Supporting Information

**CF$_3$-Containing *para*-Quinone Methides for Organic Synthesis**

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1. General Information:

1.1. General Methods

$^1$H-, $^{19}$F- and $^{13}$C-NMR spectra were recorded on a Bruker Avance III 300 MHz spectrometer with a broad band observe probe and a sample changer for 16 samples, on a Bruker Avance DRX 500 MHz spectrometer, and on a Bruker Avance III 700 MHz spectrometer with an Ascend magnet and TCI cryoprobe which are property to the Austro-Czech NMR-Research Center “RERI-uasb”. All NMR spectra were referenced on the solvent peak. High resolution mass spectra were obtained using an Agilent 6520 Q-TOF mass spectrometer with an ESI source and an Agilent G1607A coaxial sprayer or a Thermo Fisher Scientific LTQ Orbitrap XL with an Ion Max API Source. Preparative column chromatography was carried out using Davisil LC 60A 70-200 MICRO silica gel. TLC probes were detected at 254 nm or stained with an appropriate staining solution (compare section 3.1.3). HPLC was performed using a Dionex Summit HPLC system with a Chiralcel YMC-SB (250 x 4.6 mm, 5 µm) and a Chiralpak AD-H (4.6 mm x 250 mm, 5 µm) chiral stationary phase. All chemicals were purchased from commercial suppliers and used without further purification unless otherwise stated. All reactions were carried out under Argon.

1.2. Kinetic Investigations (General Details)

UV-vis measurements of 1a were done on a J&M TIDAS diode array spectrophotometer equipped with a Hellma 661.502-QX quartz Suprasil immersion probe (path d = 5 mm) and controlled by TIDASDAQ (v3) software. Kinetic studies were conducted photometrically at 20 °C (controlled by a circulating bath thermostat) in anhydrous DMSO (<50 ppm H$_2$O; commercial) using a stopped-flow spectrophotometer (Applied Photophysics SX.20MV-R) and stock solutions kept under nitrogen atmosphere by measuring the decay of the electrophile absorption (at $\lambda_{\text{max}}$). In order to achieve pseudo-first order kinetics, reference nucleophiles were used in large excess (up to 60 eq.). To show that the influence of the K$^+$-counterion or ion pairing can be neglected, 18-crown-6 ether was added for some kinetic measurements. CH-acids are added in excess (2 equivalents) with respect to the base to ensure a fast protonation of the intermediate reaction adduct.

The mono-exponential decay of the absorbance of 1a (CF$_3$QM) upon reaction with reference nucleophiles 5 follows first-order kinetics $[A_t = A_0 e^{(-k_{\text{obs}} \cdot t)}] + C$ (eq. 1), giving observed rate constants $k_{\text{obs}}$ (s$^{-1}$) by least-squares fitting. For each nucleophile concentration the average result of at least four runs is given. After plotting the nucleophile concentration against $k_{\text{obs}}$ and applying a linear fit, second-order rate constants $k_2$ (M$^{-1}$ s$^{-1}$) were obtained from the slope of the linear equation.

The electrophilicity parameter $E$ is calculated using a nonlinear solver software for minimizing the squares of the deviations between calculated and experimental rate constants $\Delta^2 = \Sigma (\log k_2 - s_p(N + E))^2$ (eq. 2).$^{[1,2]}$

$^1$Ordering polar organic reactivity according to Equation 1 (main text): (a) H. Mayr, M. Patz, Angew. Chem. Int. Ed. Engl. 1994, 33, 938-957. (b) H. Mayr, T. Bug, M. F. Gotta, N. Hering, B. Irrgang, B. Janker, B. Kempf, R. Loos, A. R. Oflial, G. Remennikov, H. Schimmel, J. Am. Chem. Soc. 2001, 123, 9500-9512. (c) H. Mayr, A. R. Oflial, Pure Appl. Chem. 2005, 77, 1807-1821. (d) H. Mayr, A. R. Oflial, SAR QSAR Environ. Res. 2015, 26, 619-646. (e) H. Mayr, Tetrahedron 2015, 71, 5095-5111.

$^2$Reactivity parameters can be obtained from the online database at www.cup.lmu.de/oc/mayr/DBintro.html.
2. Syntheses, Kinetic Studies, and Application Scope

2.1 Syntheses of the Quinone-Methides and Quinone-Methide Precursors

General procedure 1 for the synthesis of 1a:

\[ \text{Step 1:} \quad \text{The synthesis was performed according to a modified literature procedure.}^{[3]} \ \text{CuI (1 mmol) and Togni reagent II (7, 15 mmol) were dissolved in 50 mL DMF. Then the phenol 2 (10 mmol) was added and the mixture was stirred at 40 °C. After 1 h the reaction mixture was diluted with EtOAc and washed with NaHCO}_3. \ \text{The organic layer was dried over Na}_2\text{SO}_4, \text{filtered and concentrated in vacuo. The crude product was purified by column chromatography on silica gel (heptanes/EtOAc = 20:1) to yield product 8 in 91% yield.} \]

\[ \text{Step 2:} \quad \text{For the synthesis of compound 1a, the trifluoroethylated phenol 8 (10 mmol) was dissolved in 200 mL MeOH and DDQ (25 mmol) was added. The reaction mixture was stirred at room temperature for 1 h. After completion of the reaction, the solvent was evaporated and the crude reaction mixture was purified by column chromatography (heptanes/dichloromethane = 10:1) to afford product 1a in 84% yield.} \]

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3 H. Egami, T. Ide, Y. Kawato, Y. Hamashima, Chem. Commun. 2015, 51, 16675-16678.
**8:** Compound was prepared according to the general procedure 1 step 1 in 91% yield. The product occurs as a colorless oil.

HRMS (ESI): m/z calculated for C_{16}H_{21}F_{3}O: 287.1628 [M-H]−; found: 287.1628.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 7.34 (s, 2H), 5.49 (s, 1H), 3.53 (q, J = 11.0 Hz, 2H), 1.71 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -66.05 (t, J = 11.0 Hz, 3F) ppm;

**1a:** Prepared according to the general procedure 1, step 2 in 84% yield. The product occurs as yellow solid with a melting range of 34.5 – 35°C.

R$_f$ (CH$_2$Cl$_2$:heptanes = 4:1) = 0.50.

HRMS (ESI): m/z calculated for C$_{16}$H$_{21}$F$_3$O: 317.1734 [M-H+MeOH]−; found: 317.1730.

$^1$H-NMR (700 MHz, CDCl$_3$, 298 K): δ = 7.33 (s, 1H), 6.78 (s, 1H), 6.03 (q, J = 8.9 Hz, 1H), 1.29 (s, 9H), 1.28 (s, 9H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -55.40 (d, J = 8.9 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 186.2, 151.7, 151.4, 138.4 (q, J = 5.5 Hz), 132.4, 125.3, 124.1 (q, J = 34.7 Hz), 123.0 (q, J = 271.0 Hz), 35.8, 35.4, 29.5 ppm.
General procedure 2:

Step 1: The syntheses of compounds 11 were performed according to a modified literature procedure\(^4\). The corresponding phenol 9 (30 mmol) and trifluoroacetaldehyde ethyl hemiacetal 10 (30 mmol) or difluoroacetaldehyde ethyl hemiacetal 22 (30 mmol) were mixed and \(\text{K}_2\text{CO}_3\) (1.5 mmol) was added. The mixture was heated to 60 °C and stirred for 16 h. After cooling the reaction mixture it was dissolved with ethyl acetate and washed with ammonium chloride, \(\text{H}_2\text{O}\) and brine. The organic layer was dried with \(\text{Na}_2\text{SO}_4\) and evaporated to dryness. The crude products 11 were used directly in the next step.

Step 2: Compounds 12 were synthesized according to a modified literature procedure\(^5\). A mixture of phenol 11 (10 mmol) and \(\text{SOCl}_2\) (14 mmol) in 15 mL abs. toluene was cooled to 0-5 °C and pyridine (10 mmol) was added. After 1 h the mixture was heated to 70 °C and stirred for another 2 h. After cooling of the reaction it was poured on 20 g of ice and stirred for another 30 min. Then the organic layer was separated and the aqueous layer was extracted twice with ethyl acetate. The combined organic layers were dried over \(\text{Na}_2\text{SO}_4\) and evaporated to dryness. The crude reaction mixture was purified by column chromatography (\(\text{CH}_2\text{Cl}_2\) / Heptane = 2:1) to give the products 12 in the reported yields.

Note: After column chromatography around 10 % of the QMs 1 can be detected in the product mixture.

Step 3: For the synthesis of quinone methide 1b the product 12b of step 2 (5 mmol) was dissolved in 20 mL \(\text{CH}_2\text{Cl}_2\) and triethylamine (5.5 mmol) was added. The reaction mixture was stirred at room temperature and after completion of the reaction (followed by TLC / 2-24 h), \(\text{H}_2\text{O}\) was added. The organic layer was washed with 1 N \(\text{HCl}\) followed by sat. \(\text{NaHCO}_3\) and brine. After drying the organic layer over \(\text{Na}_2\text{SO}_4\) it was evaporated to dryness and the quinone methide 1b was isolated by column chromatography with gradients of heptanes and ethyl acetate (20:1 – 10:1 – 5:1 – 1:1).

\(^4\) Y. Gong, K. Kato, and H. Kimoto, *Bull. Chem. Soc. Jpn.* 2001, 74, 377-383.
\(^5\) Y. Gong, K. Kato, *Synlett* 2002, 3, 431-434.
1b: Prepared according to the general procedure 2 step 3 in 54%. The product occurs as a yellow oil (Precursors 11b and 12b are literature known compounds\cite{4,5}).

Rf (CH\textsubscript{2}Cl\textsubscript{2}:heptanes = 2:1) = 0.23.

HRMS (ESI): m/z calculated for C\textsubscript{10}H\textsubscript{8}F\textsubscript{3}O: 201.0533 [M-H]\textsuperscript{-}; found: 201.0535.

\textsuperscript{1}H-NMR (300 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = 7.34\) (s, 1H), 6.84 (s, 1H), 6.00 (q, \(J = 8.9\) Hz, 1H), 2.05 (s, 3H), 2.02 (s, 3H) ppm; \textsuperscript{19}F-NMR (282 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = -55.40\) (d, \(J = 8.9\) Hz, 3F) ppm; \textsuperscript{13}C-NMR (125 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = 186.9, 140.0, 139.4, 137.8\) (q, \(J = 5.5\) Hz), 135.8, 128.7, 124.0 (q, \(J = 34.8\) Hz), 122.7 (q, \(J = 271.7\) Hz), 16.8, 16.2 ppm.

11c: Compound was prepared according to the general procedure 2 step 1. The product occurs as yellow oil. Compound 11c was used in the next step without further purification and the crude yield is 34%.

HRMS (ESI): m/z calculated for C\textsubscript{8}H\textsubscript{5}Br\textsubscript{2}F\textsubscript{3}O\textsubscript{2}: 348.8678 [M+H]\textsuperscript{+}; found: 348.8681.

\textsuperscript{1}H-NMR (300 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = 7.60\) (s, 2H), 6.07 (s, 1H), 5.00 (q, \(J = 6.5\) Hz, 1H) ppm; \textsuperscript{19}F-NMR (282 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = -73.36\) (d, \(J = 6.5\) Hz, 3F) ppm; \textsuperscript{13}C-NMR (125 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = 151.1, 132.5, 129.2, 128.4, 126.7, 125.4, 123.1\) (q, \(J = 278.7\) Hz), 110.2, 56.9 (q, \(J = 34.5\) Hz) ppm.

12c: Compound was prepared according to the general procedure 2 step 2 in 63% yield. The product occurs as yellow oil.

Rf (CH\textsubscript{2}Cl\textsubscript{2}:heptanes = 2:1) = 0.56.

HRMS (ESI): m/z calculated for C\textsubscript{9}H\textsubscript{4}Br\textsubscript{2}Cl\textsubscript{2}F\textsubscript{3}O: 366.8342 [M+H]\textsuperscript{+}; found: 366.8348.

\textsuperscript{1}H-NMR (300 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = 7.60\) (s, 2H), 6.07 (s, 1H), 5.00 (q, \(J = 6.6\) Hz, 1H) ppm; \textsuperscript{19}F-NMR (282 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = -73.45\) (d, \(J = 6.6\) Hz, 3F) ppm; \textsuperscript{13}C-NMR (125 MHz, CD\textsubscript{3}Cl, 298 K): \(\delta = 151.1, 132.5, 129.2, 128.4, 126.7, 125.4, 123.1\) (q, \(J = 278.8\) Hz), 110.2, 50.0 (q, \(J = 34.4\) Hz) ppm.

11d: Compound was prepared according to the general procedure 2 step 1 in 66% crude yield. The product occurs as yellow oil. The crude product was directly used in the next step without further purification.

HRMS (ESI): m/z calculated for C\textsubscript{13}H\textsubscript{7}F\textsubscript{3}O\textsubscript{2}: 263.1253 [M+H]\textsuperscript{+}; found: 263.1252.
$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta = 7.21$ (s, 1H), 7.13 (s, 1H), 4.93-4.89 (m, 2H), 2.35 (d, J = 4.1 Hz, 1H), 2.27 (s, 3H), 1.42 (s, 9H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta = -78.30$ (d, J = 6.9 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta = 153.9, 136.1, 127.6, 125.4, 124.7, 124.6$ (q, J = 283.5 Hz), 123.5, 73.1 (q, J = 31.8 Hz), 35.7, 29.8, 16.1 ppm.

12d: Compound was prepared according to the general procedure 2 step 2 in 95% (yellow oil).

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.42.

HRMS (ESI): m/z calculated for C$_{13}$H$_{16}$ClF$_3$O: 281.0915 [M+H]$^+$; found: 281.0915.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta = 7.22$ (s, 1H), 7.17 (s, 1H), 5.03 (q, J = 7.0 Hz, 1H), 2.27 (s, 3H), 1.42 (s, 9H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta = -73.21$ (d, J = 7.0 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta = 154.2, 138.0, 136.1, 129.2, 128.8, 128.4, 126.1, 125.4, 123.7, 123.7$ (q, J = 279.1 Hz), 123.5, 59.2 (q, J = 34.1 Hz), 34.7, 29.7, 16.1 ppm.

11e: Prepared according to the general procedure 2 step 1 in 30% yield (colorless oil).

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.33.

HRMS (ESI): m/z calculated for C$_{11}$H$_{11}$F$_3$O$_4$: 253.0682 [M+H]$^+$; found: 253.0680.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta = 6.70$ (s, 2H), 5.60 (s, 1H), 4.98-4.90 (m, 1H), 3.91 (s, 6H), 2.54 (d, J = 4.2 Hz, 1H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta = -78.36$ (d, J = 6.3 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta = 147.2, 135.9, 127.9$ (q, J = 280.2 Hz), 125.1, 125.5, 104.4, 73.0 (q, J = 32.8 Hz), 56.5 ppm.

12e: Prepared according to the general procedure 2 step 2 in 71% yield (pink oil).

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.33.

HRMS (ESI): m/z calculated for C$_{10}$H$_{10}$ClF$_3$O$_3$: 271.0343 [M+H]$^+$; found: 271.0339.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta = 6.71$ (s, 2H), 5.65 (s, 1H), 5.03 (q, J = 6.7 Hz, 1H), 3.92 (s, 6H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta = -73.20$ (d, J = 6.7 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta = 147.1, 136.4, 129.1, 128.4, 125.4, 123.8$ (q, J = 282.8 Hz), 123.1, 105.8, 59.3 (q, J = 35.0 Hz), 56.6 ppm.
11b-CF₂H: Prepared according to the general procedure 2 step 1 in 70% yield (yellow oil). The product decomposes very quickly and have to be used directly for the next step.

Rf (heptanes:EtOAc = 1:1) = 0.62.

HRMS (ESI): m/z calculated for C₁₀H₁₂F₂O₂: 203.0878 [M+H]⁺; found: 203.0877.

¹H-NMR (300 MHz, CDCl₃, 298 K): δ = 7.03 (s, 2H), 5.74 (td, J₁ = 56.2 Hz, J₂ = 4.8 Hz, 1H), 4.74-4.66 (m, 2H), 2.26 (s, 6H) ppm; ¹⁹F-NMR (282 MHz, CDCl₃, 298 K): δ = -120.82 (dd, J₁ = 56.2 Hz, J₂ = 10.9 Hz, 1F), 120.91 (dd, J₁ = 56.2 Hz, J₂ = 10.9 Hz, 1F) ppm.

12b-CF₂H: Prepared according to the general procedure 2 step 2 in 30% yield (yellow oil).

Rf (CH₂Cl₂:heptanes = 2:1) = 0.42.

HRMS (ESI): m/z calculated for C₁₀H₁₁ClF₂O: 221.0539 [M+H]⁺; found: 221.0539.

¹H-NMR (300 MHz, CDCl₃, 298 K): δ = 7.05 (s, 2H), 5.94 (td, J₁ = 56.1 Hz, J₂ = 4.9 Hz, 1H), 4.83 (td, J₁ = 10.9 Hz, J₂ = 4.9 Hz, 1H), 4.76 (s, 1H), 2.26 (s, 6H) ppm; ¹⁹F-NMR (282 MHz, CDCl₃, 298 K): δ = -120.83 (dd, J₁ = 56.1 Hz, J₂ = 10.9 Hz, 1F), -120.88 (dd, J₁ = 56.1 Hz, J₂ = 10.9 Hz, 1F) ppm; ¹³C-NMR (125 MHz, CDCl₃, 298 K): δ = 153.4, 128.9, 125.3, 123.6, 114.5 (t, J = 249.3 Hz), 60.3 (t, J = 25.5 Hz), 16.0 ppm.
2.2. Kinetics

UV-Spectrum for 1a and Its Molar Absorption Coefficient at $\lambda_{\text{max}}$

A solution of quinone methide 1a in DMSO (3 mg in 1 mL solvent) was added stepwise to 24 mL of DMSO, by means of a microliter syringe. The molar absorption coefficient $\varepsilon$ was determined by linear regression of a correlation of absorbance (at the absorption maximum $\lambda_{\text{max}} = 292$ nm) versus the concentration.

**Kinetic Measurements**

Kinetics of the reaction of 1a with 5a (generated from diethyl malonate 5a-H)

| $[1a]_0$, mol L$^{-1}$ | $[5a-H]_0$, mol L$^{-1}$ | $[\text{KOTBu}]_0$, mol L$^{-1}$ | $[18\text{-c-6}]_0$, mol L$^{-1}$ | $[5a]_0$, mol L$^{-1}$ | $k_{\text{obs}}$, s$^{-1}$ |
|----------------------|------------------------|-------------------------------|-------------------------------|----------------------|------------------------|
| $2.52 \times 10^{-5}$ | $4.00 \times 10^{-4}$   | $2.00 \times 10^{-4}$         | $2.00 \times 10^{-4}$         | $2.00 \times 10^{-4}$ | $1.08 \times 10^2$    |
| $2.52 \times 10^{-5}$ | $5.00 \times 10^{-4}$   | $2.50 \times 10^{-4}$         | $3.00 \times 10^{-4}$         | $2.50 \times 10^{-4}$ | $1.38 \times 10^2$    |
| $2.52 \times 10^{-5}$ | $6.00 \times 10^{-4}$   | $3.00 \times 10^{-4}$         | $3.00 \times 10^{-4}$         | $3.00 \times 10^{-4}$ | $1.65 \times 10^2$    |
| $2.52 \times 10^{-5}$ | $7.00 \times 10^{-4}$   | $3.50 \times 10^{-4}$         | $5.00 \times 10^{-4}$         | $3.50 \times 10^{-4}$ | $1.91 \times 10^2$    |
| $2.52 \times 10^{-5}$ | $8.00 \times 10^{-4}$   | $4.00 \times 10^{-4}$         | $4.00 \times 10^{-4}$         | $4.00 \times 10^{-4}$ | $2.16 \times 10^2$    |

$k_2 = 5.38 \times 10^5$ M$^{-1}$ s$^{-1}$

$k_{\text{obs}} = 5.38 \times 10^5 [5a] + 2.20$

$R^2 = 0.9987$
Kinetics of the reaction of 1a with 5b (generated from ethyl cyanoacetate 5b-H)

| [1a]₀, mol L⁻¹ | [5b-H]₀, mol L⁻¹ | [KOTBu]₀, mol L⁻¹ | [18-c-6]₀, mol L⁻¹ | [5b]₀, mol L⁻¹ | k_{obs}, s⁻¹ |
|----------------|-----------------|-------------------|-------------------|--------------|-------------|
| 2.52 × 10⁻⁵    | 4.00 × 10⁻⁴     | 2.00 × 10⁻⁴       | 2.00 × 10⁻⁴       | 5.00 × 10⁻⁴  | 5.58 × 10¹  |
| 2.52 × 10⁻⁵    | 5.00 × 10⁻⁴     | 2.50 × 10⁻⁴       | 3.00 × 10⁻⁴       | 7.04 × 10¹  |
| 2.52 × 10⁻⁵    | 6.00 × 10⁻⁴     | 3.00 × 10⁻⁴       | 3.00 × 10⁻⁴       | 8.22 × 10¹  |
| 2.52 × 10⁻⁵    | 7.00 × 10⁻⁴     | 3.50 × 10⁻⁴       | 5.00 × 10⁻⁴       | 9.23 × 10¹  |
| 2.52 × 10⁻⁵    | 8.00 × 10⁻⁴     | 4.00 × 10⁻⁴       | 4.00 × 10⁻⁴       | 1.13 × 10²  |

\[ k_2 = 2.73 \times 10^5 \text{ M}^{-1} \text{s}^{-1} \]

\[ k_{obs} = 2.73 \times 10^5 [5b] + 0.96 \]

\[ R^2 = 0.9853 \]

Kinetics of the reaction of 1a with 5c (generated from malononitrile 5c-H)

| [1a]₀, mol L⁻¹ | [5c-H]₀, mol L⁻¹ | [KOTBu]₀, mol L⁻¹ | [18-c-6]₀, mol L⁻¹ | [5c]₀, mol L⁻¹ | k_{obs}, s⁻¹ |
|----------------|-----------------|-------------------|-------------------|--------------|-------------|
| 2.52 × 10⁻⁵    | 4.00 × 10⁻⁴     | 2.00 × 10⁻⁴       | 2.00 × 10⁻⁴       | 5.00 × 10⁻⁴  | 2.02 × 10¹  |
| 2.52 × 10⁻⁵    | 6.00 × 10⁻⁴     | 3.00 × 10⁻⁴       | 3.00 × 10⁻⁴       | 3.14 × 10¹  |
| 2.52 × 10⁻⁵    | 8.00 × 10⁻⁴     | 4.00 × 10⁻⁴       | 4.00 × 10⁻⁴       | 4.21 × 10¹  |
| 2.52 × 10⁻⁵    | 1.00 × 10⁻³     | 5.00 × 10⁻⁴       | 5.00 × 10⁻⁴       | 5.10 × 10¹  |

\[ k_2 = 1.03 \times 10^5 \text{ M}^{-1} \text{s}^{-1} \]

\[ k_{obs} = 1.03 \times 10^5 [5c] + 0.09 \]

\[ R^2 = 0.9974 \]
Kinetics of the reaction of 1a with 5d (generated from the phosphine oxide 5d-H)

| [1a]₀, mol L⁻¹ | [5d-H]₀, mol L⁻¹ | [KOTBu]₀, mol L⁻¹ | [18-c-6]₀, mol L⁻¹ | [5d]₀, mol L⁻¹ | k_{obs}, s⁻¹ |
|----------------|-----------------|-------------------|-------------------|---------------|-------------|
| 2.52 × 10⁻⁵    | 4.00 × 10⁻⁴     | 2.00 × 10⁻⁴       | 2.00 × 10⁻⁴       | 1.59 × 10¹    |
| 2.52 × 10⁻⁵    | 5.00 × 10⁻⁴     | 2.50 × 10⁻⁴       | 3.00 × 10⁻⁴       | 1.99 × 10¹    |
| 2.52 × 10⁻⁵    | 6.00 × 10⁻⁴     | 3.00 × 10⁻⁴       | 3.00 × 10⁻⁴       | 2.35 × 10¹    |
| 2.52 × 10⁻⁵    | 7.00 × 10⁻⁴     | 3.50 × 10⁻⁴       | 5.00 × 10⁻⁴       | 2.79 × 10¹    |

\[ k_2 = 7.92 \times 10^4 \text{ M}^{-1} \text{ s}^{-1} \]

\[ k_{obs} = 7.92 \times 10^4 [5d] + 0.02 \]

\[ R^2 = 0.9986 \]
Determination of the Electrophilicity Parameter \( E \) for the Quinone Methide 1a

| Nucleophile | \( N \)  | \( s_N \) | \( k_2^{\text{exp}} \) (M\(^{-1}\)s\(^{-1}\)) | \( k_2^{\text{eq1}} \) \([a]\) (M\(^{-1}\)s\(^{-1}\)) | \( k_2^{\text{exp}}/k_2^{\text{eq1}} \) |
|-------------|--------|--------|-----------------|-----------------|-----------------|
| \( 5a \)    | 20.22  | 0.65   | \( 5.38 \times 10^5 \) | \( 3.56 \times 10^5 \) | 1.5             |
| \( 5b \)    | 19.62  | 0.67   | \( 2.73 \times 10^5 \) | \( 2.09 \times 10^5 \) | 1.3             |
| \( 5c \)    | 19.36  | 0.67   | \( 1.03 \times 10^5 \) | \( 1.40 \times 10^5 \) | 0.74            |
| \( 5d \)    | 18.69  | 0.72   | \( 7.92 \times 10^4 \) | \( 1.11 \times 10^5 \) | 0.71            |

\([a]\) Second-order rate constant \( k_2^{\text{eq1}} \) calculated by applying Equation 1 (main text), the nucleophile-specific reactivity parameters \( N \) and \( s_N \) of \( 5a-d \) (from ref [2]) and the \( E \) parameter of 1a.

\[ E (1a) = -11.68 \]
2.3 Products 6a-d of the Kinetic Studies

General procedure 3 (Synthesis of compounds 6 in DMSO with KOTBu): 2,6-di-tert-Butyl-4-(2,2,2-trifluoroethylidene)cyclohexa-2,5-dien-1-one 1a (0.1 mmol) and KOTBu (0.2 mmol) were dissolved in DMSO (2 ml) in a flame dried Schlenk flask. Then the corresponding reaction partner 5-H (0.2 mmol) was added. The reaction mixture was stirred at room temperature. After 2 h the mixture was diluted with H$_2$O, extracted three times with EtOAc and with brine. The organic layer was dried with Na$_2$SO$_4$, filtered and concentrated in vacuo. The crude product was purified by column chromatography on silica gel (heptanes/EtOAc = 20:1).

General procedure 4 (Synthesis of compounds 6 under phase-transfer conditions): The quinone methide 1a (0.2 mmol), the corresponding nucleophiles 5-H (0.24 mmol) and triethylbenzylammonium chloride (TEBAC, 10 mol%) were dissolved in 4 mL CH$_2$Cl$_2$ and Cs$_2$CO$_3$ (0.24 mmol) was added. After stirring at room temperature for 24 h, the reaction mixture was filtered over a pad of Na$_2$SO$_4$ and evaporated to dryness. The products were purified by column chromatography (heptanes:EtoAc = 20:1).

6a: Compound was prepared according to the general procedure 3 in 49% isolated yield and according to procedure 4 in 62% (yellow oil).

R$_f$(CH$_2$Cl$_2$:heptanes = 2:1) = 0.73.

HRMS (ESI): m/z calculated for C$_{23}$H$_{33}$F$_3$O$_5$: 447.2350 [M+H]$^+$; found: 447.2353.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta$ = 7.06 (s, 2H), 5.23 (s, 1H), 4.32-4.21 (m, 2H), 4.20-4.10 (m, 1H), 4.09-4.05 (m, 1H), 3.94-3.76 (m, 2H), 1.41 (s, 18H), 1.31 (t, J = 7.1 Hz, 3H), 0.84 (t, J = 7.1 Hz, 3H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta$ = -66.61 (d, J = 8.3 Hz, 3F)
ppm; $^{13}$C-NMR (125 MHz, CDCl₃, 298 K): $\delta = 167.1$, 165.9, 154.2, 136.0, 136.4, 136.3 (q, J = 285.0 Hz), 122.4, 62.4, 61.8, 53.2, 49.3 (q, J = 27.0 Hz), 34.4, 30.3, 14.1, 13.6 ppm.

**6b**: Prepared according to the general procedure 3 in 43% yield and with a d.r. of 2:1 and according to procedure 4 in 51% (yellow oil).

Rᵣ (CH₂Cl₂:heptanes = 2:1) = 0.65.

HRMS (ESI): m/z calculated for C₂₁H₂₈F₃NO₃: 400.2094 [M+H]+; found: 400.2095.

$^1$H-NMR (300 MHz, CDCl₃, 298 K): $\delta = 7.23$ (s, 2H), 5.35 (s, 1H), 4.36-4.13 (m, 3H), 4.08-3.97 (m, 1H), 3.89-3.79 (m, 1H), 1.43 (s, 18H), 1.18-1.14 (m, 3H) ppm; $^{19}$F-NMR (282 MHz, CDCl₃, 298 K): $\delta = -67.95$ (d, J = 9.0 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl₃, 298 K): $\delta = 163.8$, 155.0, 154.9, 136.5, 126.3, 125.8, 120.0, 119.8 (q, J = 286.1 Hz), 114.1, 63.7, 49.3 (q, 28.6 Hz), 39.3, 30.3, 13.9 ppm.

**6c**: Prepared according to the general procedure 3 in 37% yield and according to procedure 4 in 48% (yellow oil).

Rᵣ (CH₂Cl₂:heptanes = 2:1) = 0.69.

HRMS (ESI): m/z calculated for C₁₉H₂₃F₃N₂O: 353.1835 [M+H]+; found: 353.1829.

$^1$H-NMR (300 MHz, CDCl₃, 298 K): $\delta = 7.23$ (s, 2H), 5.46 (s, 1H), 4.33 (d, J = 5.7 Hz, 1H), 3.89-3.79 (m, 1H), 1.45 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl₃, 298 K): $\delta = -66.92$ (d, J = 8.5 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl₃, 298 K): $\delta = 155.7$, 137.2, 125.9, 124.8 (q, J = 273.3 Hz), 118.7, 110.5, 110.2, 50.5 (q, J = 29.1 Hz), 34.6, 30.2, 25.5 ppm.

**6d**: Prepared according to the general procedure 3 in 55% yield and with a d.r. of 12:1 and according to procedure 4 in 57% and with a d.r. of 12.5:1 (yellow oil).

Rᵣ (CH₂Cl₂:heptanes = 2:1) = 0.72.

HRMS (ESI): m/z calculated for C₃₀H₃₃F₃NO₃P: 528.2274 [M+H]+; found: 528.2268.

$^1$H-NMR (300 MHz, CDCl₃, 298 K): $\delta = 7.85-7.81$ (m, 2H), 7.64-7.59 (m, 1H), 7.56-7.50 (m, 2H), 7.47-7.40 (m, 2H), 7.37-7.31 (m, 1H), 7.25 (s, 1H), 7.20-7.14 (m, 2H), 5.19, (s, 1H), 4.40-4.27 (m, 1H), 4.08-3.99 (m, 1H), 1.33 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl₃, 298 K): $\delta = -68.60$ (d, J = 9.3 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl₃, 298 K): $\delta = 154.8$, 136.0, 133.3 (d, J = 2.7 Hz), 132.4 (d, J = 2.8 Hz), 131.9 (d, J = 9.47 Hz), 130.9 (d, J = 10.1 Hz), 129.2 (d, J = 12.9 Hz), 128.9 (q, J = 273.4 Hz), 127.9 (d, J = 12.6 Hz), 127.2 (2C), 119.9, 116.1 (d, J = 2.9 Hz), 45.9 (q, J = 28.7 Hz), 34.4, 33.7 (d, J = 62.2 Hz), 30.2 ppm.
2.4 Racemic Reactions with C- and Heteroatom Nucleophiles

**General procedure 5:** The quinone methides 1a or 1b (0.2 mmol) or the QM-precursors 12b-e (0.2 mmol), the corresponding nucleophiles (0.24 mmol) and triethylbenzylammonium chloride (TEBAC, 10 mol%) were dissolved in 4 mL CH$_2$Cl$_2$ and Cs$_2$CO$_3$ (0.24 mmol) was added. After stirring at room temperature for 24 h, the reaction mixture was filtered over a pad of Na$_2$SO$_4$ and evaporated to dryness. The products were purified by column chromatography (Heptanes:EtOAc = 20:1).

**14a:** Prepared according to the general procedure 5 in an isolated yield of 69%. The product occurs as light brown solid with a melting range of 64.9 – 66.3°C.

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.71.

HRMS (ESI): m/z calculated for C$_{23}$H$_{30}$F$_3$NO: 394.2352 [M+H]$^+$; found: 394.2352.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta$ = 7.33-7.26 (m, 5H), 7.15 (s, 2H), 5.29 (s, 1H), 4.02 (q, J = 7.5 Hz, 1H), 3.86-3.82 (m, 1H), 3.71-3.64 (m, 1H), 1.45 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta$ = -73.85 (d, J = 7.5 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta$ = 154.4, 139.5, 136.1, 128.6, 128.4, 127.4, 126.0 (q, J = 283.2 Hz), 124.0, 63.5 (q, J = 28.6 Hz), 51.4, 34.5, 30.4 ppm.

**14b:** Prepared according to the general procedure 5 in 76% yield (yellow oil).

R$_f$ (CH$_2$Cl$_2$:heptanes = 3:1) = 0.54.

HRMS (ESI): m/z calculated for C$_{19}$H$_{28}$F$_3$NO: 344.2196 [M+H]$^+$; found: 344.2199.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta$ = 7.14 (s, 2H), 5.93-5.78 (m, 1H), 5.27 (s, 1H), 5.19-5.122 (m, 2H), 4.06 (q, J = 7.1 Hz, 1H), 3.22-3.16 (m, 2H), 1.44 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta$ = -73.85 (d, J = 7.1 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta$ = 154.4, 136.1, 136.0, 125.8 (q, J = 282.7 Hz), 125.2, 117.1, 63.5 (q, J = 29.3 Hz), 50.2, 34.5, 30.4 ppm.
14c: Prepared according to the general procedure 5 in 80% yield (yellow oil).

\[ \text{R}_f (\text{CH}_2\text{Cl}_2:\text{heptanes} = 3:1) = 0.42. \]

HRMS (ESI): m/z calculated for C\textsubscript{20}H\textsubscript{30}F\textsubscript{3}NO\textsubscript{2}: 374.2301 [M+H]\textsuperscript{+}; found: 374.2302.

\(^1\)H-NMR (300 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 7.11 \) (s, 2H), 5.27 (s, 1H), 3.88 (q, J = 9.5 Hz, 1H), 3.71-3.68 (m, 4H), 2.66-2.58 (m, 2H), 2.54-2.48 (m, 2H), 1.44 (s, 18H) ppm; \(^{19}\)F-NMR (282 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = -66.91 \) (d, J = 9.5 Hz, 3F) ppm; \(^{13}\)C-NMR (125 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 154.1, 135.8, 126.1, 126.0 \) (q, J = 286.1 Hz), 122.3, 71.1 (q, J = 26.9 Hz), 67.4, 34.4, 30.4 ppm.

15a: Prepared according to the general procedure 5 in 76% yield (yellow oil).

\[ \text{R}_f (\text{CH}_2\text{Cl}_2:\text{heptanes} = 2:1) = 0.56. \]

HRMS (ESI): m/z calculated for C\textsubscript{23}H\textsubscript{29}F\textsubscript{3}O\textsubscript{2}: 395.2192 [M+H]\textsuperscript{+}; found: 395.2190.

\(^1\)H-NMR (300 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 7.36 - 7.27 \) (m, 5H), 7.16 (s, 2H), 5.28 (s, 1H), 4.04 (q, J = 7.6 Hz, 1H), 3.85-3.80 (m, 1H), 3.70-3.66 (m, 1H), 1.44 (s, 18H) ppm; \(^{19}\)F-NMR (282 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = -73.87 \) (d, J = 7.6 Hz, 3F) ppm; \(^{13}\)C-NMR (125 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 154.4, 139.4, 136.1, 128.6, 128.4, 127.4, 126.2 \) (q, J = 281.2 Hz), 124.0, 63.5 (q, J = 28.1 Hz), 51.4, 34.5, 30.4 ppm.

15b: Prepared according to the general procedure 5 in 70% yield. The product occurs as yellow solid with a melting range of 66.8 - 67.3°C.

\[ \text{R}_f (\text{CH}_2\text{Cl}_2:\text{heptanes} = 2:1) = 0.74. \]

HRMS (ESI): m/z calculated for C\textsubscript{19}H\textsubscript{27}F\textsubscript{3}O: 343.1890 [M-H]; found: 343.1885.

\(^1\)H-NMR (300 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 7.19 \) (s, 2H), 5.96-5.83 (m, 1H), 5.32-5.22 (m, 3H), 4.58 (q, J = 6.8 Hz, 1H), 4.14-4.08 (m, 1H), 3.99-3.92 (m, 1H), 1.44 (s, 18H) ppm; \(^{19}\)F-NMR (282 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = -76.40 \) (d, J = 6.8 Hz, 3F) ppm; \(^{13}\)C-NMR (125 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 154.8, 136.1, 133.8, 125.1, 124.1 \) (q, J = 283.1 Hz), 123.2, 118.2, 78.9 (q, J = 30.2 Hz), 70.5, 34.5, 30.4 ppm.
**15c**: Prepared according to the general procedure 5 in 60% yield. The product occurs as white solid with a melting range of 80.4 – 81.6°C.

R\(_f\) (CH\(_2\)Cl\(_2\):heptanes = 2:1) = 0.70.

HRMS (ESI): m/z calculated for C\(_{22}\)H\(_{27}\)F\(_3\)O\(_2\): 379.1890 [M-H]; found: 379.1885.

\(^1\)H-NMR (300 MHz, CDCl\(_3\), 298 K): \(\delta = 7.26-7.20\) (m, 4H), 7.00-6.90 (m, 3H), 5.32-5.26 (m 2H), 1.41 (s, 18H) ppm; \(^1\)F-NMR (282 MHz, CDCl\(_3\), 298 K): \(\delta = -76.70\) (d, J = 6.5 Hz, 3F) ppm; \(^{13}\)C-NMR (125 MHz, CDCl\(_3\), 298 K): \(\delta = 157.5, 154.9, 136.2, 129.6, 124.7, 123.8\) (q, J = 278.2 Hz), 122.8, 122.4, 122.0, 116.5, 79.0 (q, J = 32.8 Hz), 34.4, 30.4 ppm.

**15d**: Prepared according to the general procedure 5 in 69% yield (yellow oil).

R\(_f\) (CH\(_2\)Cl\(_2\):heptanes = 2:1) = 0.73.

HRMS (ESI): m/z calculated for C\(_{18}\)H\(_{27}\)F\(_3\)O\(_2\): 331.1890 [M-H]; found: 331.1886.

\(^1\)H-NMR (300 MHz, CDCl\(_3\), 298 K): \(\delta = 7.20\) (s, 2H), 5.31 (s, 1H), 4.52 (q, J = 7.0 Hz, 1H), 3.57 (q, J = 6.8 Hz, 2H), 1.44 (s, 18H), 1.24 (t, J = 6.8 Hz, 3H) ppm; \(^1\)F-NMR (282 MHz, CDCl\(_3\), 298 K): \(\delta = -76.67\) (d, J = 7.0 Hz, 3F) ppm; \(^{13}\)C-NMR (125 MHz, CDCl\(_3\), 298 K): \(\delta = 154.7, 136.0, 124.9, 124.2\) (q, J = 284.1 Hz), 123.7, 80.0 (q, J = 32.2 Hz), 66.0, 34.5, 30.4, 15.3 ppm.

**16**: Prepared according to the general procedure 5 in 78% yield (yellow oil).

R\(_f\) (CH\(_2\)Cl\(_2\):heptanes = 2:1) = 0.68.

HRMS (ESI): m/z calculated for C\(_{13}\)H\(_{29}\)F\(_3\)O\(_3\): 409.1818 [M-H]; found: 409.1812.

\(^1\)H-NMR (300 MHz, CDCl\(_3\), 298 K): \(\delta = 7.35-7.27\) (m, 5H), 7.01 (s, 2H), 5.28 (s, 1H), 4.00 (q, J = 8.6 Hz, 1H), 3.89-3.85 (m, 1H), 3.73-3.69 (m, 1H), 1.40 (s, 18H) ppm; \(^1\)F-NMR (282 MHz, CDCl\(_3\), 298 K): \(\delta = -67.73\) (d, J = 8.6 Hz, 3F) ppm; \(^{13}\)C-NMR (125 MHz, CDCl\(_3\), 298 K): \(\delta = 154.2, 136.8, 136.2, 129.3, 128.7, 126.8\) (q, J = 278.8 Hz), 125.8, 124.0, 51.5 (q, J = 28.9 Hz), 37.0, 34.5, 30.4 ppm.
14d: Prepared according to the general procedure 5 starting from 12b in 76% yield (yellow oil).

Rf (CH$_2$Cl$_2$:heptanes = 2:1) = 0.43.

HRMS (ESI): m/z calculated for C$_{17}$H$_{18}$F$_3$NO: 310.1413 [M+H]$^+$; found: 310.1409.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 7.35-7.24 (m, 5H), 7.00 (s, 2H), 4.67 (s, 1H), 3.99 (q, J = Hz, 1H), 3.84-3.79 (m, 1H), 3.68-3.63 (m, 1H), 2.26 (s, 6H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -74.09 (d, J = 7.5 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 152.9, 139.3, 128.9, 128.7, 128.3, 127.4, 123.4, 122.7 (q, J = 273.3 Hz), 63.0 (q, J = 29.3 Hz), 51.2, 16.1 ppm.

14h: Prepared according to the general procedure 5 starting from 12b in 52% yield (yellow oil).

Rf (CH$_2$Cl$_2$:heptanes = 2:1) = 0.55.

HRMS (ESI): m/z calculated for C$_{15}$H$_{20}$F$_3$NO: 288.1570 [M+H]$^+$; found: 288.1567.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 6.96 (s, 2H), 4.65 (s, 1H), 3.88 (q, J = 9.1 Hz, 1H), 2.68-2.56 (m, 2H), 2.48-2.42 (m, 2H), 2.25 (s, 6H), 1.59-1.52 (m, 4H), 1.40-1.34 (m, 2H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -66.88 (d, J = 9.1 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 152.3, 129.8, 126.2 (q, J = 286.0 Hz), 124.1, 122.8, 70.8 (q, J = 27.5 Hz), 52.1, 26.5, 24.3, 16.2 ppm.

6e: Prepared according to the general procedure 5 starting from 12b in 52% yield (colourless oil).

Rf (CH$_2$Cl$_2$:heptanes = 2:1) = 0.43.

HRMS (ESI): m/z calculated for C$_{17}$H$_{21}$F$_3$O$_5$: 363.1414 [M+H]$^+$; found: 363.1414.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 6.92 (s, 2H), 4.79 (s, 1H), 4.31-4.19 (m, 2H), 4.11-4.02 (m, 2H), 3.91 (q, J = 8.7 Hz, 2H), 2.21 (s, 6H), 1.30 (t, J = 7.7 Hz, 3H), 0.96 (t, J = 7.7 Hz, 3H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -68.42 (d, J = 8.7 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 167.0, 165.9, 152.7, 129.8, 125.8 (q, J = 280.9 Hz) 123.3, 123.2, 62.5, 61.9, 53.0, 48.7 (q, J = 28.5 Hz), 18.0, 14.0, 13.7 ppm.
14e: Prepared according to the general procedure 5 starting from 12c in 78% yield (yellow oil).

Rf (CH$_2$Cl$_2$:heptanes = 2:1) = 0.68.

HRMS (ESI): m/z calculated for C$_{15}$H$_{12}$Br$_2$F$_3$NO: 437.9311 [M+H]$^+$; found: 437.9310.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 7.51 (s, 2H), 7.38-7.32 (m, 2H), 7.31-7.29 (m, 1H), 7.27-7.24 (m, 2H), 5.98 (s, 1H), 4.04 (q, J = 7.1 Hz, 1H), 3.84-3.80 (m, 1H), 3.65-5.60 (m, 1H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -74.16 (d, J = 7.1 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 150.2, 138.6, 132.4, 128.8, 128.2, 127.7, 124.9 (q, J = 281.6 Hz), 110.2, 62.17 (q, J = 29.4 Hz), 61.0 ppm.

14i: Prepared according to the general procedure 5 starting from 12c in 87% yield (yellow oil).

Rf (CH$_2$Cl$_2$:heptanes = 2:1) = 0.87.

HRMS (ESI): m/z calculated for C$_{13}$H$_{14}$Br$_2$F$_3$NO: 415.9467 [M+H]$^+$; found: 415.9467.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 7.49 (s, 2H), 5.92 (s, 1H), 3.94 (q, J = 8.7 Hz, 1H), 2.62-2.48 (m, 4H), 1.60-1.52 (m, 4H), 1.44-1.40 (m, 2H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -66.20 (d, J = 8.7 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 149.5, 132.7, 127.9, 126.0 (q, J = 287.1 Hz), 109.8, 69.6 (q, J = 27.7 Hz), 51.8, 26.5, 24.2 ppm.

6f: Prepared according to the general procedure 5 starting from 12c in 50% yield (yellow oil).

Rf (CH$_2$Cl$_2$:heptanes = 2:1) = 0.61.

HRMS (ESI): m/z calculated for C$_{15}$H$_{15}$Br$_2$F$_5$O$_5$: 490.9311 [M+H]$^+$; found: 490.9309.

$^1$H-NMR (700 MHz, CDCl$_3$, 298 K): δ = 7.43 (s, 2H), 5.95 (s, 1H), 4.32-4.21 (m, 2H), 4.19-4.10 (m, 1H), 4.02-3.93 (m, 3H), 1.30 (t, J = 7.1 Hz, 3H), 1.05 (t, J = 7.1 Hz, 3H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -68.26 (d, J = 8.3 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 166.3, 165.5, 150.1, 134.5, 133.2, 126.6, 125.8 (q, J = 283.3 Hz), 110.0, 62.8, 62.4, 52.5, 48.1 (q, J = 28.2 Hz), 14.0, 13.9 ppm.
14f: Prepared according to the general procedure 5 starting from 12d in 84% yield (colorless oil).

Rf (CH2Cl2:heptanes = 2:1) = 0.68.

HRMS (ESI): m/z calculated for C16H21F3O: 352.1883 [M+H]+; found: 352.1882.

1H-NMR (300 MHz, CDCl3, 298 K): δ = 7.34-7.26 (m, 5H), 7.10 (s, 1H), 7.06 (s, 1H), 4.85 (s, 1H), 4.02 (q, J = 7.6 Hz, 1H), 3.85-3.80 (m, 1H), 3.69-3.65 (m, 1H), 2.27 (s, 3H), 1.42 (s, 9H) ppm; 19F-NMR (282 MHz, CDCl3, 298 K): δ = -73.08 (d, J = 7.6 Hz, 3F) ppm; 13C-NMR (125 MHz, CDCl3, 298 K): δ = 153.3, 139.4, 135.9, 128.6, 128.4, 127.4, 125.9, 125.8 (q, J = 281.0 Hz), 125.4, 123.4, 63.3 (q, J = 27.8 Hz), 51.3, 34.7, 29.8, 29.2, 16.2 ppm.

14j: Prepared according to the general procedure 5 starting from 12d in 88% yield (colorless oil).

Rf (CH2Cl2:heptanes = 2:1) = 0.73.

HRMS (ESI): m/z calculated for C16H21F3O: 330.2039 [M+H]+; found: 330.2041.

1H-NMR (700 MHz, CDCl3, 298 K): δ 7.11 (s, 1H), 7.00 (s, 1H), 4.78 (s, 1H), 3.93 (q, J = 9.1 Hz, 1H), 2.63-2.60 (m, 2H), 2.50-2.47 (m, 2H), 1.59-1.54 (m, 4H), 1.43 (s, 9H), 1.40-1.38 (m, 2H) ppm; 19F-NMR (282 MHz, CDCl3, 298 K): δ = -66.82 (d, J = 9.1 Hz, 3F) ppm; 13C-NMR (125 MHz, CDCl3, 298 K): δ = 152.7, 135.4, 129.2, 126.6, 126.5 (q, J = 286.6 Hz), 123.7, 122.8, 71.0 (q, J = 27.1 Hz), 52.0, 34.7, 29.9, 26.6, 24.3, 16.3 ppm.

6g: Prepared according to the general procedure 5 starting from 12d in 72% yield (colorless oil).

Rf (CH2Cl2:heptanes = 2:1) = 0.42.

HRMS (ESI): m/z calculated for C16H21F3O: 405.1883 [M+H]+; found: 405.1881.

1H-NMR (700 MHz, CDCl3, 298 K): δ = 7.05 (s, 1H), 6.94 (s, 1H), 4.80 (s, 1H), 4.30-4.23 (m, 2H), 4.16-4.13 (m, 1H), 4.06-4.04 (m, 1H), 3.92-3.85 (m, 2H), 2.22 (s, 3H), 1.40 (s, 9H), 1.31 (t, J = 7.1 Hz, 3H), 0.94 (t, J = 7.1 Hz, 3H) ppm; 19F-NMR (282 MHz, CDCl3, 298 K): δ = -68.51 (d, J = 8.4 Hz, 3F) ppm; 13C-NMR (125 MHz, CDCl3, 298 K): δ = 167.0, 165.9, 153.1, 143.2, 135.8, 129.7, 127.0 (q, J = 267.4 Hz), 126.5, 123.0, 122.9, 62.4, 61.9, 53.1, 49.0 (q, J = 27.5 Hz), 34.7, 29.8, 16.1, 14.0, 13.8 ppm.
**14g**: Prepared according to the general procedure 5 starting from **12e** in 54% yield (yellow oil).

R<sub>f</sub> (CH<sub>2</sub>Cl<sub>2</sub>:heptanes = 2:1) = 0.25.

HRMS (ESI): m/z calculated for C<sub>17</sub>H<sub>18</sub>F<sub>3</sub>NO<sub>3</sub>: 342.1312 [M+H]<sup>+</sup>; found: 342.1315.

1<sup>H</sup>-NMR (300 MHz, CDCl<sub>3</sub>, 298 K): δ = 7.34-7.28 (m, 5H), 6.63 (s, 1H), 5.58 (br s, 1H), 4.03 (q, J = 7.6 Hz, 1H), 3.90 (s, 6H), 3.89-3.79 (m, 1H), 3.70 (s, 1H), 3.67-3.63 (m, 1H) ppm;

19<sup>F</sup>-NMR (282 MHz, CDCl<sub>3</sub>, 298 K): δ = -74.11 (d, J = 7.6 Hz, 3F) ppm;

13<sup>C</sup>-NMR (125 MHz, CDCl<sub>3</sub>, 298 K): δ = 153.1, 147.3, 139.1, 135.4, 128.7, 128.3, 127.5, 126.6 (q, J = 287.4 Hz), 125.1, 105.5, 63.6 (q, J = 28.1 Hz), 56.5, 51.1 ppm.

**14k**: Prepared according to the general procedure 5 starting from **12e** in 64% yield (yellow oil).

R<sub>f</sub> (CH<sub>2</sub>Cl<sub>2</sub>:heptanes = 2:1) = 0.25.

HRMS (ESI): m/z calculated for C<sub>15</sub>H<sub>20</sub>F<sub>3</sub>NO<sub>3</sub>: 320.1468 [M+H]<sup>+</sup>; found: 320.1474.

1<sup>H</sup>-NMR (300 MHz, CDCl<sub>3</sub>, 298 K): δ = 6.61 (s, 2H), 5.53 (s, 1H), 3.95-3.87 (m, 7H), 2.64-2.56 (m, 2H), 2.54-2.47 (m, 2H), 1.60-1.53 (m, 4H), 1.43-1.37 (m, 2H) ppm;

19<sup>F</sup>-NMR (282 MHz, CDCl<sub>3</sub>, 298 K): δ = -66.41 (d, J = 8.7 Hz, 3F) ppm;

13<sup>C</sup>-NMR (125 MHz, CDCl<sub>3</sub>, 298 K): δ = 146.9, 134.9, 128.1, 124.1, 122.9 (q, J = 288.9 Hz), 106.2, 71.2 (q, J = 26.7 Hz), 56.5, 52.0, 26.6, 24.3 ppm.

**6h**: Prepared according to the general procedure 5 starting from **12e** in 62% yield (yellow oil).

R<sub>f</sub> (CH<sub>2</sub>Cl<sub>2</sub>:heptanes = 2:1) = 0.25.

HRMS (ESI): m/z calculated for C<sub>17</sub>H<sub>21</sub>F<sub>3</sub>NO<sub>7</sub>: 395.1312 [M+H]<sup>+</sup>; found: 395.1321.

1<sup>H</sup>-NMR (300 MHz, CDCl<sub>3</sub>, 298 K): δ = 6.53 (s, 1H), 5.53 (s, 1H), 4.31-4.25 (m, 2H), 4.20-4.04 (m, 2H), 3.94-3.92 (m, 2H), 3.88 (s, 6H), 1.31 (t, J = 7.2 Hz, 3H), 0.99 (t, J = 7.2 Hz, 3H) ppm;

19<sup>F</sup>-NMR (282 MHz, CDCl<sub>3</sub>, 298 K): δ = -68.40 (d, J = 8.1 Hz, 3F) ppm;

13<sup>C</sup>-NMR (125 MHz, CDCl<sub>3</sub>, 298 K): δ = 166.8, 165.8, 147.0, 135.3, 124.7 (q, J = 276.1 Hz), 106.6, 62.6, 62.1, 56.5, 53.1, 49.5 (q, J = 27.5 Hz), 14.1, 13.9 ppm.
**14d-CF2H:** Prepared according to the general procedure 5 starting from **12b-CF2H** in 62% yield (yellow oil).

\[ R_f (\text{CH}_2\text{Cl}_2: \text{heptanes} = 2:1) = 0.33. \]

HRMS (ESI): m/z calculated for C_{17}H_{19}F_2NO: 292.1507 [M+H]^+; found: 292.1511.

1^H-NMR (500 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 7.35-7.32 \) (m, 2H), 7.28-7.25 (m, 3H), 7.03 (s, 2H), 5.77 (td, \( J_1 = 55.8 \) Hz, \( J_2 = 5.3 \) Hz, 1H), 5.28 (s, 1H), 3.83 (td, \( J_1 = 6.7 \) Hz, \( J_2 = 5.3 \) Hz, 1H), 3.75 (d, \( J = 13.5 \) Hz, 1H), 3.58 (d, \( J = 13.5 \) Hz, 1H), 2.26 (s, 1H) ppm; \( ^{19} \text{F-NMR} \) (470 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = -123.96 \) (dd, \( J_1 = 55.8 \) Hz, \( J_2 = 6.7 \) Hz, 1F), -124.50 (dd, \( J_1 = 55.8 \) Hz, \( J_2 = 6.7 \) Hz, 1F) ppm; \( ^{13} \text{C-NMR} \) (125 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 153.9, 139.7, 132.0, 129.0, 128.7, 128.3, 127.4, 117.2 \) (t, \( J = 245.5 \) Hz), 97.8, 63.6 (t, \( J = 21.7 \) Hz), 51.0, 16.9 ppm.

**6e-CF2H:** Prepared according to the general procedure 5 starting from **12b-CF2H** in 58% yield (yellow oil).

\[ R_f (\text{CH}_2\text{Cl}_2: \text{heptanes} = 2:1) = 0.76. \]

HRMS (ESI): m/z calculated for C_{17}H_{22}F_2O_5: 345.1508 [M+H]^+; found: 345.1510.

1^H-NMR (500 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 6.89 \) (s, 2H), 6.09 (td, \( J_1 = 56.2 \) Hz, \( J_2 = 3.0 \) Hz, 1H), 4.58 (s, 1H), 4.25 (q, \( J = 7.1 \) Hz, 2H), 3.96 (q, \( J = 7.1 \) Hz, 2H), 3.80-3.74 (m, 2H), 2.21 (s, 6H), 1.29 (t, \( J = 7.1 \) Hz, 3H), 1.00 (t, \( J = 7.1 \) Hz, 3H) ppm; \( ^{19} \text{F-NMR} \) (470 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = -120.3 - -122.2 \) (m, 2F) ppm; \( ^{13} \text{C-NMR} \) (125 MHz, CDCl\textsubscript{3}, 298 K): \( \delta = 167.7, 166.9, 125.3, 129.9, 124.6, 123.2, 116.2 \) (t, \( J = 243.6 \) Hz), 62.2, 61.7 52.8, 48.1 (t, \( J = 20.1 \) Hz), 41.8, 16.1, 14.1, 13.8 ppm.
2.5 Reactions with Indole

![Reaction Scheme]

General procedure 6: To 0.1 mmol of the corresponding quinone methide 1a or 1b and 0.12 mmol indole, in 2 mL CH$_2$Cl$_2$, 20 mol% of BF$_3$.OEt$_2$ were added. After stirring the reaction for 16 h at room temperature, the solvent was evaporated and the crude product was purified by column chromatography (CH$_2$Cl$_2$:heptanes = 2:1) to yield the products in the yields stated below.

General procedure 7 (in situ formation of the quinone methide): The chlorinated QM precursor 12d (0.1 mmol) was dissolved in 2 mL CH$_2$Cl$_2$ and NEt$_3$ (0.12 mmol) was added. This reaction mixture was stirred for 1 h at room temperature and then indole (0.12 mmol) and BF$_3$.OEt$_2$ (0.2 mmol) were added. After stirring the reaction for 16 h at room temperature, the solvent was evaporated and the crude product was purified by column chromatography (CH$_2$Cl$_2$:heptanes = 2:1) to yield product 13d.

13a: Prepared according to the general procedure 6 in 88% isolated yield (brown oil).

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.68.

HRMS (ESI): m/z calculated for C$_{24}$H$_{28}$F$_3$NO: 404.2196 [M+H]$^+$; found: 404.2196.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 8.15 (s, 1H), 7.54-7.52 (m, 1H), 7.40-7.37 (m, 1H), 7.30-7.28 (m, 1H), 7.25-7.19 (m, 2H), 7.15-7.10 (m, 1H), 5.19 (s, 1H), 1.42 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -67.38 (d, J = 9.8 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 153.5, 135.9, 127.0, 126.8 (q, J = 278.2 Hz), 126.1, 125.9, 122.9, 122.5, 120.0, 119.2, 111.3, 47.6 (q, J = 29.1 Hz), 34.5, 30.3, 29.2 ppm.
**13b**: Prepared according to the general procedure 6 in 55% yield (brown oil).

HRMS (ESI): m/z calculated for C_{18}H_{16}F_{3}NO: 320.1257 [M+H]^+; found: 320.1255.

R_f (CH$_2$Cl$_2$:heptanes = 2:1) = 0.18.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 8.16 (s, 1H), 7.41-7.36 (m, 2H), 7.31 (s, 1H), 7.22-7.17 (m, 1H), 7.10-7.05 (m, 1H) 7.03 (s, 2H), 4.84 (q, J = 9.5 Hz, 1H), 4.58 (s, 1H), 2.21 (s, 6H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -67.58 (d, J = 9.5 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 152.1, 136.0, 129.6, 127.3 (q, J = 28.8 Hz), 127.0, 123.1, 122.7, 122.6, 122.0, 119.0, 111.3, 110.7, 47.1 (q, J = 28.8 Hz), 29.8, 16.1 ppm.

**13d**: Prepared according to the general procedure 7 in 59% yield (yellow oil).

R_f (CH$_2$Cl$_2$:heptanes = 2:1) = 0.71.

HRMS (ESI): m/z calculated for C_{21}H_{22}F_{3}NO: 362.1726 [M+H]^+; found: 362.1722.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 8.14 (s, 1H), 7.46-7.43 (m, 1H), 7.39-7.36 (m, 1H), 7.30 (s, 1H), 7.23-7.18 (m, 2H), 7.12-7.06 (m, 1H), 7.03 (s, 1H), 4.87 (q, J = 9.3 Hz, 1H), 4.73 (s, 1H), 2.19 (s, 3H), 1.40 (s, 9H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -67.50 (d, J = 9.3 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 152.5, 136.0, 135.7, 129.2, 127.3 (q, J = 281.0 Hz), 127.0, 126.6, 126.5, 123.1, 122.8, 122.6, 120.0, 119.1, 111.3, 111.0, 47.3 (q, J = 29.1 Hz), 34.6, 29.8, 29.1, 16.2 ppm.
2.6 Spirocyclopropanation reaction

**General procedure 8:** QM 1a (0.2 mmol, 57.2 mg) and Cs$_2$CO$_3$ (0.4 mmol, 130.4 mg) were suspended in 2 mL DCM. Then the corresponding ammonium salt 20 (0.3 mmol) was added and the mixture stirred at RT for 24 h. Afterwards the reaction mixture was dried with Na$_2$SO$_4$, filtered and then concentrated in vacuo. The crude product was purified by column chromatography on silica gel (Heptanes/EtOAc = 50:1).

**21a:** The compound was prepared according to the general procedure 8 using achiral and chiral ammonium salts 20. The product occurs as yellow solid with a melting range of 122.9 – 123.3°C. When using Me$_3$N-based salt 20 the product was obtained in 79% yield with d.r. > 20:1. With E the product was obtained in 76% with d.r. > 20:1 and an e.r. of 77:23. With C the product was obtained in 78% with d.r. > 20:1 and an e.r. of 88:12.

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.77.

C: [α]$_D^{22}$ (c = 1.00, dichloromethane, 77:23 e.r.)= 31.3°.

E: [α]$_D^{22}$ (c = 1.00, dichloromethane, 88:12 e.r.)= -41.3°.

HRMS (ESI): m/z calculated for C$_{24}$H$_{27}$F$_3$O$_2$: 405.2036 [M+H]$^+$; found: 405.2035.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): δ = 7.83-7.80 (m, 2H), 7.64-7.59 (m, 1H), 7.51-7.46 (m, 2H), 6.55 (s, 1H), 6.23 (s, 1H), 3.77 (d, J = 7.1 Hz, 1H), 3.35 (qu, J = 7.1 Hz, 1H), 1.30 (s, 9H), 1.10 (s, 8H) ppm;

$^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): δ = -60.12 (d, J = 7.1 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): δ = 191.9, 185.3, 152.2, 151.4, 136.6, 134.6, 134.2, 133.8, 133.5 (q, J = 282.6 Hz), 129.1, 128.4, 37.2, 36.1, 35.5 (q, J = 35.5 Hz), 29.5, 29.4 ppm.
Column: Chiralcel YMC-SB (250 x 4.6 mm, 5 µm) chiral stationary phase; flow: 0.5 mL/min; Temperature: 10 °C; Hexane/IPA: 200/1.

21b: Compound was prepared according to the general procedure 8 in 76% yield (d.r. > 20:1). The product occurs as yellow solid with a melting range of 115.2 – 115.9°C.

R$_f$ (CH$_2$Cl$_2$:heptanes = 2:1) = 0.74.

HRMS (ESI): m/z calculated for C$_{20}$H$_{27}$F$_3$O$_3$: 373.1985 [M+H]$^+$; found: 373.1988.

$^1$H-NMR (300 MHz, CDCl$_3$, 298 K): $\delta$ = 6.52 (s, 1H), 6.32 (s, 1H), 4.24 (q, J = 7.3 Hz, 2H), 3.00 (qu, J = 7.3 Hz, 1H), 2.89 (d, J = 7.3 Hz, 1H), 1.31 (t, J = 7.1 Hz, 3H), 1.24 (s, 9H), 1.22 (s, 9H) ppm; $^{19}$F-NMR (282 MHz, CDCl$_3$, 298 K): $\delta$ = -60.39 (d, J = 7.3 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl$_3$, 298 K): $\delta$ = 185.6, 167.6, 151.4, 151.1, 134.7, 134.1, 124.1 (q, J = 276.8 Hz), 62.4, 35.5, 35.1, 34.1, 33.2, 30.4, 29.5, 29.5 ppm.
2.7 Reactions with Glycine Schiff Base

General Procedure 9: The quinone methides 1a or 1b (0.1 mmol), the glycine Schiff base 18 (0.1 mmol) and the chiral or achiral PTC (10 mol%) were dissolved in 2 mL CH₂Cl₂ and Cs₂CO₃ (0.11 mmol) was added. After the reaction was stirred for 24 h at room temperature, the mixture was filtered over Na₂SO₄, washed with Et₂O and evaporated to dryness. Products 17 were purified by column chromatography (DCM:Heptane = 2:1).
17a: Prepared according to the general procedure 9, the product occurs as white oil, with an isolated yield of 96% (using TEBAC) or 84% (catalyst B). The asymmetric conditions resulted in a d.r. = 7:1 and an e.r. = 90:10.

R_f (CH_2Cl_2:heptanes = 2:1) = 0.70.

[α]_D^{22} (c = 1.00, dichloromethane, 90:10 e.r.) = 12.3°.

HRMS (ESI): m/z calculated for C_{35}H_{42}F_{3}N_{3}O_{3}: 582.3196 [M+H]^+; found: 582.3191.

1H-NMR (300 MHz, CDCl_3, 298 K): δ = 7.62-7.59 (m, 2H), 7.44-7.42 (m, 5H), 7.38-7.35 (m, 1H), 7.31-7.29 (m, 2H), 7.08-7.05 (m, 2H), 5.18 (s, 1H), 4.50 (d, J = 5.7 Hz, 1H), 4.02-3.91 (m, 1H), 1.43 (1s, 18H), 1.25 (s, 9H) ppm; 19F-NMR (282 MHz, CDCl_3, 298 K): δ = -65.73 (d, J = 9.9 Hz, 3F) ppm; 13C-NMR (125 MHz, CDCl_3, 298 K): δ = 171.1, 168.7, 153.8, 139.7, 136.2, 135.4, 130.4, 129.1, 128.9, 128.5, 128.0, 127.7, 126.6 (q, J = 279.7 Hz), 123.4, 81.8, 52.6 (q, J = 25.9 Hz), 34.5, 30.4, 27.8 ppm.

Column: Chiralcel AD-H (250 x 4.6 mm, 5 μm) chiral stationary phase; flow: 0.5 mL/min; Temperature: 10 °C; Hexane/IPA: 99/1.

17b: Prepared according to the general procedure 9 using TEBAC in 84% isolated yield and with a d.r. = 5:1 (colorless oil).

R_f (CH_2Cl_2:heptanes = 2:1) = 0.53.

HRMS (ESI): m/z calculated for C_{29}H_{38}F_{3}N_{3}O_{3}: 498.2251 [M+H]^+; found: 498.2255.

1H-NMR (300 MHz, CDCl_3, 298 K): δ = 7.33-7.28 (m, 2H), 7.27-7.22 (m, 3H), 7.19-7.00 (m, 4H), 6.92-6.87 (m, 3H), 4.50 (s, 1H), 4.31 (d, J = 5.9 Hz, 1H), 3.90-3.76 (m, 1H), 2.03 (s, 6H), 1.16 (s, 8H) ppm; 19F-NMR (282 MHz, CDCl_3, 298 K): δ = -66.05 (d, J = 9.7 Hz, 3F) ppm; 13C-NMR (125 MHz, CDCl_3, 298 K): δ = 136.2, 131.1, 130.4, 129.1, 128.9, 128.3, 128.1, 128.0, 126.5 (q, J = 272.5 Hz), 123.7, 122.9, 122.6, 82.0, 65.6, 52.1 (q, J = 26.2 Hz), 7.9, 16.0 ppm.
2.8 Deprotection and Debutylation of 17a

**General procedure 10**: Compound 17a (0.1 mmol) was dissolved in 10 mL toluene and a mixture of Tf₂O and TfOH (19/1, 20 µL) was added. After stirring the reaction for 24 h at 60 °C, the reaction was quenched with water and extracted two times with EtOAc. The water phase was evaporated to dryness to yield the debutylated and deprotected amino acid 19.

19: Prepared according to the general procedure 10 in 62% yield with d.r. = 8.2:1 (colorless oil).

HRMS (ESI): m/z calculated for C₁₀H₁₀F₃NO₃: 250.0686 [M+H]+; found: 250.0688.

¹H-NMR (300 MHz, D₂O, 298 K): δ = 7.33-7.30 (m, 2H), 6.97-6.94 (m, 2H), 4.65 (d, J = 5.8 Hz, 1H), 4.48-4.36 (m, 1H) ppm; ¹⁹F-NMR (282 MHz, CDCl₃, 298 K): δ = -66.51 (d, J = 9.7 Hz, 3F) ppm; ¹³C-NMR (125 MHz, CDCl₃, 298 K): δ = 169.5, 156.9, 131.1, 130.0, 125.9, 125.1 (q, J = 285.2 Hz), 121.7, 119.3, 117.4, 116.4, 116.0, 113.3, 52.9, 48.7 (q, J = 30.2 Hz) ppm.
2.9 Hydrid- and deuterid-reduction of quinone methide 1a

**General procedure 11:** Quinone methide 1a (0.1 mmol) was dissolved in 4 mL t-BuOH and NaBH₄ respectively NaBD₄ (0.12 mmol) was added portionwise. The reaction mixture was stirred at room temperature overnight and after completion of the reaction it was filtered over a pad of Na₂SO₄, washed with Et₂O and evaporated to dryness. The crude product was purified by column chromatography (CH₂Cl₂:heptanes = 2:1) to yield compound 8 and 8-D.

**8-D:** Prepared according to the general procedure 11 in 97% isolated yield (colorless oil).

Rₜ (CH₂Cl₂:heptanes = 2:1) = 0.91.

HRMS (ESI): m/z calculated for C₁₆H₂₂DF₃O: 290.1837 [M+H]⁺; found: 290.1837.

$^{1}H$-NMR (300 MHz, CDCl₃, 298 K): $\delta$ = 7.06 (s, 2H), 5.22 (s, 1H), 3.25 (q, $J$ = 10.7 Hz, 1H), 1.11 (s, 18H) ppm; $^{19}$F-NMR (282 MHz, CDCl₃, 298 K): $\delta$ = -66.27 (d, $J$ = 10.7 Hz, 3F) ppm; $^{13}$C-NMR (125 MHz, CDCl₃, 298 K): $\delta$ = 153.7, 136.2, 126.9, 126.1, 122.8 (q, $J$ = 262.2 Hz), 39.9 (m), 34.4, 30.4 ppm.
3. Copies of NMR-Spectra of new Compounds
