz, CDCl\(_3\)) (ppm) 7.84 – 7.76 (m, 3H), 7.74 (d, \(J = 1.3\) Hz, 1H), 7.51 – 7.42 (m, 3H), 4.87 (t, \(J = 7.3\) Hz, 1H), 2.51 (d, \(J = 7.3\) Hz, 2H), 1.33 (s, 9H), 1.15 (s, 3H), 0.99 (s, 3H); \(^19\)F NMR (376 MHz, CDCl\(_3\)) (ppm) -33.76
(s, 3F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 175.9, 138.5, 133.2, 132.9, 128.7, 128.0 (C-F, $J_{C-F}$ = 332.3 Hz), 127.8, 127.6, 126.6, 126.4, 126.2, 125.6, 124.7 (C-F, $J_{C-F}$ = 332.3 Hz), 121.4 (C-F, $J_{C-F}$ = 332.3 Hz), 118.1 (C-F, $J_{C-F}$ = 332.3 Hz), 80.5, 46.0, 44.8, 43.6, 27.7, 26.7, 24.9; HRMS (ESI) m/z: [M+Na]$^+$ Calcd for C$_{21}$H$_{25}$O$_2$F$_3$NaSe 469.0864; Found 469.0864.

tert-butyl-2,2-dimethyl-4-(14-methyl-15-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-3-yl)-4-((trifluoromethyl)selanyl)butanoate (35)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 35 (35.4 mg, 31%, dr = 1:1, diastereomeric mixture) as a slightly green liquid. $^1$H NMR (400 MHz, CDCl$_3$) (ppm) 7.23 (d, $J$ = 8.0 Hz, 1H + 1H), 7.15 – 7.08 (m, 1H + 1H), 7.07 – 6.99 (m, 1H + 1H), 4.69 – 4.61 (m, 1H + 1H), 3.00 – 2.81 (m, 2H + 2H), 2.59 – 2.37 (m, 4H + 4H), 2.36 – 2.23 (m, 1H + 1H), 2.23 – 1.88 (m, 4H + 4H), 1.73 – 1.42 (m, 6H + 6H), 1.37 (d, $J$ = 3.8 Hz, 9H + 9H), 1.15 (s, 3H + 3H), 1.02 (d, $J$ = 4.0 Hz, 3H + 3H), 0.93 (s, 3H + 3H); $^{19}$F NMR (376 MHz, CDCl$_3$) (ppm) -33.82 (s, 3F), -33.82 (s, 3F); $^{13}$C NMR (101 MHz, CDCl$_3$) (ppm) 220.8, 176.0, 139.5, 138.1, 136.9, 136.8, 128.3, 128.2, 125.8,125.7, 125.1, 125.0, 128.2 (C-F, $J_{C-F}$ = 334.6 Hz), 124.9 (C-F, $J_{C-F}$ = 334.6 Hz), 121.6 (C-F, $J_{C-F}$ = 334.6 Hz), 117.8 (C-F, $J_{C-F}$ = 334.6 Hz), 80.3, 50.5, 47.9, 46.4, 46.3, 44.3, 43.5, 43.4, 38.0, 35.8, 31.5, 29.3, 27.7, 26.5, 26.4, 25.6, 25.3, 25.2, 21.5, 13.8; HRMS (ESI) m/z: [M+Na]$^+$ Calcd for C$_{29}$H$_{39}$O$_3$F$_3$NaSe 595.1909; Found 595.1912.

Into a 10 mL sealed tube were added alkene 1a (18 mg, 0.1 mmol), (NMe$_4$)SeCF$_3$ (33 mg, 0.15 mmol), 3e (47.4 mg, 0.15 mmol), Cu$_2$O (1.43 mg, 0.01 mmol) , L8 (5.8 mg, 0.015 mmol) and
anhydrous 1,4-dioxane (1.5 mL) under argon atmosphere. The tube was sealed and the reaction mixture was stirred at room temperature for 48 h. After the completion of reaction, the product mixture was purified by silica gel column chromatography (petroleum ether) to afford 36 (13.5 mg, 34%) as a white solid.

(1-([1,1'-biphenyl]-4-yl)-3,3,3-trifluoropropyl)(trifluoromethyl)selane (36)

\[
\begin{align*}
\text{Ph} & \quad \text{SeCF}_3 \\
\text{36} & \quad \text{CF}_3
\end{align*}
\]

The product mixture was purified by silica gel column chromatography (petroleum ether) to afford 36 (13.5 mg, 34%) as a white solid. \( ^1\text{H NMR (400 MHz, CDCl}_3) \text{ (ppm)} 7.70 – 7.57 \text{ (m, 4H), 7.54 – 7.35} \text{ (m, 5H), 4.91} \text{ (dd,} \quad J = 10.7, 4.3 \text{ Hz, 1H), 3.32 – 3.13} \text{ (m, 1H), 3.16 – 2.87} \text{ (m, 1H);} \quad ^{19}\text{F NMR (376 MHz, CDCl}_3) \text{ (ppm) } -33.69 \text{ (s, 3F), } -64.12 \text{ (t,} \quad J = 9.7 \text{ Hz, 3F);} \quad ^{13}\text{C NMR (101 MHz, CDCl}_3) \text{ (ppm) } 141.6, 140.1, 136.5, 128.8, 127.8, 127.7, 127.0, 129.3 (C-F,} \quad J_{C-F} = 278.9 \text{ Hz), 127.8 (C-F,} \quad J_{C-F} = 332.5 \text{ Hz), 126.6 (C-F,} \quad J_{C-F} = 278.9 \text{ Hz), 124.5 (C-F,} \quad J_{C-F} = 332.5 \text{ Hz), 123.8 (C-F,} \quad J_{C-F} = 278.9 \text{ Hz), 121.2 (C-F,} \quad J_{C-F} = 332.5 \text{ Hz), 121.0 (C-F,} \quad J_{C-F} = 278.9 \text{ Hz), 117.9 (C-F,} \quad J_{C-F} = 332.5 \text{ Hz), 41.7 (C-F,} \quad J_{C-F} = 28.6 \text{ Hz), 41.4 (C-F,} \quad J_{C-F} = 28.6 \text{ Hz), 41.1 (C-F,} \quad J_{C-F} = 28.6 \text{ Hz), 40.8 (C-F,} \quad J_{C-F} = 28.6 \text{ Hz), 38.5 (s);} \quad \text{HRMS (ESI) } m/z: \quad [\text{M-H}]^- \text{ Calcd for C}_{16}\text{H}_{11}\text{F}_6\text{Se }396.9936; \quad \text{Found }396.9937.\]

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5 Large Scale Reaction

Into a 100 mL Schlenk bottle were added alkene 1a (0.54 g, 3.0 mmol), (Me₄N)SeCF₃ (1.0 g, 4.5 mmol), ICF₂CO₂Et (2.25 g, 9.0 mmol), Cu₂O (43.0 mg, 0.3 mmol), L8 (175.0 mg, 0.45 mmol), Cs₂CO₃ (0.98 g, 3.0 mmol) and anhydrous 1,4-dioxane (45 mL) under argon atmosphere. The Schlenk bottle was sealed and the reaction mixture was stirred at room temperature for 72 h. After the completion of reaction, the pure product 4 was isolated by flash column chromatography (0.89 g, 66%).

6. Mechanistic Study

Into a 10 mL sealed tube were added alkene 1a (18 mg, 0.1 mmol), 3c or 3d (0.3 mmol), Cu₂O (1.4 mg, 0.01 mmol), L8 (5.8 mg, 0.015 mmol), Cs₂CO₃ (33 mg, 0.1 mmol) and anhydrous 1,4-dioxane (1.5 mL) under argon atmosphere. The tube was sealed and the reaction mixture was stirred at room temperature for 48 h. But no conversion of alkene was observed.

Into a 10 mL sealed tube were added chloride 8 or a similar bromide substrate (0.1 mmol), (Me₄N)SeCF₃ (33 mg, 0.15 mmol) and anhydrous 1,4-dioxane (1.5 mL) under argon atmosphere. The
tube was sealed and the reaction mixture was stirred at room temperature for 48 h. After the completion of reaction, the reaction system was added with PhCF₃ (0.1 mmol) as internal standard. The chloride substrate could not react with (Me₄N)SeCF₃ to generated the desired product 30, but the bromide substrate reacted well with (Me₄N)SeCF₃ to provide the substitution product in 30% yield.

![Chemical structure](image)

Into a 10 mL sealed tube were added radical clock substrate 37 (22 mg, 0.1 mmol), (NMe₄)SeCF₃ (33 mg, 0.15 mmol), ICF₂CO₂Et (75 mg, 0.3 mmol), Cu₂O (1.43 mg, 0.01 mmol), L₈ (5.8 mg, 0.015 mmol), Cs₂CO₃ (33 mg, 0.1 mmol) and anhydrous 1,4-dioxane (1.5 mL) under argon atmosphere. The tube was sealed and the reaction mixture was stirred at room temperature for 48 h. After the completion of reaction, the pure product 38 was isolated by flash column chromatography.

**ethyl (Z)-2,2-difluoro-4,7-diphenyl-7-((trifluoromethyl)selanyl)hept-4-enoate (38)**

![Chemical structure](image)

The product mixture was purified by silica gel column chromatography (petroleum ether/ethyl acetate = 10:1) to afford 38 (33.2 mg, 67%, mixture of Z/E = 1:10) as a slightly green liquid. ¹H NMR (400 MHz, CDCl₃) (major) (ppm) 7.35 (d, J = 4.2 Hz, 4H), 7.31 – 7.26 (m, 3H), 7.24 – 7.21 (m, 1H), 7.20 – 7.14 (m, 2H), 5.74 (t, J = 7.3 Hz, 1H), 4.66 (dd, J = 8.7, 6.8 Hz, 1H), 3.87 (q, J = 7.2 Hz, 2H), 3.33 – 3.20 (m, 2H), 3.13 – 3.04 (m, 2H), 1.13 (t, J = 7.2 Hz, 3H); ¹⁹F NMR (376 MHz, CDCl₃) (ppm) -33.07 (s, 3F), -103.05 (dt, J = 38.5, 15.8 Hz, 2F); ¹³C NMR (101 MHz, CDCl₃) (ppm) 164.0 (C-F, J_C-F = 32.5 Hz), 163.7 (C-F, J_C-F = 32.5 Hz), 163.3 (C-F, J_C-F = 32.5 Hz), 141.5, 139.7, 132.93 (C-F, J_C-F = 4.1 Hz), 132.89 (C-F, J_C-F = 4.1 Hz), 132.85 (C-F, J_C-F = 4.1 Hz), 131.6, 128.9, 128.2, 128.1, 128.0 (C-F, J_C-F = 331.6 Hz), 127.6, 127.5, 126.8, 124.7 (C-F, J_C-F = 331.6 Hz), 121.4 (C-F, J_C-F = 331.6 Hz), 118.1 (C-F, J_C-F = 331.6 Hz), 117.4 (C-F, J_C-F = 252.5 Hz), 114.9 (C-F, J_C-F = 252.5 Hz), 112.4 (C-F, J_C-F = 252.5 Hz), 62.7, 46.4, 36.3, 35.9 (C-F, J_C-F = 24.6 Hz), 35.7 (C-F, J_C-F = 24.6 Hz).
$f = 24.6$ Hz), 35.4 (C-F, $^2J_{C-F} = 24.6$ Hz), 13.6; HRMS (ESI) $m/z$: [M+H]$^+$ Calcd for C$_{22}$H$_{22}$F$_5$O$_2$Se 493.0700; Found 493.0690.

Into a 10 mL sealed tube were added alkene 1a (18 mg, 0.1 mmol), (NMe$_4$)SeCF$_3$ (33 mg, 0.15 mmol), ICF$_2$CO$_2$Et (75 mg, 0.3 mmol), Cu$_2$O (1.4 mg, 0.01 mmol), L$_8$ (5.8 mg, 0.015 mmol), Cs$_2$CO$_3$ (33 mg, 0.1 mmol), TEMPO (47 mg, 0.3 mmol) and anhydrous 1,4-dioxane (1.5 mL) under argon atmosphere. The tube was sealed and the reaction mixture was stirred at room temperature for 48 h. After the completion of reaction, the reaction system was added with PhCF$_3$ (0.1 mmol) as internal standard, followed by direct fluorine spectrum to monitoring reaction system and high resolution mass of product 39. HRMS (ESI) $m/z$: [M+H]$^+$ Calcd for C$_{13}$H$_{24}$F$_2$NO$_3$ 280.1719; Found 280.1713.
7. References


8. NMR spectra

$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}\text{F NMR: (376 MHz, CDCl}_3\text{)}$

$^{13}\text{C NMR: (101 MHz, CDCl}_3\text{)}$
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^{19}\text{F NMR: (376 MHz, CDCl}_3\text{)}$

$^{13}\text{C NMR: (101 MHz, CDCl}_3\text{)}$
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

![Chemical Structure 10](image)

$^1$H NMR: (400 MHz, CDCl$_3$)

![Chemical Structure 11](image)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}\text{F NMR:}\ (376\text{ MHz, CDCl}_3)$

$^{13}\text{C NMR:}\ (101\text{ MHz, CDCl}_3)$
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}F$ NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)

S50
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^{1}$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

![NMR spectrum](image1)

$^{19}$F NMR: (376 MHz, CDCl$_3$)

![NMR spectrum](image2)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl₃)

$^{19}$F NMR: (376 MHz, CDCl₃)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

![Spectrum Image]

$^1$H NMR: (400 MHz, CDCl$_3$)

![Spectrum Image]
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
$^{13}$C NMR: (101 MHz, CDCl$_3$)

$^1$H NMR: (400 MHz, CDCl$_3$)
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)
$^1$H NMR: (400 MHz, CDCl$_3$)

$^{19}$F NMR: (376 MHz, CDCl$_3$)
\[ ^{13}\text{C NMR: (101 MHz, CDCl}_3) \]

\[ ^{1}\text{H NMR: (400 MHz, CDCl}_3) \]
$^{19}$F NMR: (376 MHz, CDCl$_3$)

$^{13}$C NMR: (101 MHz, CDCl$_3$)