The Iridium-Catalysed Alkylation of Aromatic Ketones *via* Hydrogen Borrowing

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Declaration

I declare that this thesis and the data described herein are entirely my own, except where I have acknowledged help and/or data from a named person, or given reference to a published source.

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Chapter 9. Experimental

9.1 General Experimental

Reaction Setup: Microwave vials and vial caps (containing a resealing Silicone/PTFE septum) were purchased from Kinesis (Cole-Palmer) and were used without flame-drying. Unless otherwise stated, all other reactions were performed in flame-dried glassware equipped with a stir bar sing standard Schlenk techniques under an atmosphere of Ar dried over passage through Chameleon® silica gel, before replacing with a balloon of Ar. Fresh double-walled balloons of Ar, H_2 or O_2 were used for each reaction. Room temperature (RT) is defined to be 25 °C (298 K).

Reagents and solvents: Unless detailed below or otherwise stated, all reagents and solvents were purchased and used as supplied from Sigma-Aldrich (now Merck KGaA), Thermo Fisher Scientific (including Alfa Aesar, Fisher Scientific and Acros Organics), Fluorochem, Honeywell, Tokyo Chemical Industry, Apollo Scientific, Manchester Organics (part of Navin Fluorine Int. Ltd.), Santa Cruz Biotechnology and Strem Chemicals.

The following reagents were freshly distilled under Ar at atmospheric pressure and used immediately: acetyl chloride, acetaldehyde and butyraldehyde (over flame-dried $CaSO_4$), and TMSCl (from CaH_2). *n*-BuLi and *t*-BuLi were titrated with 2,6-di-*tert*-butyl-4-methylphenol, using 1,10-phenanthroline as indicator, according to the Watson–Eastham method immediately prior to use.[1]

Anhydrous $AlCl_3$ (powder) was purchased from Alfa Aesar and used as supplied. Anhydrous $CeCl_3$ was purchased from Alfa Aesar in a glass ampule that was sacrificed, manipulated and stored in a dry box (Belle Technology) under a flow of N_2 dried by passage through KOH. Sublimed grade KO*t*-Bu (99.9%) was purchased from Sigma-Aldrich, stored under Ar and used as supplied.

Zinc dust (≤ 10 μm) was purchased from Sigma-Aldrich and was activated using the following procedure: To a flask containing 1 M aq. HCl (20 mL) and zinc dust (c.a. 3 g) was vigorously stirred for 10 min at RT, then filtered under suction and rinsed liberally with H_2O. The residue was promptly dried *in vacuo*, and the activated zinc dust was used immediately.

Pearlman's catalyst (20 wt% $Pd(OH)_2$/C dry basis, contains 50 wt% H_2O) was purchased from Sigma-Aldrich and used as supplied.[*] $[Ir(cod)Cl]_2$ and $[Cp^*IrCl_2]_2$ were purchased from Sigma-Aldrich and/or Alfa Aesar and used as supplied.[†] All other transition metal catalysts and phosphine ligands were purchased from Sigma-Aldrich, Alfa Aesar, Fluorochem or Strem Chemicals, stored under Ar and used as supplied.

Anhydrous BnOH was purchased from Acros Organics in an AcroSeal™ bottle. Anhydrous 1,2-dichloroethane, diisopropylamine, DMF, DMSO, Et_3N, and Hünig's base (*N*-ethyldiisopropylamine) were purchased from Sigma-Aldrich in Sure/Seal™ bottles. Anhydrous Et_2O, DCM, MeOH, THF and toluene were obtained from MBRAUN SPS-5 solvent purification system by passage through double filtration columns under N_2.

[*] The Degussa grade of Pearlman's catalyst purchased from Sigma-Aldrich performs just as well as the conventional grade catalyst.

[†] Negligible variation was observed between either suppliers across multiple batches.

Chromatography: Thin layer chromatography (TLC) was performed on pre-coated aluminium- (200 μm) or glass-backed (250 μm) Merck Kieselgel 60 F_{254} plates, or polyester-backed Macherey-Nagel Polygram® SIL G/UV_{254} plates, visualised using UV irradiation (λ = 254 nm) and/or staining with potassium permanganate ($KMnO_4$), vanillin, 2,4-dinitrophenylhydrazine (2,4-DNPH) or cerium ammonium molybdate (CAM, or Hanessian's stain) solutions. Preparative TLC was performed using the abovementioned TLC plates for samples within 5 – 25 mg of crude mass, or Merck Kieselgel 60 F_{254} preparative TLC plates (500 μm) for samples within 25 – 100 mg of crude mass.

Purification by flash column chromatography was performed with Merck Kieselgel 60 (40 – 63 μm) silica gel according to the method by W. C. Still et al.[2] All solvents used for chromatography were HPLC grade or equivalent and supplied by Honeywell, Sigma-Aldrich or Thermo Fisher Scientific.

In cases of challenging chromatographic purification, analysis of the mixtures isolated from flash column chromatography (with known masses and identification of all individual components) was performed by NMR integration under quantitative conditions (*vide infra*). The yields of the individual components were then calculated and combined with other corresponding components of other fractions to obtain the total isolated yield.

Nomenclature: Systematic names were generated by the software ChemDraw according to the guidelines specified by the International Union of Pure and Applied Chemistry (IUPAC). Conventional names are also provided for reference where applicable. With the exception of (*S*,*S*)-**225**, (*S*,*S*)-**226**, (*S*,*S*)-**227** and (*S*,*S*)-**228** (as a pair of epimers), all compounds reported are racemates, and stereodescriptors drawn in the structures are relative. Compounds with multiple stereocentres have the prefix *rel* (relative) to reflect their racemic nature; for *meso* and other symmetric achiral cyclic compounds, the prefixes *cis* and *trans* are used for clarity where appropriate.

Compound Numbering: Unless otherwise stated, compounds are numbered such that only unique carbons are labelled based on their systematic names analogous to IUPAC nomenclature guidelines.

Melting points: Melting points (m.p.) were obtained using a Leica VMTG heated-stage microscope equipped with a Testo 720 thermometer and are uncorrected.

Infrared spectroscopy: Fourier-transform infrared (FT-IR) spectra were recorded from evaporated films on a Bruker Tensor 27 spectrometer equipped with a Pike Miracle Attenuated Total Reflectance (ATR) sampling accessory. Absorption maxima are quoted in wavenumbers (ν_{max}) with units of cm^{-1} and for the range of 3600 – 600 cm^{-1}.

NMR spectroscopy: All spectra were acquired on a Bruker DPX 200 equipped with a 5 mm $^{13}C/1H$ dual probe, a Bruker AVIII HD 400 equipped with a 5 mm *z*-gradient BBFO probe, Bruker AVIII HD 400 equipped with a 5 mm *z*-gradient BBFO "SMART" probe, Bruker AVII 500 equipped with a 5 mm BBFO "SMART" probe or 5 mm *z*-gradient TFI probe, or Bruker AVIII HD equipped with a 5 mm triple resonance TBO probe. The deuterated solvent acted as internal deuterium lock, except for ^{2}H NMR experiments which were run unlocked in protic solvent containing ~1% deuterated solvent.

^{1}H NMR experiments were recorded at 400 or 500 MHz, ^{2}H NMR at 76.8 MHz, ^{13}C NMR at 101 or 126 MHz with broadband proton decoupling, ^{15}N NMR at 50.7 MHz, ^{19}F NMR at 377 or 471 MHz with or without decoupling, and ^{31}P NMR at 202 MHz with or without decoupling. All NMR experiments were performed at 298 K.

NMR acquisition was performed using the software Bruker TopSpin®. NMR data processing and analyses were performed with the software MestReNova. Chemical shifts (δ) are quoted in parts per million (ppm) to the nearest 0.01 ppm for ^{1}H and ^{2}H NMR, and 0.1 ppm for ^{13}C, ^{15}N, ^{19}F and ^{31}P NMR; for cases where signals in ^{13}C NMR spectra are within 0.1 ppm, only the signals involved are reported to 0.01 ppm. Chemical shifts for ^{15}N nuclei, where available, were obtained by direct detection from ^{15}N NMR or by indirect detection from ^{1}H-^{15}N HMBC experiments; the chemical shifts thus recorded have a deviation of within 0.1 ppm from either experiments.

Residual protic solvent signal acted as an internal reference for ^{1}H NMR, and deuterated solvent carbon signal acted as an internal reference for ^{13}C NMR ($CDCl_3$: ^{1}H NMR = 7.26 ppm; ^{13}C NMR = 77.16 ppm; C_6D_6: ^{1}H NMR = 7.16 ppm, ^{13}C NMR = 128.06 ppm; CD_3OD: ^{1}H NMR = 4.79, 3.31 ppm, ^{13}C NMR = 49.00 ppm; DMSO-d_6: ^{1}H NMR = 2.50 ppm, ^{13}C NMR = 39.52 ppm; CD_3CN: ^{1}H NMR = 1.94 ppm, ^{13}C NMR = 1.32 ppm). ^{2}H NMR spectra were referenced to the deuterated solvent dope ($CDCl_3$: ^{2}H NMR = 7.26 ppm). In accordance to IUPAC guidelines, the chemical shifts for ^{15}N, ^{19}F and ^{31}P NMR spectra reported are based on the secondary frequencies (Ξ) of the respective nuclei in the unified scale relative to ^{1}H in tetramethylsilane.[3*]

[*] For ^{15}N NMR, the compound of reference is liq. NH_3. The chemical shift reference can be converted to a nitromethane reference by substracting 380.5 ppm.

Every attempt was made to obtain *J*-coupling information through multiplet analysis with the aid of line fitting (spectral deconvolution). The multiplicity of a signal is reported as such: s – singlet, d – doublet, t – triplet, q – quartet, quint. – quintet, sext. – sextet, sept. – septet, oct. – octet, non. – nonet, q_{AB} – AB quartet, m – multiplet, app. – apparent or approximate, br. – broad, v. – very, or combinations thereof. Coupling constants and Δ_{AB} are quoted in Hz to the nearest 0.1 Hz.

Structural assignments were made with the aid of DEPTQ, COSY, HSQC, HMBC, H2BC, NOESY, ROESY and TOCSY experiments. Where available, $^{13}C\{^{1}H\}\{^{19}F\}$, ^{1}H-^{19}F-HOESY, ^{19}F-^{13}C-HSQC, ^{19}F-^{13}C HMBC, ^{1}H-^{15}N HMBC and ^{1}H-^{31}P HMBC experiments were also performed for additional structural and assignment confirmation.

For quantitative analysis of mixtures, ^{1}H NMR was performed for the purposes of accurately the ratio of the different components present in the mixture. As such, ^{1}H NMR was performed with a relaxation time (D1) of 30 s and a minimum of 32 transients (typically 64 transients, 16 for concentrated samples) and *without* an internal standard. Sum integration was used for integral analysis, while multiplet analysis with line fitting was used for known key signals that are overlapped (only for mixtures with known masses and identification of all individual components).

Mass spectrometry (MS): Low resolution MS were recorded on an Agilent 6120 Quadrupole mass spectrometer equipped with an Agilent 1260 Infinity LC pump, or a Waters LCT Premier XE mass spectrometer equipped with a Waters 1525µ Binary HPLC pump, both with a flow rate of 0.2 mL min^{-1} using H_2O:MeOH:HCOOH (10:89.9:0.1) as eluent. The mass reported is the mass-to-charge ratio (*m*/*z*) containing the most abundant isotopes under the conditions of electrospray ionisation (ESI), with each value to 1 decimal place.

High resolution mass spectrometry (HRMS) were performed by Dr. James Wickens, Dr. Victor Mikhailov or Dr. Colin Sparrow. HRMS under ESI conditions were recorded on a Thermo Exactive Orbitrap mass spectrometer equipped with a Waters Equity LC system, a Bruker MicroToF mass spectrometer equipped with an Agilent 1100 HPLC pump and autosampler, or on a Waters Xevo Quadrupole Time of Flight (Q-ToF) mass spectrometer. The Thermo Exactive system employs a flow rate of 0.2 mL min^{-1} using H_2O:MeOH:HCOOH (10:89.9:0.1) as eluent, with a heated electrospray ionisation (HESI-II) probe and has a resolution of 50,000 FWHM. The Bruker system uses the built-in electrospray source, while the Waters system runs on a lock-mass mode with ESI performed by a secondary electrospray source, both using conditions identical to the Thermo Exactive system. Instrument control and data processing were performed using the softwares Thermo Xcalibur for the Thermo Exactive system, Compass DataAnalysis 4.0 for the Bruker system, and MassLynx for the Waters system.

Atmospheric pressure chemical ionisation (APCI) HRMS were recorded on the abovementioned Thermo Exactive spectrometer under identical conditions using N_2 as the reagent gas.

Chemical ionisation (CI) and electron impact ionisation (EI) HRMS were performed on an Agilent 7200 Quadrupole Q-ToF mass spectrometer equipped with a direct insertion probe supplied by Scientific Instrument Manufacturer (SIM) GmbH. Instrument control and data processing were performed using the software Agilent MassHunter. The reagent gas used for CI was NH_3 or CH_4.

All HRMS conditions were adjusted for maximum sensitivity, with an accuracy of better than 5 ppm for 24 h following external calibration on the day of analysis. Unless otherwise specified, the mass reported for HRMS is the mass-to-charge ratio containing the most abundant isotopes, with each value to 4 or 5 decimal places and within 5 ppm of the calculated mass.

Polarimetry: Specific rotations were measured on a Schmidt Haensch Unipol L2000 polarimeter at the sodium D line (589.3 nm) with a water-jacketed 100 mm quartz glass microtube (1.0 mL internal volume) pre-equilibrated to 25.0 °C using a Grant TC120-ST12 heated circulating bath. The rotations reported are the average of 10 readings and are quoted in units of 10^{-1} deg cm^2 g^{-1}, with their concentrations (*c*) quoted in units of 10^{-2} g mL^{-1}.

Chiral HPLC: Chiral high performance liquid chromatography (HPLC) was performed using an Agilent 1260 Infinity II LC system equipped with a UV-vis diode array detector, and fitted with Daicel Chiralpak® IA, IB or IC columns (4.6 mm Ø × 250 mm length) together with their corresponding guard columns (4.0 mm Ø × 10 mm length). All HPLC runs were performed at RT using *n*-hexane:isopropanol as the eluent, a flow rate of 1.0 mL min^{-1} and a sample injection volume of 10 μL. Data collection and analyses were performed with the software OpenLab CDS Chemstation. Wavelengths (λ) are quoted in nm and retention time (τ_R) in min.

X-Ray Crystallography: Single crystal X-ray diffraction was performed by Dr. Kirsten E. Christensen, Wasim M. Akhtar or Choon Boon Cheong on a Nonius KappaCCD diffractometer using Mo-K_α radiation (λ = 0.71073 Å) and a graphite monochromator, or a (Rigaku) Oxford Diffraction/Agilent Supernovae A diffractometer using Cu-K_α radiation (λ = 1.54184 Å) and a graphite monochromator. Samples were mounted on perfluoropoly-ethyl ether oil and cooled by a Cryostream N_2 open-flow cooling device to 150 K throughout the data collection process. For very small crystals, diffraction data was collected on beamline I-19 at the Diamond Light Source (λ = 0.68890 Å) at a temperature of 100 K. The diffraction patterns were integrated and reduced using the software DENZO/SCALEPACK for the Nonius diffractometer, or CrysAlisPro for the Oxford instrument. The software CRYSTALS for Microsoft Windows was used to obtain *ab initio* solutions (using SIR92 or SuperFlip embedded within CRYSTALS) and carry out structure refinement.[4] The images of the solved structures were generated with the software Mercury, and represent displacement ellipsoid plots of the best-fit model drawn at 50% probability level.

9.2 General Procedures

General Procedure A: Synthesis of Enones *via* Aldol Condensation[5]

To a solution of substrate (1.0 equiv) and aldehyde (1.1 equiv) in EtOH:H_2O (1:1, 3.3 mL per mmol) at RT was added a solution of NaOH (1.25 equiv) in EtOH:H_2O (1:1, 3.3 mL per mmol, final concentration 0.15 M) dropwise over 5 min in the open atmosphere. The reaction mixture was stirred at RT for the stated time, then diluted with water (5 mL per mmol), brine (5 mL per mmol) and DCM (10 mL per mmol) sequentially. The layers were separated, the aqueous layer extracted with DCM (3 × 20 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography provided the desired compound.

In cases where the chalcone precipitates out of solution, the mixture was filtered under suction, the residue washed with H_2O and dried *in vacuo* to provide the desired compound.

General Procedure B: Friedel–Crafts Acylation of Arenes[5]

To a solution of substrate (1.0 equiv) in anhydrous DCM (0.2 M) was added acid chloride (1.1 equiv) at RT. The reaction mixture was cooled to 0 °C, then $AlCl_3$ (1.25 equiv) was carefully added and the reaction stirred at 0 °C for 2 h. The reaction mixture was then poured onto ice/H_2O (20 mL per mmol), allowed to warm up to RT, then diluted with DCM (15 mL per mmol) and saturated with NaCl. The layers were separated, the aqueous layer extracted with DCM (3 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography provided the desired compound.

General Procedure C: Palladium-catalysed Hydrogenation[5]

To a solution of substrate (1.0 equiv) in EtOAc (0.2 M) was added $Pd(OH)_2/C$ (10 wt%) in the open atmosphere.[*] The resulting suspension was evacuated and back-filled with H_2 four times, then left to stir under a H_2 atmosphere at RT for the stated time. The reaction mixture was filtered under suction through a pad of Celite®, eluting with EtOAc, and concentrated *in vacuo*. Purification by flash column chromatography provided the desired compound.

General Procedure D: $[Ir(COD)Cl]_2$-Catalysed Alkylation of Aromatic Ketones[5]

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added alcohol (10.0 equiv), substrate (1.0 equiv), $[Ir(COD)Cl]_2$ (1 mol%), 1,2-bis(diphenylphosphanyl)benzene (dppBz) (2 mol%), and KOH (2.0 equiv) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap and purged for 5 min with an Ar balloon. The vial (complete with the Ar balloon) was then heated to the temperature stated (either 85 °C or 105 °C) in a preheated oil bath for 24 h. The reaction mixture was cooled to RT, diluted with Et_2O (5 mL per mmol), filtered through a plug of silica (eluting with Et_2O) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

[*] The use of $Pd(OH)_2/C$ was preferred over Pd/C as it was much less prone to ignition during reaction setup and filtration.

General Procedure E: Hydrogen Borrowing of Secondary Alcohols[6]

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added alcohol (2.0 equiv), substrate (1.0 equiv), $[Cp^*IrCl_2]_2$ (2 mol%), NaO*t*-Bu (3.0 equiv) and toluene (4.0 M) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap and briefly purged with an Ar balloon. The vial (complete with the Ar balloon) was then heated to the temperature stated (either 85 °C or 105 °C) in a preheated oil bath for 24 h. The reaction mixture was cooled to RT, diluted with Et_2O (5 mL per mmol), filtered through a plug of silica (eluting with Et_2O) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure F: Hydrogen Borrowing of Cyclopropyl Secondary Alcohols

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added alcohol (2.0 equiv), ketone **121** (1.0 equiv), $[Ir(COD)Cl]_2$ (1 mol%), cataCXium® A (8 mol%), KO*t*-Bu (99.9%, 2.0 equiv) and toluene (4.0 M) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap, then evacuated and backfilled with H_2 five times (using a H_2 balloon). The vial (complete with the H_2 balloon) was then heated to the temperature stated (either 105 °C or 125 °C) in a preheated oil bath for 24 h. The reaction mixture was cooled to RT, diluted with Et_2O (5 mL per mmol), filtered through a plug of silica (eluting with Et_2O) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure G: Alkylation with Alkyl Halides

To a vigorously stirred flame-dried flask containing NaH (60% dispersion in mineral oil, 1.1 equiv) pre-cooled to 0 °C was added a solution of substrate (1.0 equiv) in anhydrous DMF or THF (0.2 M) over 10 min (caution: exotherm and effervescence). The flask was then warmed up to RT and stirred for a further 20 min, during which time small amounts of solvent were used to rinse the sides of the flask periodically, followed by the addition of tetrabutylammonium iodide (0 or 10 mol%) and the appropriate alkyl halide (1.1 – 1.2 equiv) in single portions. The reaction mixture was stirred at RT for the stated time, then diluted with Et_2O (20 mL per mmol), sat. aq. NH_4Cl (10 mL per mmol) and brine (25 mL per mmol) sequentially. The layers were separated, the aqueous layer extracted with Et_2O (3 × 15 mL per mmol) and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure H: Reductions with DIBAL-H

To a solution of substrate (1.0 equiv) in anhydrous DCM (0.3 M) at –78 °C was added the appropriate amount of DIBAL-H (1.0 M in DCM) over 5 min. The reaction mixture was warmed up to 0 °C and stirred for 2 h. A few drops of sat. aq. Rochelle's salt were carefully added, and the reaction mixture allowed to warm up to RT over 10 min, followed by further careful addition of sat. aq. Rochelle's salt (minimum 2.5 mL per mmol DIBAL-H). The ensuing gelatinous mixture was stirred for a minimum of 1 h (typically 16 h), during which time the mixture clarifies and homogenises, followed by the addition of brine (10 mL per mmol). The layers were separated, the aqueous layer extracted with DCM (5 × 15 mL per mmol), the combined organics were dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure I: Formation of Weinreb Amides

To a solution of substrate (1.0 equiv) in anhydrous DCM (0.4 M) was added CDI (1.1 or 1.35 equiv) at 0 °C and stirred for 30 min. The reaction mixture was then warmed up to RT followed by the addition of *N*,*O*-dimethylhydroxylamine·HCl (1.4 equiv) and Et_3N (1.4 equiv) in single portions, The mixture was stirred at 0 °C and allowed to warm up to RT over 16 h. To the reaction mixture was added sat. aq. NH_4Cl (2.5 mL per mmol), H_2O (2.5 mL per mmol), brine (2.5 mL per mmol) and DCM (5 mL per mmol) sequentially. The layers were separated, the aqueous layer extracted with DCM (3 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure J: Addition of Organometallic Reagents to Carbonyl Electrophiles

To a solution of substrate (1.0 equiv) in anhydrous THF or Et_2O (0.2 M) at –78 °C was added the organometallic reagent (1.0 or 1.2 equiv) dropwise. The reaction was warmed up to 0 °C and stirred for 2 h. To the reaction mixture was added sat. aq. NH_4Cl (10 mL per mmol), brine (10 mL per mmol) and Et_2O (15 mL per mmol) sequentially. The layers were separated, the aqueous layer extracted with Et_2O (3 × 15 mL per mmol) and the combined organics and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure K: Reductions with $NaBH_4$

To a solution of substrate (1.0 equiv) in the appropriate solvent (0.2 M) was added $NaBH_4$ (2.0 equiv) in a single portion at RT in the open atmosphere and stirred for 2 h. The reaction mixture was carefully quenched with sat. aq. NH_4Cl (10 mL per mmol), then diluted with Et_2O (20 mL per mmol), H_2O (10 mL per mmol $NaBH_4$) and brine (20 mL per mmol $NaBH_4$) sequentially. The layers were separated, the aqueous layer extracted with Et_2O (5 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure L: Johnson–Corey–Chachovskey Cyclopropanation[7]

To a vigorously stirred flame-dried flask containing trimethylsulfoxonium iodide (1.2 equiv) and NaH (60% dispersion in mineral oil, 1.2 equiv) cooled to 0 °C was added anhydrous DMSO (1.0 mL per mmol) over 30 min carefully (caution: exotherm and effervescence). The flask was then warmed up to RT and stirred for a further 30 min, during which time small amounts of DMSO were used to rinse the sides of the flask periodically. A solution of substrate (1.0 equiv) in DMSO (1 mL per mmol, final concentration 0.5 M) was added dropwise over 5 min and stirred at RT for 2 h. The reaction mixture was then poured into ice/H_2O (25 mL per mmol), allowed to warm up to RT, then diluted with sat. aq. NH_4Cl (10 mL per mmol) and DCM (20 mL per mmol), and saturated with NaCl. The layers were separated, and the aqueous layer extracted with DCM (3 × 15 per mmol). The combined organics were washed with brine (20 mL per mmol), dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure M: Oxidation of Alcohols to Aldehydes or Ketones

To a solution of alcohol (1.0 equiv) in anhydrous DCM (0.05 M) was added Celite® (150 wt% to PCC) and PCC (1.5 equiv) in single portions sequentially and stirred at RT for 2 h. The reaction mixture was then filtered under suction through a plug of silica, eluting liberally with EtOAc. The filtrate was concentrated *in vacuo*, then purified by column chromatography to provide the desired compound.

General Procedure N: Oxidation of Arenes to Phenols[8]

To a flame-dried flask containing a solution of substrate (1.0 equiv) in HFIP (0.1 M) over Ar was added phthaloyl peroxide (1.3 – 1.5 equiv) at RT. The reaction mixture was then warmed to 40 °C and stirred for 12 h. The reaction mixture was directly concentrated *in vacuo*, followed by the addition of aq. sat. $NaHCO_3$:MeOH (1:9, 0.05 M) over Ar. The ensuing suspension was heated to 40 °C and stirred for a further 12 h. The reaction mixture was cooled to RT, then diluted with brine (30 mL per mmol) and DCM (20 mL per mmol). The layers were separated, the aqueous layer extracted with DCM (5 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General procedure O: Nitration of Arenes[9]

To a solution of substrate (1.0 equiv) in TFA:H_2O (9:1, 2.0 mL per mmol) was added a solution of HNO_3 (70% aq. solution, 1.1 equiv) in TFA:H_2O (9:1, 1.3 mL per mmol, final concentration 0.33 M) at RT over a balloon of Ar, during which time the headspace of the flask turned dark reddish-brown. The flask was stirred for 1 h, by which time the headspace of the flask had mostly decolourised, then poured into a large flask containing no more than one-third volume of ice/H_2O (35 mL per mmol). While still cold, the reaction mixture was *very* carefully neutralised with solid Na_2CO_3 (caution: *very* vigorous effervescence), then diluted with DCM (15 mL per mmol). The layers were separated, the aqueous layer extracted with DCM (3 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure P: Reduction of Nitroarenes[10]

To a 10 – 20 mL microwave vial equipped with a large stirrer bar was added substrate (1.0 equiv), freshly activated zinc dust (13.2 equiv), $CaCl_2 \cdot 2H_2O$ (1.0 equiv) and EtOH:H_2O (4:1, 0.3 M) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap, heated to the 75 °C and vigorously stirred for 16 h. The reaction mixture was cooled to RT, filtered under suction through a pad of Celite®, eluting liberally with EtOH, then concentrated *in vacuo*. The residue was redissolved in DCM (20 mL per mmol), followed by the addition of H_2O (5 mL per mmol) and brine (15 mL per mmol). The layers were separated, the aqueous layer extracted with DCM (3 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo* to directly afford the desired compound.

General Procedure Q: Br_2-mediated Cleavage of Pentamethylbenzene[5]

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added substrate (1.0 equiv) and CH_2Cl_2 (0.2 M) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap, cooled to –17 °C (ice/NaCl bath), then Br_2 (2.0 equiv) was added and stirred at –17 °C. Once TLC analysis indicated complete consumption of the substrate (typically 15 min), the appropriate nucleophile (3.0 equiv) was added at –17 °C and the reaction allowed to warm up to RT over 16 h. To the reaction mixture was added Et_2O (15 mL per mmol substrate), sat. aq. Na_2SO_3 (10 mL per mmol substrate) and brine (10 mL per mmol) sequentially. The layers were separated, the aqueous layer extracted with Et_2O (3 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

General Procedure R: Oxidative Cleavage with Cerium Ammonium Nitrate (CAN)

To a solution of substrate (1.0 equiv) in the appropriate solvent (0.1 M) was titrated a solution of CAN (5 equiv) in the appropriate solvent (0.2 M) at RT in the open atmosphere until the colour of the CAN solution persisted (orange for alcohols, yellow for H_2O, typically 4 – 5 equiv). The reaction mixture was diluted with H_2O (30 mL per mmol) and stirred for 5 – 10 min,[*] then further diluted with DCM (20 mL per mmol) and saturated with NaCl. The layers were separated, and the aqueous layer extracted with DCM (5 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

[*] If the step involving stirring with water is omitted, then duroquinone dimethyl acetal will be present in varying amounts which may interfere with chromatographic purification.

General Procedure S: Oxidation of Phenols with Hypervalent Iodine Reagents[11]

To a solution of substrate (1.0 equiv) in the appropriate solvent (0.1 M) was added the nucleophile (0 or 3 equiv) and oxidant (1.3 equiv) in single portions sequentially, then stirred at RT for 2 h. To the reaction mixture was added water (10 mL per mmol), sat. aq. Na_2SO_3 (10 mL per mmol) and DCM (20 mL per mmol) sequentially, then saturated with NaCl. The layers were separated, the aqueous layer extracted with DCM (3 × 15 mL per mmol), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography provided the desired compound.

9.3 NMR Experiments

9.3.1 Equilibration of *cis*-1-Decalone to *trans*-1-Decalone

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added *t*-BuOH (7.4 mg, 0.10 mmol, 1.0 equiv), *cis*-1-decalone *cis*-**174** (15.2 mg, 0.100 mmol, 1.0 equiv), KO*t*-Bu (11.2 mg, 0.100 mmol, 1.0 equiv) and C_6D_6 (0.5 mL, 0.2 M) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap and briefly purged with an Ar balloon, then stirred at RT for 1 h, during which time the base remained insoluble. The liquid contents of the reaction mixture was carefully transferred by an Ar-flushed syringe to an NMR tube (evacuated and back-filled with Ar thrice) over an Ar funnel, then quickly capped, sealed with Parafilm®, and immediately analysed by ^{1}H NMR spectroscopy. The *cis*:*trans* ratio was approximately 5:95. A repeat of the experiment without *t*-BuOH present gave a *cis*:*trans* ratio of approximately 7:93.

Performing the reaction directly in the NMR tube in the absence of *t*-BuOH (i.e. without stirring) resulted in a *cis*:*trans* ratio of approximately 79:21 after 1 h, which continued to decrease over time to 72:28 after 2.5 h, 37:63 after 16 h, and 22:78 after 24 h. Repeating the NMR tube experiment but with heating at 85 °C for 1 h in a pre-heated oil bath gave a *cis*:*trans* ratio of approximately 16:84. The primary source of error in the integration is the broad signal of C1H and C10H_AH$_B$ for *cis*-1-decalone that had a small amount of overlap with C10H$_{ax}$$H_{eq}$ for *trans*-1-decalone.

9.3.2 Investigations into the Formation of Metal Hydrides in the Hydrogen Borrowing Reaction

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added, where appropriate, 1-cyclopropylethanol (103 mg, 1.20 mmol) *or* cyclopropyl methyl ketone (101 mg, 1.20 mmol), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol), cataCXium® A (17.2 mg, 48.0 μmol), KO*t*-Bu (67.3 mg, 0.600 mmol) and toluene-d_8 (150 μL) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap, then evacuated and backfilled with Ar or H_2 five times (using an Ar or H_2 balloon). The vial (complete with the respective balloon) was then heated to 105 °C in a pre-heated oil bath for 4 h. The reaction mixture was cooled to RT, then diluted with additional toluene-d_8 (500 μL). The reaction mixture was quickly transferred by syringe under an Ar or H_2 funnel (**caution:** ignition risk) to an NMR tube that was evacuated and back-filled with Ar or H_2 five times. The NMR tube was quickly capped, sealed with Parafilm®, and immediately analysed by ^{1}H NMR spectroscopy.

8.3.3 *in situ*-Formation of Acetyl Bromide by Br_2-Mediated Deacylation of Ketone 121

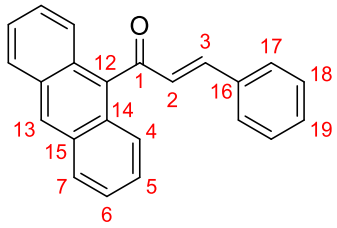
Under an Ar funnel, ketone **121** (47.6 mg, 0.250 mmol, 1.0 equiv) was dissolved in $CDCl_3$ (0.50 mL, 0.5 M) from a freshly-sacrificed ampoule, and the solution was transferred to an NMR tube that was evacuated and backfilled with Ar five times. To the NMR tube was added Br_2 (25 μL, 80 mg, 0.50 mmol, 2.0 equiv), then the tube was capped and sealed with Parafilm®. The NMR tube was then thoroughly mixed, then immediately analysed by ^{1}H and ^{13}C NMR spectroscopy.

9.3.4 Formation of VCP Rearrangement Product 176 from Enone 198 with H_2 as the Only Hydride Source

To a 2 – 5 mL microwave vial equipped with a stirrer bar was added enone **198** (38.5 mg, 0.150 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (1.00 mg, 1.50 μmol, 1 mol%), cataCXium® A (4.31 mg, 12.0 μmol, 8 mol%), KO*t*-Bu (16.8 mg, 0.150 mmol, 1.0 equiv) and toluene-d_8 (40 μL) sequentially in the open atmosphere. The vial was sealed with a microwave vial cap, then evacuated and backfilled with H_2 five times (using a H_2 balloon). The vial was sealed with a microwave vial cap, then evacuated and backfilled with H_2 five times (using a H_2 balloon). The vial (complete with the H_2 balloon) was then heated to 105 °C in a preheated oil bath for 24 h. The reaction mixture was cooled to RT, diluted with Et_2O (5 mL per mmol), filtered through a plug of silica (eluting with Et_2O) and concentrated *in vacuo*. The crude mixture was analysed by quantitative NMR analysis.

9.4 Experimental Details

(*E*)-1-(Anthracen-9-yl)-3-phenylprop-2-en-1-one (9)



9-Acetylanthracene (330 mg, 1.50 mmol, 1.0 equiv), benzaldehyde (175 mg, 1.65 mmol, 1.1 equiv), NaOH (75.0 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 10 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Filtration and drying *in vacuo* afforded enone **9** (430 mg, 1.38 mmol, 92%) as a bright yellow solid.

m.p. = 204 – 206 °C.

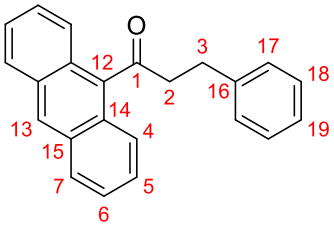
IR (film) ν_{max}/cm^{-1} 3054, 3028, 3009, 1633, 1616, 1595, 1449, 1355, 1288, 1224, 1197, 1151, 992, 981, 966.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 8.56 (1H, s, C13H), 8.11 – 8.02 (2H, m, 2 × C7H), 7.95 – 7.87 (2H, m, 2 × C4H), 7.53 – 7.46 (4H, m, 2 × C6H and 2 × C5H), 7.46 – 7.42 (2H, m, 2 × C17H), 7.40 – 7.31 (3H, m, 2 × C18H and C19H), 7.31 (1H, d, J = 16.2 Hz, C2H), 7.22 (1H, d, J = 16.2 Hz, C3H).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 200.4 (C1=O), 148.1 (C3H), 134.6 (C12), 134.4 (C16), 131.25 (2C, 2 × C14), 131.15 (C19H), 129.3 (C2H), 129.1 (2C, 2 × C18H), 128.8 (4C, 2 × C7H and 2 × C17H), 128.55 (C13H), 128.52 (2C, 2 × C15), 126.8 (2C, 2 × C5H), 125.7 (2C, 2 × C6H), 125.4 (2C, 2 × C4H).

HRMS (ESI^+) Found $[M+H]^+$ = 309.12741; $C_{23}H_{17}O$ requires 309.12739, Δ 0.06 ppm.

1-(Anthracen-9-yl)-3-phenylpropan-1-one (10)



Anthracene (267 mg, 1.50 mmol, 1.0 equiv), hydrocinnamoyl chloride (223 mL, 253 mg, 1.50 mmol, 1.0 equiv), $AlCl_3$ (220 mg, 1.65 mmol, 1.1 equiv) and DCM (15 mL, 0.1 M) were subjected to a modification of **General Procedure B** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **10** (291 mg, 0.936 mmol, 62%) as a yellow solid.

m.p. = 168 – 170 °C.

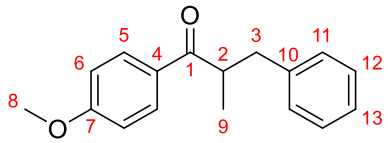
IR (film) ν_{max}/cm^{-1} 3084, 3054, 3027, 2958, 2925, 1696, 1624, 1603, 1521, 1496, 1452, 1445, 1402, 1362, 1262, 1160, 1106, 1075, 1030, 1015, 956.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 8.48 (1H, s, C9H), 8.06 – 7.98 (2H, m, 2 × C7H), 7.69 – 7.60 (2H, m, 2 × C4H), 7.47 (2H, qd, J = 6.6, 1.4 Hz, 2 × C6H), 7.45 (2H, qd, J = 6.6, 1.4 Hz, 2 × C5H), 7.35 – 7.28 (4H, m, 2 × C13H and 2 × C14H), 7.28 – 7.20 (1H, m, C15H), 3.39 (2H, t, J = 7.3 Hz, $C2H_2$), 3.26 (2H, t, J = 7.3 Hz, $C3H_2$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.5 (C1=O), 140.8 (C12), 136.5 (C8), 131.1 (2C, 2 × C11), 128.9 (2C, 2 × C7H), 128.8 (2C, 2 × C13H), 128.7 (2C, 2 × C14H), 128.3 (C9H), 127.0 (2C, 2 × C10), 126.8 (2C, 2 × C5H), 126.4 (C15H), 125.6 (2C, 2 × C6H), 124.4 (2C, 2 × C4H), 47.9 ($C2H_2$), 29.9 ($C3H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 333.12500; $C_{23}H_{18}ONa$ requires 333.12499, Δ 0.04 ppm.

1-(4-Methoxyphenyl)-2-methyl-3-phenylpropan-1-one (42)[12]



Ketone **41** (72.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 2 mol%), (±)-BINAP (7.96 mg, 12.0 μmol, 4 mol%), KOH (50.5 mg, 0.900 mmol, 3.0 equiv) and MeOH (3.0 mL, 0.1 M) were subjected to a modification of **General Procedure D** at 65 °C for 48 h. Purification by flash column chromatography (Pentane:Et_2O, 98:2 → 95:5) afforded ketone **42** (64.9 mg, 0.255 mmol, 85%) as a colourless oil.

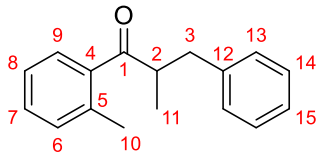
IR (film) ν_{max}/cm^{-1} 3027, 2968, 2933, 2840, 1671, 1598, 1574, 1509, 1496, 1454, 1419, 1372, 1360, 1308, 1259, 1233, 1169, 1118, 1029, 973.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.93 (2H, d, J = 8.9 Hz, 2 × C5H), 7.30 – 7.24 (2H, m, 2 × C12H), 7.23 – 7.14 (3H, m, 2 × C11H and C13H), 6.92 (2H, d, J = 8.9 Hz, 2 × C6H), 3.86 (3H, s, $C8H_3$), 3.71 (1H, dquint., J = 7.9, 6.8 Hz, C1H), 3.16 (1H, dd, J = 13.7, 6.3 Hz, $C3H_AH_B$), 2.69 (1H, dd, J = 13.7, 7.8 Hz, $C3H_AH_B$), 1.20 (3H, d, J = 6.9 Hz, $C9H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 202.4 (C1=O), 163.5 (C7), 140.3 (C10), 130.7 (2C, 2 × C5H), 129.5 (C4), 129.2 (2C, 2 × C11H), 128.5 (2C, 2 × C12H), 126.2 (C13H), 113.9 (2C, 2 × C6H), 55.6 ($C8H_3$), 42.5 (C2H), 39.7 ($C3H_2$), 17.7 ($C9H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 277.11995; $C_{17}H_{18}O_2Na$ requires 277.11990, Δ 0.18 ppm.

2-Methyl-3-phenyl-1-(2-methylphenyl)propan-1-one (55)



Ketone **56** (67.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 2 mol%), (±)-BINAP (7.96 mg, 12.0 μmol, 4 mol%), KOH (50.5 mg, 0.900 mmol, 3.0 equiv) and MeOH (3.0 mL, 0.1 M) were subjected to a modification of **General Procedure A** at 65 °C for 48 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **55** (59.1 mg, 0.248 mmol, 83%) as a pale yellow oil.

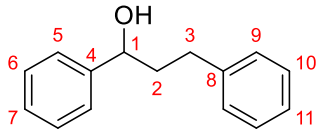
IR (film) ν_{max}/cm^{-1} 3063, 3026, 2967, 2929, 2872, 1684, 1601, 1571, 1495, 1454, 1227, 1031, 967.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.41 (1H, dd, J = 7.7, 1.5 Hz, C9H), 7.33 (1H, td, J = 7.5, 1.5 Hz, C7H), 7.30 – 7.24 (2H, m, 2 × C14H), 7.24 – 7.16 (5H, m, C8H, C10H, 2 × C13H and C15H), 3.56 (1H, dquint., J = 7.7, 6.8 Hz, C2H), 3.17 (1H, dd, J = 13.6, 6.6 Hz, C3H_AH$_B$), 2.65 (1H, dd, J = 13.6, 7.7 Hz, C3H$_A$$H_B$), 2.40 (3H, s, C10$H_3$), 1.17 (3H, d, J = 6.9 Hz, C11H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 208.1 (C1=O), 140.0 (C12), 138.6 (C4), 137.7 (C5), 131.7 (C6H), 130.8 (C7H), 129.1 (2C, 2 × C13H), 128.4 (2C, 2 × C14H), 127.5 (C9H), 126.2 (C15H), 125.5 (C8H), 46.3 (C2H), 39.1 (C3H_2), 20.7 (C10H_3), 17.0 (C11H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 261.1250; $C_{17}H_{18}ONa$ requires 261.1250, Δ 0.05 ppm.

1,3-Diphenylpropan-1-ol (57)



Ketone **35** (63.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded benzylic alcohol **57** (61.6 mg, 0.290 mmol, 97%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3354, 3085, 3062, 3027, 2920, 2860, 1603, 1494, 1454, 1391, 1306, 1203, 1156, 1058, 1029, 914, 848, 745, 698.

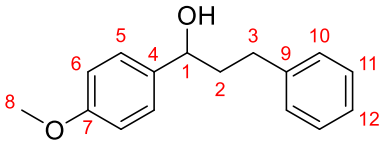
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.36 (4H, m), 7.34 – 7.26 (3H, m), 7.23 – 7.16 (3H, m), 4.70 (1H, dd, J = 7.9, 5.3 Hz, C1H), 2.76 (1H, ddd, J = 13.9, 9.8, 5.8 Hz, C3H_AH$_B$), 2.68 (1H, ddd, J = 13.9, 9.5, 6.5 Hz, C3H$_A$$H_B$), 2.15 (1H, dddd, J = 13.7, 9.6, 7.9, 5.8 Hz, C2H_AH$_B$), 2.04 (1H, dddd, J = 13.7, 9.8, 6.5, 5.3 Hz, C2H$_A$$H_B$), 1.89 (1H, s, OH).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 144.7 (C4), 141.9 (C8), 128.67 (2C, 2 × C6H), 128.58 (2C, 2 × C9H), 128.5 (2C, 2 × C10H), 127.8 (C7H), 126.06 (2C, 2 × C5H), 126.00 (C11H), 74.0 (C1H), 40.6 (C3H_2), 32.2 (C2H_2).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 235.10947; $C_{15}H_{16}ONa$ requires 235.10934, Δ 0.55 ppm.

Spectroscopic data were identical to those from the literature.[13]

1-(4-Methoxyphenyl)-3-phenylpropan-1-ol (58)



Ketone **41** (72.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 2 mol%), (±)-BINAP (7.96 mg, 12.0 μmol, 4 mol%), KOH (50.5 mg, 0.900 mmol, 3.0 equiv) and BnOH (209 μL, 217 mg, 2.03 mmol. 6.7 equiv) were subjected to a modification of **General Procedure D** at 65 °C for 48 h. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded benzylic alcohol **58** (46.6 mg, 0.192 mmol, 64%) as a colourless oil.

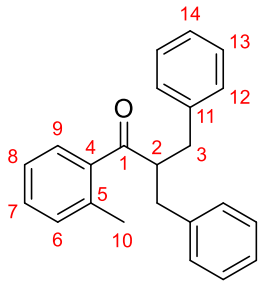
IR (film) ν_{max}/cm^{-1} 3380, 3026, 2933, 2859, 2836, 1611, 1585, 1511, 1496, 1454, 1302, 1245, 1175, 1110, 1032.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.35 – 7.26 (2H, m, 2 × C11H), 7.29 (2H, d, J = 8.7 Hz, 2 × C5H), 7.24 – 7.18 (3H, m, 2 × C10H and C12H), 6.90 (2H, d, J = 8.7 Hz, 2 × C6H), 4.64 (1H, dd, J = 7.6, 5.7 Hz, C1H), 3.82 (3H, s, $C8H_3$), 2.74 (1H, ddd, J = 13.6, 9.8, 6.0 Hz, $C3H_AH_B$), 2.65 (1H, ddd, J = 13.7, 9.5, 6.4 Hz, $C3H_AH_B$), 2.15 (1H, dddd, J = 13.6, 9.5, 7.8, 6.1 Hz, $C2H_AH_B$), 2.09 (1H, br. s, OH), 2.02 (1H, ddt, J = 13.5, 9.9, 6.3 Hz, $C2H_AH_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 159.1 (C7), 141.9 (C9), 136.8 (C4), 128.52 (2C, 2 × C10H), 128.45 (2C, 2 × C11H), 127.3 (2C, 2 × C5H), 125.9 (C12H), 113.9 (2C, 2 × C6H), 73.5 (C1H), 55.4 ($C8H_3$), 40.4 ($C2H_2$), 32.2 ($C3H_2$).

Note: A stable molecular ion could not be detected by ESI or APCI.

2-Benzyl-3-phenyl-1-(2-methylphenyl)propan-1-one (59)[5]



Ketone **56** (67.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **59** (65.7 mg, 0.209 mmol, 70%) as a pale yellow solid.

m.p. = 25 – 27 °C.

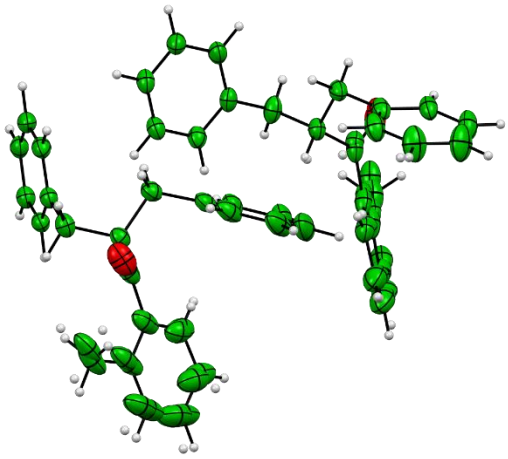
IR (film) ν_{max}/cm^{-1} 3062, 3027, 2952, 2924, 1682, 1601, 1571, 1495, 1454, 1228, 1081, 1029, 950.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.43 – 7.34 (5H, m, C7H and 4 × C13H), 7.34 – 7.25 (7H, m, C6H and 4 × C12H and 2 × C14H), 7.25 – 7.18 (2H, m, C8H and C9H), 4.02 (1H, tt, J = 8.0, 6.4 Hz, C2H), 3.26 (2H, dd, J = 13.6, 8.0 Hz, 2 × C3H_AH$_B$), 2.91 (2H, dd, J = 13.6, 6.4 Hz, 2 × C3H$_A$$H_B$), 2.43 (3H, s, C10$H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 207.2 (C1=O), 139.6 (2C, 2 × C11), 138.9 (C4), 138.1 (C5), 131.7 (C6H), 131.0 (C7H), 129.2 (4C, 4 × C12H), 128.6 (4C, 4 × C13H), 127.9 (C9H), 126.4 (2C, 2 × C14H), 125.5 (C8H), 54.0 (C2H), 38.2 (2C, 2 × C3H_2), 20.7 (C10H_3).

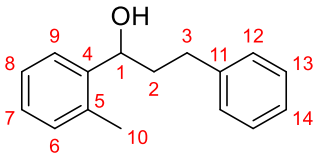
HRMS (ESI^+) Found $[M+Na]^+$ = 337.1562; $C_{23}H_{22}ONa$ requires 337.1563, Δ –0.38 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule (Z' = 2) is shown below.



Note: There is significant disorder within the molecule, particularly about the *ortho*-tolyl group. Nevertheless, the *ortho*-methyl group is clearly not coplanar with the ketone.

3-Phenyl-1-(2-methylphenyl)propan-1-ol (60)[5]



In the preparation of ketone **56**, benzylic alcohol **60** (20.2 mg, 89.3 μmol, 30%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3365, 3063, 3026, 2951, 2920, 2859, 1604, 1495, 1455, 1380, 1286, 1182, 1063, 1033, 993, 925, 759, 726, 699.

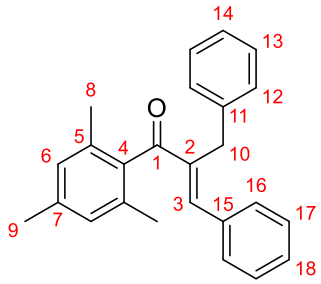
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.52 (1H, dd, J = 7.7, 1.5 Hz, C9H), 7.33 – 7.28 (2H, m, 2 × C13H), 7.25 (1H, td, J = 7.4, 1.7 Hz, C8H), 7.27 – 7.17 (3H, m, 2 × C12H and C14H), 7.19 (1H, td, J = 7.4, 1.6 Hz, C7H), 7.14 (1H, d, J = 7.4 Hz, C6H), 4.94 (1H, dd, J = 8.3, 4.4 Hz, C1H), 2.87 (1H, ddd, J = 14.6, 9.5, 5.5 Hz, C3H_AH$_B$), 2.75 (1H, ddd, J = 13.8, 9.2, 7.0 Hz, C3H$_A$$H_B$), 2.25 (3H, s, C10H$_3$), 2.08 (1H, dddd, J = 13.7, 9.1, 8.2, 5.4 Hz, C2H_AH$_B$), 2.01 (1H, dddd, J = 13.9, 9.5, 7.2, 4.6 Hz, C2H$_A$$H_B$), 1.85 (1H, s, OH).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 142.8 (C5), 141.9 (C11), 134.6 (C4), 130.6 (C6H), 128.58 (2C, 2 × C12H), 128.51 (2C, 2 × C13H), 127.4 (C7H), 126.4 (C8H), 126.0 (C14H), 125.2 (C9H), 70.1 (C1H), 39.6 ($C2H_2$), 32.4 ($C3H_2$), 19.0 ($C10H_3$).

HRMS (NH_3 CI^+) Found $[M+NH_4]^+$ = 244.1699; $C_{16}H_{22}NO$ requires 244.1696, Δ –1.37 ppm.

HRMS (EI) Found $[M]^{\bullet+}$ = 226.1354; $C_{16}H_{18}O$ requires 226.1352, Δ 0.81 ppm.

(*E*)-2-Benzyl-1-(2,4,6-trimethylphenyl)-3-phenylprop-2-en-1-one (61)



In the preparation of ketone **62**, enone **61** (26.3 mg, 77.2 μmol, 26%) was also isolated as a yellow oil.

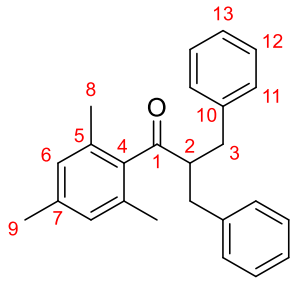
IR (film) ν_{max}/cm^{-1} 3060, 3027, 2919, 2857, 1650, 1612, 1574, 1494, 1449, 1378, 1320, 1298, 1256, 1228, 1163, 1101, 1072, 1030, 966.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.42 (1H, s, C3H), 7.40 – 7.32 (5H, m, 2 × C16H, 2 × C17H and C18H), 7.32 – 7.27 (4H, m, 2 × C12H and 2 × C13H), 7.26 – 7.18 (1H, m, C14H), 6.88 (2H, s, 2 × C6H), 4.13 (2H, s, $C10H_2$), 2.33 (3H, s, $C9H_3$), 2.14 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 202.7 (C1=O), 145.8 (C3H), 140.4 (C2), 139.4 (C11), 138.2 (C7), 137.0 (C4), 135.4 (C15), 134.5 (2C, 2 × C5), 129.6 (2C, 2 × C16H), 129.4 (C18H), 128.76 (2C, 2 × C17H), 128.58 (2C, 2 × C12H), 128.50 (2C, 2 × C13H), 128.42 (2C, 2 × C6H), 126.2 (C14H), 31.7 ($C10H_2$), 21.3 ($C9H_3$), 19.4 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 363.1718; $C_{25}H_{24}ONa$ requires 363.1719, Δ –0.34 ppm.

2-Benzyl-1-(2,4,6-trimethylphenyl)-3-phenylpropan-1-one (62)[5]



Ketone **5** (75.7 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 2 mol%), (±)-BINAP (7.96 mg, 12.0 μmol, 4 mol%), KOH (50.5 mg, 0.900 mmol, 3.0 equiv) and BnOH (209 μL, 217 mg, 2.03 mmol. 6.7 equiv) were subjected to a modification of **General Procedure D** at 65 °C for 48 h. Purification by flash column chromatography (Pentane:Et_2O, 98:2 → 95:5) afforded ketone **62** (76.0 mg, 0.222 mmol, 74%) as a pale yellow solid.

m.p. = 80 – 82 °C.

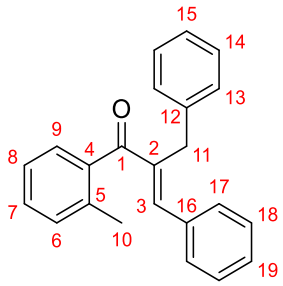
IR (film) ν_{max}/cm^{-1} 3027, 2922, 2855, 1692, 1609, 1496, 1453, 1228, 1153, 1029, 924.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.27 – 7.20 (4H, m, 4 × C12H), 7.20 – 7.14 (2H, m, 2 × C13H), 7.14 – 7.08 (4H, m, 4 × C11H), 6.78 (2H, s, 2 × C6H), 3.48 (1H, quint., J = 6.8 Hz, C2H), 3.18 (2H, dd, J = 13.5, 6.8 Hz, 2 × C3$H_A$$H_B$), 2.57 (2H, dd, J = 13.5, 7.1 Hz, 2 × C3$H_A$$H_B$), 2.26 (3H, s, C9$H_3$), 1.94 (6H, s, 2 × C8$H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.6 (C1=O), 140.0 (2C, 2 × C10), 138.9 (C7), 137.9 (C4), 134.2 (2C, 2 × C5), 129.4 (4C, 4 × C11H), 129.1 (2C, 2 × C6H), 128.5 (4C, 4 × C12H), 126.3 (2C, 2 × C13H), 58.0 (C2H), 35.9 (2C, 2 × C3H_2), 21.2 (C9H_3), 19.6 (2C, 2 × C8H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 365.1875; $C_{25}H_{26}ONa$ requires 365.1876, Δ –0.24 ppm.

(*E*)-2-Benzyl-3-phenyl-1-(2-methylphenyl)prop-2-en-1-one (63)[5]



Ketone **56** (67.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to a modification of **General Procedure D** at 85 °C with a balloon of O_2. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded enone **63** (54.4 mg, 0.174 mmol, 58%) as a pale yellow oil.

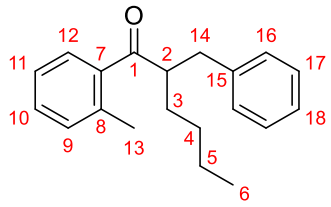
IR (film) ν_{max}/cm^{-1} 3061, 3026, 2924, 1650, 1619, 1494, 1451, 1380, 1318, 1296, 1257, 1228, 1131, 1098, 1073, 1030, 962.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.42 – 7.17 (15H, m, C3H, C6H, C7H, C8H, C9H, 2 × C13H, 2 × C14H, C15H, 2 × C17H, 2 × C18H and C19H), 4.13 (2H, s, $C11H_2$), 2.32 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 200.7 (C1=O), 145.7 (C3H), 140.8 (C2), 139.43 (C12), 139.34 (C4), 136.5 (C5), 135.3 (C16), 130.9 (C9H), 129.8 (C7H), 129.5 (2C, 2 × C17H), 129.3 (C6H), 128.75 (2C, 2 × C13H), 128.71 (2C, 2 × C18H), 128.4 (2C, 2 × C14H), 128.1 (C19H), 126.3 (C15H), 125.3 (C8H), 32.3 ($C11H_2$), 19.8 ($C10H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 335.1408; $C_{23}H_{20}ONa$ requires 335.1406, Δ 0.51 ppm.

2-Benzyl-1-(2-methylphenyl)hexan-1-one (64)[5]



Ketone **56** (67.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **64** (50.5 mg, 0.180 mmol, 60%) as a colourless oil.

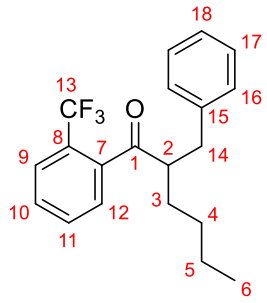
IR (film) ν_{max}/cm^{-1} 3063, 3026, 3956, 2929, 2858, 1683, 1601, 1571, 1495, 1455, 1380, 1292, 1227, 1031, 938.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.35 – 7.28 (2H, m, C10H and C12H), 7.28 – 7.22 (2H, m, 2 × C17H), 7.22 – 7.13 (5H, m, C9H, C11H, 2 × C16H and C18H), 3.55 (1H, tt, J = 7.7, 5.9 Hz, C2H), 3.10 (1H, dd, J = 13.5, 8.0 Hz, C14H_AH$_B$), 2.75 (1H, dd, J = 13.5, 6.3 Hz, C14H$_A$$H_B$), 2.40 (3H, s, C13$H_3$), 1.83 – 1.69 (1H, m, C3H_AH$_B$), 1.57 – 1.46 (1H, m, C3H$_A$$H_B$), 1.37 – 1.17 (4H, m, C4H_2 and C5H_2), 0.84 (3H, t, J = 7.1 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 208.0 (C1=O), 140.3 (C15), 139.2 (C7), 138.0 (C8), 131.8 (C9H), 131.0 (C10H), 129.2 (2C, 2 × C16H), 128.5 (2C, 2 × C17H), 128.0 (C12H), 126.3 (C18H), 125.6 (C11H), 51.9 (C1H), 38.0 (C2H_2), 32.0 (C3H_2), 29.6 (C4H_2), 22.9 (C5H_2), 20.9 (C13H_3), 14.0 (C6H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 303.1719; $C_{20}H_{24}ONa$ requires 303.1719, Δ –0.13 ppm.

2-Benzyl-1-(2-(trifluoromethyl)phenyl)hexan-1-one (67)



Ketone **S2** (83.5 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **67** (61.7 mg, 0.185 mmol, 62%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2038, 2959, 2933, 2860, 1702, 1604, 1581, 1496, 1454, 1412, 1273, 1226, 1167, 1142, 1064, 1036, 943.

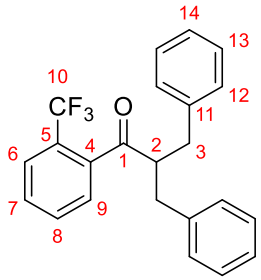
$^1H\{^{19}F\}$ NMR ($CDCl_3$, 400 MHz) δ = 7.76 – 7.68 (1H, m, C9H), 7.57 – 7.47 (2H, m, C10H and C11H), 7.31 – 7.22 (2H, m, 2 × C17H), 7.22 – 7.15 (4H, m, C12H, 2 × C16H and C18H), 3.40 (1H, qd, J = 7.0, 5.8 Hz, C2H), 3.11 (1H, dd, J = 13.6, 7.2 Hz, C14H_AH$_B$), 2.74 (1H, dd, J = 13.7 Hz, 7.0 Hz, C14H$_A$$H_B$), 1.73 (1H, dddd, J = 13.7, 10.1, 6.6, 5.6 Hz, C3H_AH$_B$), 1.47 (1H, ddt, J = 13.7, 9.5, 5.6 Hz, C3H$_A$$H_B$), 1.39 – 1.18 (4H, m, $C4H_2$ and $C5H_2$), 0.83 (3H, t, J = 7.1 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 205.9 (C1=O), 140.05 (C15), 139.98 (q, $^3J_{CF}$ = 2.1 Hz, C7), 131.7 (C11H), 130.5 (C10H), 129.2 (2C, 2 × C16H), 128.6 (2C, 2 × C17H), 127.93 (q, $^2J_{CF}$ = 32.4 Hz, C8), 127.89 (C12H), 127.2 (q, $^3J_{CF}$ = 5.2 Hz, C9H), 126.4 (C18H), 123.7 (q, $^1J_{CF}$ = 273.9 Hz, $C13F_3$), 53.5 (C2H), 36.9 ($C14H_2$), 30.5 ($C3H_2$), 29.2 ($C4H_2$), 22.8 ($C5H_2$), 14.0 ($C6H_3$).

^{19}F NMR ($CDCl_3$, 377 MHz) δ = –57.8 (3F, s, $C13F_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 357.1435; $C_{20}H_{21}F_3ONa$ requires 357.1437, Δ –0.41 ppm.

2-Benzyl-3-phenyl-1-(2-(trifluoromethyl)phenyl)propan-1-one (68)



Ketone **S2** (83.5 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **68** (80.4 mg, 0.217 mmol, 72%) as a colourless solid.

m.p. = 70 – 72 °C.

IR (film) ν_{max}/cm^{-1} 3064, 3028, 2928, 2859, 1702, 1604, 1581, 1496, 1454, 1351, 1312, 1274, 1225, 1167, 1140, 1118, 1066, 1035, 944.

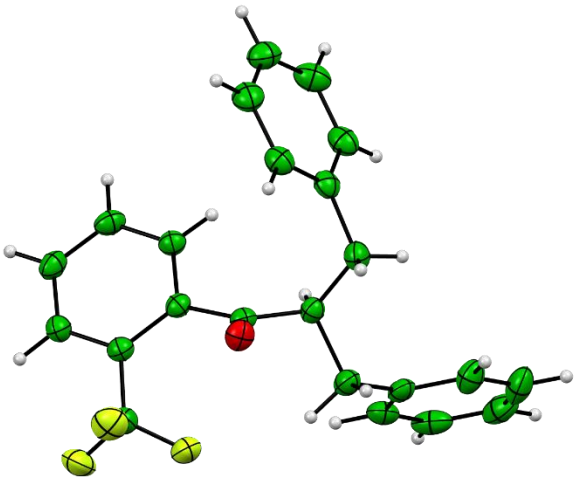
^{1}H{^{19}F} NMR ($CDCl_3$, 400 MHz) δ = 7.69 (1H, dd, J = 7.9, 1.3 Hz, C6H), 7.48 (1H, td, J = 7.7, 1.3 Hz, C7H), 7.39 (1H, td, J = 7.6 Hz, 1.3 Hz, C8H), 7.29 – 7.20 (4H, m, 4 × C13H), 7.20 – 7.15 (2H, m, 2 × C14H), 7.15 – 7.09 (4H, m, 4 × C12H), 6.85 (1H, dd, J = 7.7, 1.3 Hz, C9H), 3.71 (1H, quint., J = 7.1 Hz, C1H), 3.11 (2H, dd, J = 13.7, 7.2 Hz, 2 × C2H_AH$_B$), 2.71 (2H, dd, J = 13.7, 7.0 Hz, 2 × C2H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 205.3 (C1=O), 139.6 (q, $^{3}J_{CF}$ = 1.9 Hz, C4), 139.5 (2C, 2 × C11), 131.6 (C8H), 130.5 (C7H), 129.2 (4C, 4 × C12H), 128.6 (4C, 4 × C13H), 127.9 (q, $^{2}J_{CF}$ = 32.4 Hz, C5), 127.8 (C9H), 127.0 (q, $^{3}J_{CF}$ = 5.3 Hz, C6H), 126.5 (2C, 2 × C14H), 123.6 (q, $^{1}J_{CF}$ = 274.0 Hz, C10F_3), 55.9 (C2H), 37.1 (2C, 2 × C3H_2).

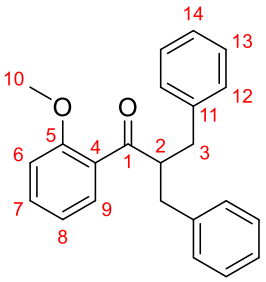
^{19}F NMR ($CDCl_3$, 377 MHz) δ = –57.7 (3F, s, C10F_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 391.1280; $C_{23}H_{19}OF_3{}^{23}Na$ requires 391.1280, Δ –0.16 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(2-methoxyphenyl)-3-phenylpropan-1-one (69)



1-(2-Methoxyphenyl)-3-phenylpropan-1-one (72.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **69** (22.0 mg, 64.2 μmol, 21%) as a colourless oil.

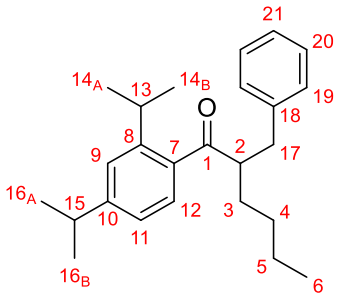
IR (film) ν_{max}/cm^{-1} 3027, 2922, 2852, 1671, 1597, 1484, 1464, 1435, 1362, 1284, 1243, 1022, 947.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.35 (1H, ddd, J = 8.3, 7.3, 1.8 Hz, C7H), 7.26 (1H, dd, J = 7.9, 1.8 Hz, C9H), 7.26 – 7.19 (4H, m, 4 × C13H), 7.18 – 7.10 (6H, m, 4 × C12H and 2 × C14H), 6.90 – 6.82 (2H, m, C6H and C8H), 4.11 (1H, tt, J = 7.5, 6.8 Hz, C2H), 3.79 (3H, s, $C10H_3$), 3.15 (2H, dd, J = 13.7, 7.5 Hz, 2 × C3$H_A$$H_B$), 2.69 (2H, dd, J = 13.7, 6.8 Hz, 2 × C3$H_A$$H_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 206.3 (C1=O), 157.9 (C5), 140.2 (2C, 2 × C11), 133.0 (C7H), 130.3 (C9H), 129.6 (C4), 129.2 (4C, 4 × C12H), 128.3 (4C, 4 × C13H), 126.1 (2C, 2 × C14H), 120.7 (C8H), 111.4 (C6H), 55.5 ($C10H_3$), 54.6 (C2H), 37.8 (2C, 2 × $C3H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 353.1512; $C_{23}H_{22}O_2Na$ requires 353.1512, Δ –0.05 ppm.

2-Benzyl-1-(2,4-diisopropylphenyl)hexan-1-one (73)



Ketone **S7** (88.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **73** (84.7 mg, 0.242 mmol, 81%) as a colourless oil.

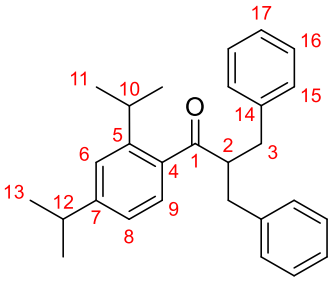
IR (film) ν_{max}/cm^{-1} 3106, 3085, 3063, 3027, 2959, 2928, 2870, 1681, 1606, 1561, 1496, 1457, 1414, 1382, 1362, 1329, 1279, 1228, 1206, 1163, 1103, 1086, 1073, 1055, 1030, 972, 946, 919, 894, 832, 774, 749, 700, 648.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.22 (2H, m, 2 × C19H), 7.20 (1H, s, C9H), 7.22 – 7.16 (2H, m, 2 × C19H), 7.20 – 7.14 (1H, m, C21H), 7.11 (1H, d, J = 8.0 Hz, C12H), 7.00 (1H, dd, J = 8.0, 1.8 Hz, C11H), 3.46 (1H, tt, J = 7.5, 6.0 Hz, C2H), 3.19 (1H, sept., J = 6.8 Hz, C13H), 3.11 (1H, dd, J = 13.5, 7.9 Hz, C17H_AH$_B$), 2.89 (1H, sept., J = 6.9 Hz, C15H), 2.71 (1H, dd, J = 13.5, 6.3 Hz, C17H$_A$$H_B$), 1.73 (1H, dddd, J = 13.0, 9.6, 7.2, 5.5 Hz, C3H_AH$_B$), 1.47 (1H, ddt, J = 14.3, 8.9, 4.8 Hz, C3H$_A$$H_B$), 1.36 – 1.24 (4H, m, $C4H_2$ and $C5H_2$), 1.24 (6H, d, J = 7.0 Hz, C16$_A$H$_3$ and C16$_B$H$_3$), 1.21 (3H, d, J = 6.8 Hz, C14$_A$H$_3$), 1.19 (3H, d, J = 6.9 Hz, C14$_B$H$_3$), 0.84 (3H, t, J = 7.0 Hz, C6H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 208.6 (C1=O), 151.8 (C10), 148.5 (C8), 140.5 (C18), 137.3 (C7), 129.2 (2C, 2 × C19H), 128.5 (2C, 2 × C20H), 127.4 (C12H), 126.2 (C21H), 124.9 (C9H), 123.2 (C11H), 52.9 (C2H), 37.7 ($C17H_2$), 34.3 (C15H), 31.9 ($C3H_2$), 29.64 ($C4H_2$), 29.54 (C13H), 24.7 ($C14_AH_3$), 24.5 ($C14_BH_3$), 23.91 ($C16_AH_3$), 23.88 ($C16_BH_3$), 23.0 ($C5H_2$), 14.0 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 351.26858; $C_{25}H_{35}O$ requires 351.26824, Δ 0.97 ppm.

2-Benzyl-1-(2,4-diisopropylphenyl)-3-phenylpropan-1-one (74)



Ketone **S7** (88.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **74** (90.8 mg, 0.236 mmol, 79%) as a colourless solid.

m.p. = 82 – 84 °C.

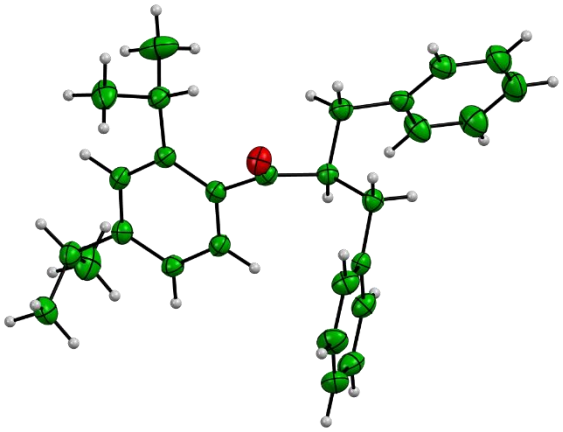
IR (film) ν_{max}/cm^{-1} 3106, 3086, 3063, 3027, 3003, 2961, 2926, 2869, 1681, 1605, 1561, 1496, 1455, 1415, 1383, 1361, 1331, 1279, 1230, 1195, 1179, 1163, 1080, 1056, 1030, 983, 948, 920, 894, 844, 823, 775, 749, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.28 – 7.21 (4H, m, 4 × C16H), 7.20 – 7.13 (7H, m, C6H, 4 × C15H and 2 × C17H), 6.96 – 6.89 (2H, m, C8H and C9H), 3.78 (1H, tt, J = 7.7, 6.6 Hz, C2H), 3.12 (2H, dd, J = 13.5, 7.6 Hz, 2 × C3$H_A$$H_B$), 3.07 (1H, sept., J = 6.8 Hz, C10H), 2.86 (1H, sept., J = 7.0 Hz, C12H), 2.70 (2H, dd, J = 13.6, 6.6 Hz, 2 × C3$H_A$$H_B$), 1.22 (6H, d, J = 6.9 Hz, 2 × C13H_3), 1.14 (6H, d, J = 6.8 Hz, 2 × C11H_3).

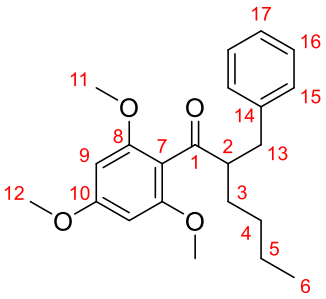
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.7 (C1=O), 151.9 (C7), 148.6 (C5), 139.8 (2C, 2 × C14), 136.9 (C4), 129.2 (4C, 4 × C15H), 128.6 (4C, 4 × C16H), 127.4 (C9H), 126.4 (2C, 2 × C17H), 124.8 (C6H), 123.2 (C8H), 55.1 (C2H), 37.9 (2C, 2 × C3H_2), 34.3 (C12H), 29.5 (C10H), 24.6 (2C, 2 × C11H_3), 23.9 (2C, 2 × C13H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 385.25266; $C_{28}H_{33}O$ requires 385.25259, Δ 0.16 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(2,4,6-trimethoxyphenyl)hexan-1-one (75)[5]



1-(2,4,6-Trimethoxyphenyl)-3-phenylpropan-1-one [*] (90.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **75** (97.0 mg, 0.261 mmol, 87%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3026, 3002, 2954, 2934, 2858, 1693, 1603, 1586, 1495, 1455, 1413, 1337, 1226, 1205, 1153, 1126, 1059, 1035, 953.

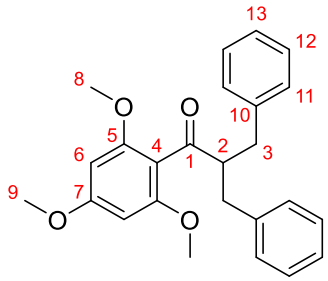
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.28 – 7.22 (2H, m, 2 × C16H), 7.21 – 7.13 (3H, m, 2 × C15H and C17H), 6.07 (2H, s, 2 × C9H), 3.81 (3H, s, $C12H_3$), 3.70 (6H, s, 2 × $C11H_3$), 3.28 (1H, tdd, *J* = 7.7, 6.0, 4.6 Hz, C2H), 3.15 (1H, dd, *J* = 13.7, 6.1 Hz, $C13H_AH_B$), 2.61 (1H, dd, *J* = 13.7, 7.9 Hz, $C13H_AH_B$), 1.75 – 1.64 (1H, m, $C3H_AH_B$), 1.43 – 1.14 (5H, m, $C3H_AH_B$, $C4H_2$ and $C5H_2$), 0.81 (3H, t, *J* = 7.2 Hz, $C6H_3$).

[*] The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 206.7 (C1=O), 162.4 (C10), 158.6 (2C, 2 × C8), 141.1 (C14), 129.4 (2C, 2 × C15H), 128.1 (2C, 2 × C16H), 125.8 (C17H), 113.8 (C7), 90.7 (2C, 2 × C9H), 55.7 (2C, 2 × $C11H_3$), 55.5 ($C12H_3$), 54.7 (C2H), 36.6 ($C13H_2$), 30.4 ($C3H_2$), 29.1 ($C4H_2$), 23.0 ($C5H_2$), 14.1 ($C6H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 379.1877; $C_{22}H_{28}O_4Na$ requires 379.1880, Δ –0.86 ppm.

2-Benzyl-3-phenyl-1-(2,4,6-trimethoxyphenyl)propan-1-one (76)



1-(2,4,6-Trimethoxyphenyl)-3-phenylpropan-1-one * (90.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **76** (108 mg, 0.277 mmol, 92%) as a pale yellow solid.

m.p. = 120 – 122 °C.

IR (film) ν_{max}/cm^{-1} 3026, 2939, 2840, 1695, 1604, 1587, 1495, 1454, 1438, 1414, 1337, 1227, 1206, 1154, 1128, 1032, 955.

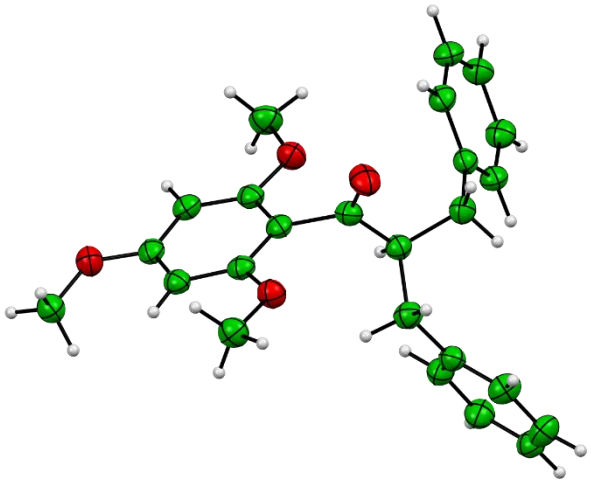
* The material was provided by Dr. James Frost.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.25 – 7.17 (4H, m, 4 × C12H), 7.16 – 7.09 (6H, m, 4 × C11H and 2 × C13H), 5.99 (2H, s, 2 × C6H), 3.79 (3H, s, $C9H_3$), 3.65 (1H, quint., J = 7.0 Hz, C2H), 3.57 (6H, s, 2 × $C8H_3$), 3.13 (2H, dd, J = 13.8, 7.0 Hz, 2 × C3$H_A$$H_B$), 2.63 (2H, dd, J = 13.8, 6.9 Hz, 2 × C3$H_A$$H_B$).

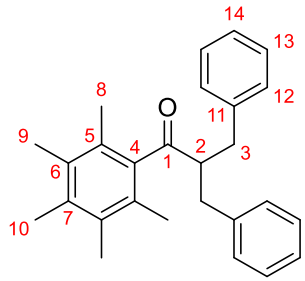
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 205.6 (C1=O), 162.5 (C7), 158.7 (2C, 2 × C5), 140.6 (2C, 2 × C10), 129.4 (4C, 4 × C11H), 128.1 (4C, 4 × C12H), 125.9 (2C, 2 × C13H), 113.4 (C4), 90.6 (2C, 2 × C6H), 56.5 (C2H), 55.7 (2C, 2 × $C8H_3$), 55.5 ($C9H_3$), 36.7 (2C, 2 × $C3H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 413.1728; $C_{25}H_{26}O_4Na$ requires 413.1723, Δ 1.04 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylpropan-1-one (79)[5]



Ketone **145** (84.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **79** (81.2 mg, 0.201 mmol, 69%) as a colourless solid.

m.p. = 124 – 126 °C.

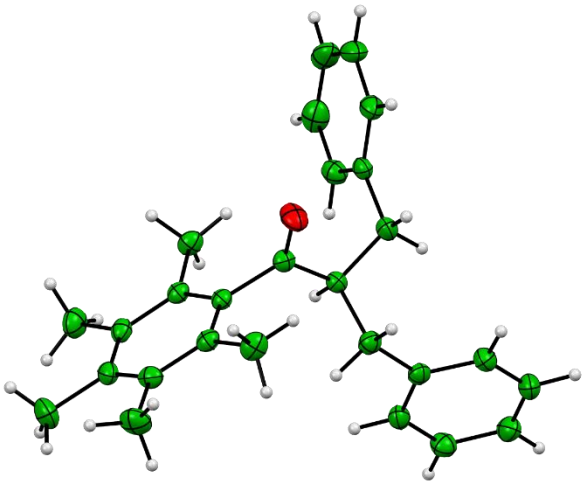
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 3000, 2925, 1692, 1603, 1496, 1454, 1382, 1300, 1264, 1201, 1120, 1077, 1029, 913, 898.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.25 – 7.19 (4H, m, 4 × C13H), 7.19 – 7.13 (2H, m, 2 × C14H), 7.12 – 7.06 (4H, m, 4 × C12H), 3.36 (1H, quint., J = 6.9 Hz, C2H), 3.18 (2H, dd, J = 13.5, 6.7 Hz, 2 × C3$H_A$$H_B$), 2.56 (2H, dd, J = 13.5, 7.1 Hz, 2 × C3$H_A$$H_B$), 2.21 (3H, s, C10$H_3$), 2.13 (6H, s, 2 × C9$H_3$), 1.82 (6H, s, 2 × C8$H_3$).

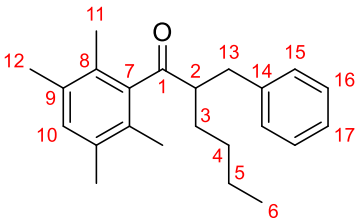
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.8 (C1=O), 140.1 (2C, 2 × C11), 139.1 (C4), 135.8 (C7), 133.2 (2C, 2 × C6), 129.5 (4C, 4 × C12H), 128.8 (2C, 2 × C5), 128.4 (4C, 2 × C13H), 126.2 (2C, 2 × C14H), 58.8 (C2H), 35.7 (2C, 2 × C3H_2), 17.6 (2C, 2 × C8H_3), 16.9 (C10H_3), 16.1 (2C, 2 × C9H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 393.2119; $C_{27}H_{30}ONa$ requires 393.2119, Δ –0.04 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(2,3,5,6-tetramethylphenyl)hexan-1-one (80)



Ketone **181** (79.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **80** (67.4 mg, 0.199 mmol, 66%) as a colourless solid.

m.p. = 74 – 76 °C.

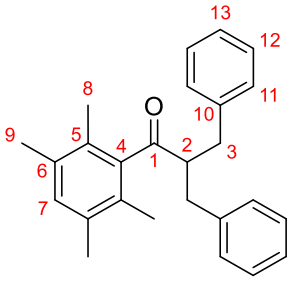
IR (film) ν_{max}/cm^{-1} 3085, 3063, 3026, 3003, 2955, 2931, 2861, 1693, 1604, 1496, 1466, 1455, 1376, 1299, 1275, 1230, 1178, 1130, 1098, 1075, 1008, 969, 947.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.22 (2H, m, 2 × C16H), 7.21 – 7.15 (3H, m, 2 × C15H and C17H), 6.95 (1H, s, C10H), 3.16 (1H, dd, J = 13.5, 6.4 Hz, C13H_AH$_B$), 3.07 (1H, dq, J = 7.4, 5.9 Hz, C2H), 2.69 (1H, dd, J = 13.5, 7.3 Hz, C13H$_A$$H_B$), 2.18 (6H, s, 2 × C12$H_3$), 1.94 (6H, br. s, 2 × C11H_3), 1.74 – 1.66 (1H, m, C3H_AH$_B$), 1.43 – 1.28 (3H, m, C3H$_A$$H_B$ and C4H_2), 1.28 – 1.18 (2H, m, C5H_2), 0.82 (3H, t, J = 7.2 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.8 (C1=O), 141.8 (C7), 140.5 (C14), 134.5 (2C, 2 × C9), 131.9 (C10H), 129.49 (2C, 2 × C15H), 129.43 (2C, 2 × C8), 128.4 (2C, 2 × C16H), 126.2 (C17H), 55.9 (C2H), 35.6 (C13H_2), 29.52 (C3H_2), 29.46 (C4H_2), 22.9 (C5H_2), 19.8 (2C, 2 × C12H_3), 16.6 (2C, 2 × C11H_3), 14.0 (C6H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 323.23694; $C_{23}H_{31}O$ requires 323.23694, Δ –0.01 ppm.

2-Benzyl-3-phenyl-1-(2,3,5,6-tetramethylphenyl)propan-1-one (81)



Ketone **181** (79.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **81** (56.5 mg, 0.158 mmol, 53%) as a colourless solid.

m.p. = 101 – 104 °C. [Lit.: 106 – 107 °C.][14]

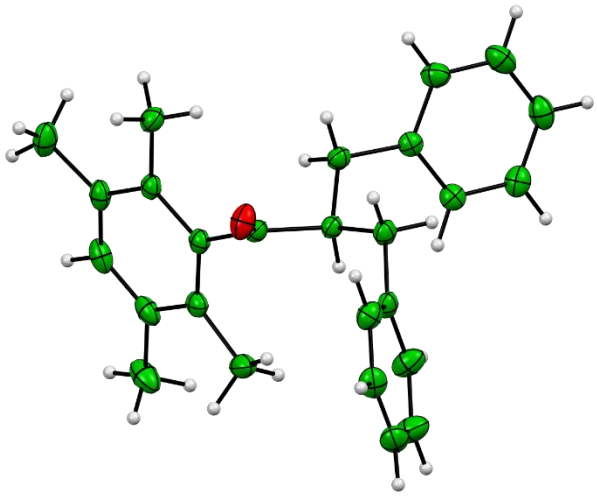
IR (film) ν_{max}/cm^{-1} 3085, 3063, 3027, 3003, 2924, 2861, 1695, 1603, 1585, 1496, 1467, 1454, 1386, 1375, 1353, 1295, 1266, 1230, 1199, 1117, 1077, 1019, 976, 950.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.25 – 7.20 (4H, m, 4 × C12H), 7.19 – 7.14 (2H, m, 2 × C13H), 7.12 – 7.07 (4H, m, 4 × C11H), 6.94 (1H, s, C7H), 3.38 (1H, quint., J = 6.9 Hz, C2H), 3.18 (2H, dd, J = 13.6, 6.7 Hz, 2 × C3H_AH$_B$), 2.58 (2H, dd, J = 13.6, 7.1 Hz, 2 × C3H$_A$$H_B$), 2.15 (6H, s, 2 × C9$H_3$), 1.79 (6H, s, 2 × C8$H_3$).

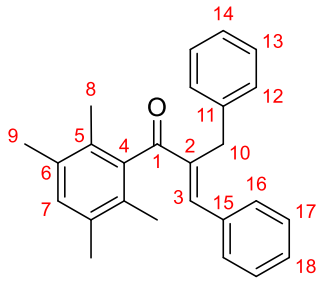
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.6 (C1=O), 141.2 (C4), 140.0 (2C, 2 × C10), 134.5 (2C, 2 × C6), 132.1 (C7H), 129.53 (2C, 2 × C5), 129.45 (4C, 4 × C11H), 128.4 (4C, 4 × C12H), 126.3 (2C, 2 × C13H), 58.6 (C2H), 35.7 (2C, 2 × C3H_2), 19.7 (2C, 2 × C9H_3), 16.4 (2C, 2 × C8H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 357.22144; $C_{26}H_{29}O$ requires 357.22129, Δ 0.40 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



(*E*)-2-Benzyl-3-phenyl-1-(2,3,5,6-tetramethylphenyl)prop-2-en-1-one (436)



Ketone **181** (952 mg, 3.57 mmol, 1.0 equiv), benzaldehyde (400 μL, 417 mg, 3.93 mmol, 1.1 equiv), NaOH (179 mg, 4.47 mmol, 1.25 equiv) and EtOH (24 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Filtration and drying *in vacuo* afforded enone **436** (460 mg) as a pale yellow solid.

The filtrate was diluted with H_2O (75 mL) and extracted with DCM (3 × 20 mL), then the combined organics were dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **436** (447 mg, total 907 mg, 2.56 mmol, 72%) as a pale yellow solid.

In the preparation of ketone **81** by **General Procedure D**, enone **436** (22.1 mg, 62.3 μmol, 21%) was also isolated as a pale yellow solid.

m.p. = 99 – 100 °C.

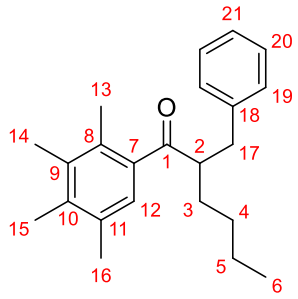
IR (film) ν_{max}/cm^{-1} 3083, 3060, 3027, 3002, 2920, 2865, 1652, 1619, 1601, 1574, 1494, 1469, 1450, 1378, 1305, 1230, 1203, 1184, 1161, 1077, 1030, 1009, 962, 933, 872, 831, 762, 735, 698.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 (1H, s, C3H), 7.38 – 7.31 (5H, m, 2 × C16H, 2 × C17H and C18H), 7.30 – 7.28 (4H, m, 2 × C12H and 2 × C13H), 7.24 – 7.18 (1H, m, C14H), 6.99 (1H, s, C7H), 4.12 (2H, s, C10H), 2.22 (6H, s, 2 × $C9H_3$), 1.99 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.6 (C1=O), 146.2 (C3H), 140.5 (C2), 140.0 (C4), 139.4 (C11), 135.5 (C15), 134.2 (2C, 2 × C6), 131.7 (C7H), 130.2 (2C, 2 × C5), 129.7 (2C, 2 × C16H), 129.4 (C18H), 128.8 (2C, 2 × C17H), 128.59 (2C, 2 × C12H), 128.57 (2C, 2 × C13H), 126.2 (C14H), 31.7 ($C10H_2$), 19.7 (2C, 2 × $C9H_3$), 16.3 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 355.20575; $C_{26}H_{27}O$ requires 355.20564, Δ 0.30 ppm.

2-Benzyl-1-(2,3,4,5-tetramethylphenyl)hexan-1-one (82)



Ketone **340** (79.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **82** (73.1 mg, 0.205 mmol, 68%) as a colourless oil.

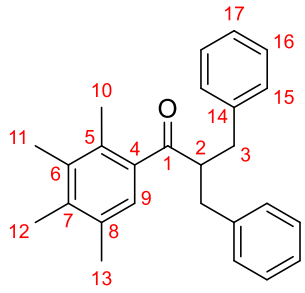
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 3002, 2955, 2929, 2859, 1681, 1602, 1562, 1495, 1454, 1380, 1358, 1295, 1241, 1215, 1179, 1124, 1105, 1073, 1030, 1010, 928.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.31 – 7.23 (2H, m, 2 × C20H), 7.22 – 7.13 (3H, m, 2 × C19H and C21H), 6.73 (1H, s, C12H), 3.44 (1H, tt, J = 7.6, 5.9 Hz, C2H), 3.11 (1H, dd, J = 13.4, 8.0 Hz, C3$H_A$$H_B$), 2.72 (1H, dd, J = 13.5, 6.3 Hz, C3$H_A$$H_B$), 2.22 (3H, s, $C13H_3$), 2.20 (3H, s, $C15H_3$), 2.19 (3H, s, $C14H_3$), 2.19 (3H, s, $C16H_3$), 1.74 (1H, dddd, J = 13.0, 9.7, 7.3, 5.4 Hz, C3$H_A$$H_B$), 1.55 – 1.41 (1H, m, C3$H_A$$H_B$), 1.37 – 1.19 (4H, m, $C4H_2$ and $C5H_2$), 0.84 (3H, t, J = 7.1 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.3 (C1=O), 140.6 (C18), 138.5 (C8), 138.0 (C11), 136.6 (C9), 133.2 (C10), 132.7 (C18), 129.3 (2C, 2 × C19H), 128.5 (2C, 2 × C20H), 126.24 (C12H), 126.19 (C21H), 53.0 (C2H), 37.9 ($C17H_2$), 32.0 ($C3H_2$), 29.6 ($C4H_2$), 23.0 ($C5H_2$), 20.9 ($C16H_3$), 17.1 ($C13H_3$), 16.5 ($C14H_3$), 16.2 ($C15H_3$), 14.0 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 323.23709; $C_{27}H_{29}O$ requires 323.23694, Δ 0.46 ppm.

2-Benzyl-3-phenyl-1-(2,3,4,5-tetramethylphenyl)propan-1-one (83)



Ketone **340** (79.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **83** (71.0 mg, 0.199 mmol, 66%) as a colourless solid.

m.p. = 79 – 82 °C.

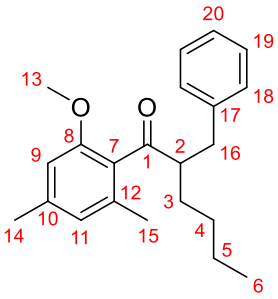
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3027, 3003, 2944, 2921, 2859, 1678, 1602, 1561, 1495, 1454, 1444, 1381, 1357, 1294, 1241, 1199, 1118, 1078, 1030, 1004, 928.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.28 – 7.23 (4H, m, 4 × C16H), 7.21 – 7.14 (6H, m, 4 × C15H and 2 × C17H), 6.44 (1H, s, C9H), 3.77 (1H, tt, J = 7.8, 6.5 Hz, C2H), 3.12 (2H, dd, J = 13.5, 7.9 Hz, 2 × C3H_AH$_B$), 2.74 (2H, dd, J = 13.5, 6.5 Hz, 2 × C3H$_A$$H_B$), 2.16 (3H, s, $C12H_3$), 2.16 (3H, s, $C11H_3$), 2.11 (3H, s, $C10H_3$), 2.10 (3H, s, $C13H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 208.5 (C1=O), 139.9 (2C, 2 × C14), 138.16 (C4), 138.14 (C7), 136.5 (C6), 133.1 (C8), 132.8 (C5), 129.3 (4C, 4 × C15H), 128.5 (4C, 4 × C16H), 126.3 (2C, 2 × C17H), 126.2 (C9H), 55.1 (C2H), 38.2 (2C, 2 × $C3H_2$), 20.8 ($C13H_3$), 16.9 ($C10H_3$), 16.5 ($C12H_3$), 16.2 ($C11H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 379.20303; $C_{26}H_{28}ONa$ requires 379.20324, Δ –0.54 ppm.

2-Benzyl-1-(2-methoxy-4,6-dimethylphenyl)hexan-1-one (84)



Ketone **S9** (80.5 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **84** (84.6 mg, 0.261 mmol, 86%) as a colourless oil.

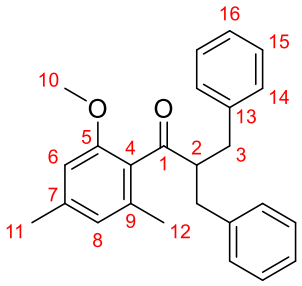
IR (film) ν_{max}/cm^{-1} 3084, 3063, 3026, 3003, 2955, 2930, 2858, 1688, 1610, 1574, 1496, 1456, 1377, 1310, 1284, 1245, 1223, 1198, 1156, 1098, 1030, 1000, 984, 932.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.23 (2H, m, 2 × C19H), 7.23 – 7.14 (3H, m, 2 × C18H and C20H), 6.61 (1H, s, C11H), 6.53 (1H, s, C9H), 3.66 (3H, s, $C13H_3$), 3.40 (1H, tt, J = 7.8, 6.1 Hz, C2H), 3.14 (1H, dd, J = 13.7, 6.3 Hz, C16H_AH$_B$), 2.63 (1H, dd, J = 13.6, 7.8 Hz, C16H$_A$$H_B$), 2.31 (3H, s, $C14H_3$), 2.15 (3H, s $C15H_3$), 1.69 (1H, dddd, J = 12.8, 10.0, 7.1, 5.0 Hz, C3H_AH$_B$), 1.41 – 1.35 (1H, m, C3H$_A$$H_B$), 1.35 – 1.25 (2H, m, $C4H_2$), 1.25 – 1.16 (2H, m, $C5H_2$), 0.82 (3H, t, J = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.0 (C1=O), 157.3 (C8), 140.9 (C17), 140.6 (C10), 137.0 (C12), 129.4 (2C, 2 × C18H), 128.23 (2C, 2 × C19H), 128.07 (C7), 125.9 (C20H), 124.1 (C11H), 109.5 (C9H), 55.4 ($C13H_3$), 54.4 (C2H), 36.6 ($C16H_2$), 30.3 ($C3H_2$), 29.4 ($C4H_2$), 23.0 ($C5H_2$), 21.8 ($C14H_3$), 19.5 ($C15H_3$), 14.1 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 325.21640; $C_{22}H_{29}O_2$ requires 325.21621, Δ 0.59 ppm.

2-Benzyl-1-(2-methoxy-4,6-dimethylphenyl)-3-phenylpropan-1-one (85)



Ketone **S9** (80.5 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **85** (68.6 mg, 0.191 mmol, 64%) as a colourless solid.

m.p. = 75 – 77 °C.

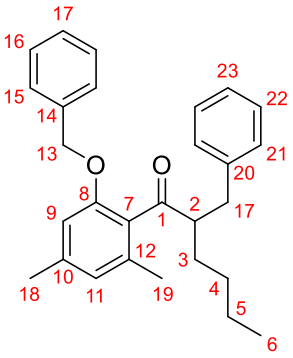
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 3002, 2925, 2853, 1689, 1609, 1574, 1496, 1454, 1410, 1377, 1360, 1310, 1285, 1266, 1245, 1222, 1191, 1155, 1098, 1030, 987, 935.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.25 – 7.18 (4H, m, 4 × C15H), 7.18 – 7.11 (2H, m, 2 × C16H), 7.14 – 7.08 (4H, m, 4 × C14H), 6.54 (1H, s, C6H), 6.49 (1H, s, C4H), 3.82 – 3.72 (1H, m, C2H), 3.54 (3H, s, $C10H_3$), 3.15 (2H, dd, J = 13.8, 7.0 Hz, 2 × $C3H_AH_B$), 2.61 (2H, dd, J = 13.8, 7.2 Hz, 2 × $C3H_AH_B$), 2.28 (3H, s, $C11H_3$), 1.98 (3H, s, $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.2 (C1=O), 157.4 (C5), 140.8 (C7), 140.4 (2C, 2 × C13), 137.4 (C9), 129.3 (4C, 4 × C14H), 128.3 (4C, 4 × C15H), 127.7 (C4), 126.0 (2C, 2 × C16H), 124.1 (C8H), 109.5 (C6H), 56.1 (C2H), 55.3 ($C10H_3$), 36.8 (2C, 2 × $C3H_2$), 21.8 ($C11H_3$), 19.3 ($C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 359.20059; $C_{25}H_{27}O$ requires 359.20056, Δ 0.10 ppm.

2-Benzyl-1-(2-(benzyloxy)-4,6-dimethylphenyl)hexan-1-one (86)



Ketone **S10** (103 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **86** (75.7 mg, 0.189 mmol, 63%) as a colourless oil.

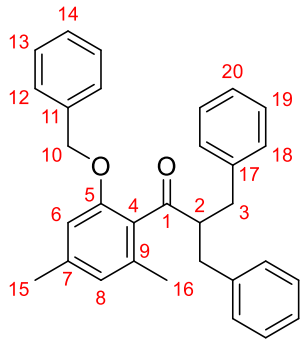
IR (film) ν_{max}/cm^{-1} 3085, 3063, 3028, 2955, 2929, 2859, 1688, 1610, 1573, 1496, 1454, 1378, 1307, 1280, 1246, 1222, 1197, 1156, 1086, 1029, 1001, 931.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.41 – 7.34 (4H, m, 2 × C15H and 2 × C16H), 7.34 – 7.29 (1H, m, C17H), 7.20 – 7.14 (2H, m, 2 × C22H), 7.14 – 7.09 (1H, m, C23H), 7.05 – 6.97 (2H, m, 2 × C21H), 6.62 (1H, s, C11H), 6.60 (1H, s, C9H), 4.99 (2H, s, $C13H_2$), 3.44 (1H, ddt, J = 8.7, 6.8, 5.4 Hz, C2H), 3.04 (1H, dd, J = 13.7, 5.5 Hz, C17H_AH$_B$), 2.60 (1H, dd, J = 13.7, 8.8 Hz, C17H$_A$$H_B$), 2.29 (3H, s, $C18H_3$), 2.16 (3H, s, $C19H_3$), 1.61 (1H, dddd, J = 12.9, 11.4, 6.7, 4.9 Hz, C3H_AH$_B$), 1.33 (1H, ddt, J = 13.4, 10.6, 4.9 Hz, C3H$_A$$H_B$), 1.25 – 1.14 (1H, m, C4H_AH$_B$), 1.14 – 1.00 (3H, m, C4H$_A$$H_B$ and $C5H_2$), 0.72 (3H, t, J = 7.0 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.0 (C1=O), 156.3 (C8), 140.7 (C20), 140.5 (C10), 137.2 (C7), 136.7 (C14), 129.3 (2C, 2 × C21H), 128.7 (2C, 2 × C15H), 128.26 (C12), 128.22 (C17H), 128.19 (2C, 2 × C22H), 127.9 (2C, 2 × C16H), 125.8 (C23H), 124.4 (C11H), 110.7 (C9H), 70.6 ($C13H_2$), 54.1 (C2H), 36.3 ($C17H_2$), 29.8 ($C3H_2$), 29.2 ($C4H_2$), 22.9 ($C5H_2$), 21.8 ($C18H_3$), 19.6 ($C19H_3$), 14.0 ($C6H_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 423.22980; $C_{28}H_{32}O_2Na$ requires 423.22945, Δ 0.82 ppm.

2-Benzyl-1-(2-(benzyloxy)-4,6-dimethylphenyl)-3-phenylpropan-1-one (87)



Ketone **S10** (103 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **87** (62.1 mg, 0.143 mmol, 48%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3062, 3027, 2961, 2921, 2853, 1686, 1609, 1572, 1496, 1453, 1378, 1305, 1280, 1261, 1221, 1186, 1155, 1084, 1029, 932.

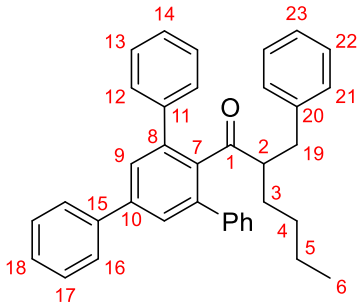
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.34 (2H, m, 2 × C13H), 7.34 – 7.31 (1H, m, C14H), 7.31 – 7.27 (2H, m, 2 × C12H), 7.13 (4H, m, 4 × C19H), 7.11 – 7.06 (2H, m, 2 × C18H), 6.99 – 6.93 (4H, m, 4 × C20H), 6.53 (1H, s, C8H), 6.51 (1H, s, C6H), 4.88 (2H, s, $C10H_2$), 3.85 (1H, quint., J = 7.1 Hz, C2H), 3.07 (2H, dd, J = 13.9, 6.8 Hz, 2 × C3$H_A$$H_B$), 2.60 (2H, dd, J = 13.9, 7.3 Hz, 2 × C3$H_A$$H_B$), 2.24 (3H, s, $C15H_3$), 1.98 (3H, s, $C16H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 208.9 (C1=O), 156.3 (C5), 140.7 (C15), 140.3 (2C, 2 × C17), 137.6 (C9), 136.8 (C11), 129.2 (4C, 4 × C18H), 128.7 (2C, 2 × C13H), 128.2 (5C, 4 × C19H and C14H), 127.84 (C4), 127.77 (2C, 2 × C12H), 125.9 (2C, 2 × C20H), 124.4 (C8H), 110.7 (C6H), 70.4 ($C10H_2$), 55.7 (C2H), 36.5 (2C, 2 × $C3H_2$), 21.8 ($C16H_3$), 19.5 ($C15H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 435.23209; $C_{31}H_{31}O_2$ requires 435.23186, Δ 0.53 ppm.

2-Benzyl-1-(5′-phenyl-[1,1′:3′,1′′-terphenyl]-2′-yl)hexan-1-one (88), or

2-Benzyl-3-phenyl-1-(2,4,6-triphenylphenyl)hexan-1-one (88)



Ketone **S12** (132 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **88** (13.6 mg, 0275 mmol, 9.2%) as a colourless oil.

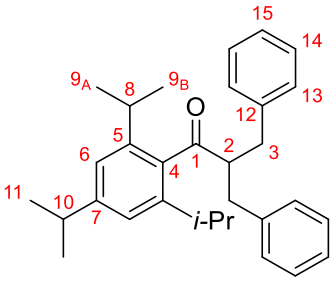
IR (film) ν_{max}/cm^{-1} 3084, 3059, 3029, 2955, 2928, 2869, 2856, 1694, 1595, 1576, 1556, 1495, 1454, 1427, 1394, 1377, 1282, 1249, 1217, 1200, 1181, 1157, 1073, 1030, 988.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.72 – 7.66 (2H, m, 2 × C16H), 7.61 (2H, s, 2 × C9H), 7.57 – 7.50 (4H, m, 4 × C12H), 7.49 – 7.45 (2H, m, 2 × C17H), 7.45 – 7.41 (4H, m, 4 × C13H), 7.41 – 7.37 (3H, m, 2 × C14H and C18H), 7.13 – 7.03 (3H, m, 2 × C22H and C23H), 6.62 – 6.50 (2H, m, 2 × C21H), 2.38 – 2.29 (2H, m, C2H and C19H_AH$_B$), 2.24 (1H, dd, J = 13.9, 10.9 Hz, C19H$_A$$H_B$), 1.01 – 0.92 (1H, m, C3H_AH$_B$), 0.92 – 0.82 (1H, m, C3H$_A$$H_B$), 0.80 – 0.62 (3H, m, C4H_AH$_B$ and C5H_2), 0.54 (3H, t, J = 7.1 Hz, C6H_3), 0.12 – 0.01 (1H, m, C4H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.7 (C1=O), 141.4 (C10), 140.59 (2C, 2 × C8), 140.58 (2C, 2 × C11), 140.04 (C20), 140.01 (C15), 139.0 (C7), 130.3 (4C, 4 × C12H), 129.06 (2C, 2 × C17H), 128.99 (2C, 2 × C21H), 128.35 (4C, 4 × C13H), 128.27 (2C, 2 × C9H), 128.12 (2C, 2 × C22H), 128.06 (C18H), 127.9 (2C, 2 × C14H), 127.4 (2C, 2 × C16H), 125.8 (C23H), 54.3 (C2H), 35.0 ($C19H_2$), 27.6 ($C3H_2$), 27.3 ($C4H_2$), 22.7 ($C5H_2$), 13.8 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 495.26791; $C_{37}H_{35}O$ requires 495.26824, Δ –0.66 ppm.

2-Benzyl-3-phenyl-1-(2,4,6-triisopropylphenyl)propan-1-one (89)



Ketone **S14** (101 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **89** (55.3 mg, 0.130 mmol, 43%) as a colourless solid.

m.p. = 175 – 177 °C.

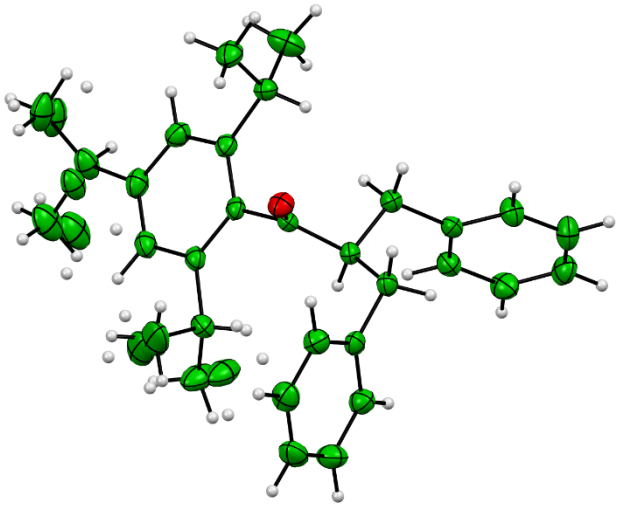
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3027, 2961, 2927, 2868, 1693, 1605, 1568, 1496, 1455, 1384, 1362, 1319, 1264, 1223, 1099, 950.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.30 – 7.22 (4H, m, 4 × C14H), 7.22 – 7.15 (2H, m, 2 × C15H), 7.15 – 7.09 (4H, m 4 × C13H), 6.93 (2H, s, 2 × C6H), 3.38 (1H, quint., J = 7.0 Hz, C2H), 3.19 (2H, dd, J = 13.3, 6.8 Hz, 2 × C3H_AH$_B$), 2.86 (1H, sept., J = 6.9 Hz, C10H), 2.54 (2H, dd, J = 13.3, 7.1 Hz, 2 × C3H$_A$$H_B$), 2.23 (2H, sept., J = 6.7 Hz, 2 × C8H), 1.23 (6H, d, J = 6.9 Hz, 2 × C11H$_3$), 1.11 (6H, br. s, C9$_A$H$_3$), 0.94 (6H, br. s, C9$_B$H$_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.0 (C1=O), 150.0 (C7), 145.4 (2C, 2 × C5), 140.1 (2C, 2 × C12), 135.9 (C4), 129.4 (4C, 4 × C13H), 128.5 (4C, 4 × C14H), 126.3 (2C, 2 × C15H), 121.4 (2C, 2 × C6H), 59.3 (C2H), 35.7 (2C, 2 × C3H$_2$), 34.4 (C10H), 30.7 (2C, 2 × C8H), 25.7 (2C, br. s, 2 × C9$_B$H$_3$), 24.0 (2C, 2 × C11H$_3$), 23.5 (2C, br. s, 2 × C9$_A$H$_3$).

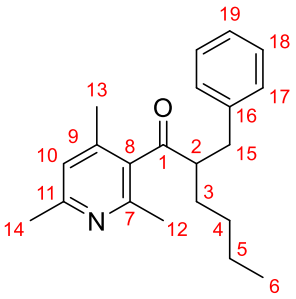
HRMS (ESI$^+$) Found $[M+H]^+$ = 427.2995; $C_{31}H_{39}O$ requires 427.2995, Δ –0.17 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



Note: There is some disorder observed around two of the isopropyl groups.

2-Benzyl-1-(2,4,6-trimethylpyridin-3-yl)hexan-1-one (90)[5]



Ketone **S16** (76.0 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 75:25 → 60:40) afforded ketone **90** (83.0 mg, 0.268 mmol, 89%) as a pale yellow oil.

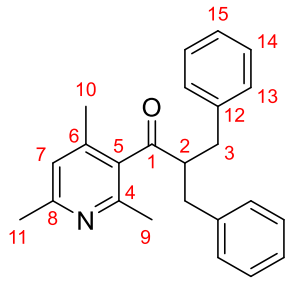
IR (film) ν_{max}/cm^{-1} 3027, 2958, 2931, 2973, 2857, 1692, 1590, 1557, 1496, 1468, 1415, 1377, 1236, 1160, 1029.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.29 – 7.22 (2H, m, 2 × C18H), 7.21 – 7.15 (3H, m, 2 × C17H and C19H), 6.79 (1H, s, C10H), 3.20 – 3.08 (2H, m, C2H and C15H_AH_B), 2.69 (1H, app. q_{AB}, J_{AB} = 9.3 Hz, Δ_{AB} = 13.2 Hz, C15H_AH_B), 2.46 (3H, s, C12H_3), 2.26 (3H, s, C14H_3), 2.04 (3H, s, C13H_3), 1.75 – 1.60 (1H, m, C3H_AH_B), 1.46 – 1.15 (5H, m, C3H_AH_B and C4H_2 and C5H_2), 0.83 (3H, t, J = 7.2 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.0 (C1=O), 158.0 (C7), 153.3 (C11), 144.3 (C9), 140.0 (C16), 133.9 (C8), 129.4 (2C, 2 × C17H), 128.5 (2C, 2 × C18H), 126.4 (C19H), 122.7 (C10H), 55.6 (C2H), 35.6 (C15H_2), 30.0 (C3H_2), 29.5 (C4H_2), 24.3 (C12H_3), 23.1 (C14H_3), 22.9 (C5H_2), 19.3 (C13H_3), 14.0 (C6H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 332.1985; $C_{21}H_{27}NONa$ requires 332.1985, Δ –0.09 ppm.

2-Benzyl-3-phenyl-1-(2,4,6-trimethylpyridin-3-yl)propan-1-one (91)



Ketone **S16** (76.0 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 75:25 → 60:40) afforded ketone **91** (65.1 mg, 0.190 mmol, 63%) as a pale yellow solid.

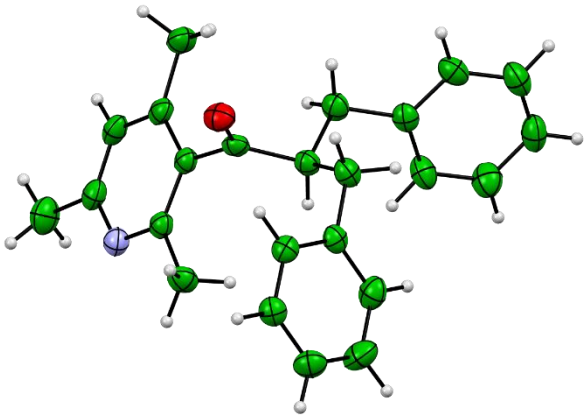
m.p. = 85 – 87 °C.

IR (film) ν_{max}/cm^{-1} 3063, 3027, 2923, 2853, 1694, 1590, 1556, 1496, 1440, 1414, 1386, 1377, 1237, 1157, 1029, 957.

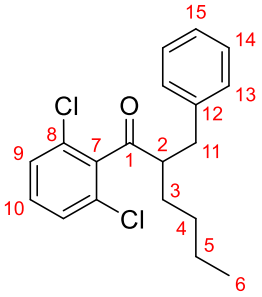
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.27 – 7.21 (4H, m, 4 × C14H), 7.20 – 7.14 (2H, m, 2 × C15H), 7.13 – 7.07 (4H, m, 4 × C13H), 6.75 (1H, s, C7H), 3.47 (1H, quint., J = 7.0 Hz, C2H), 3.13 (2H, dd, J = 13.5, 7.0 Hz, 2 × C3H_AH$_B$), 2.60 (2H, dd, J = 13.5, 7.0 Hz, 2 × C3H$_A$$H_B$), 2.45 (3H, s, C9$H_3$), 2.12 (3H, s, C11$H_3$), 1.92 (3H, s, C10$H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.0 (C1=O), 158.2 (C4), 153.4 (C8), 144.5 (C6), 139.5 (2C, 2 × C12), 133.5 (C5), 129.3 (4C, 4 × C13H), 128.6 (4C, 4 × C14H), 126.5 (2C, 2 × C15H), 122.7 (C7H), 58.2 (C2H), 36.0 (2C, 2 × C3H_2), 24.3 (C9H_3), 22.9 (C11H_3), 19.2 (C10H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 366.1829; $C_{24}H_{25}NONa$ requires 366.1828, Δ 0.15 ppm. The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(2,6-dichlorophenyl)hexan-1-one (92)



1-(2,6-Dichlorophenyl)-3-phenylpropan-1-one [*] (83.8 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **92** (46.0 mg, 0.137 mmol, 46%) as a colourless oil.

[*] The material was provided by Dr. James Frost.

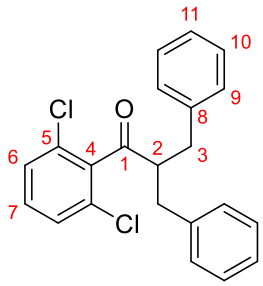
IR (film) ν_{max}/cm^{-1} 3028, 2956, 2931, 2860, 1706, 1579, 1560, 1496, 1455, 1427, 1262, 1222, 1201, 1097, 939.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.33 – 7.23 (8H, m, 2 × C9, C10 and 2 × C14H), 7.23 – 7.15 (3H, m, 2 × C13 and C15H), 3.39 (1H, ddt, *J* = 8.6, 6.5, 5.5 Hz, C2H), 3.19 (1H, dd, *J* = 13.9, 5.6 Hz, C11H_AH$_B$), 2.76 (1H, dd, *J* = 13.9, 8.6 Hz, C11H$_A$$H_B$), 1.75 (1H, dddd, *J* = 13.7, 10.5, 6.5, 5.4 Hz, C3H_AH$_B$), 1.50 (1H, ddt, *J* = 13.6, 10.3, 5.2 Hz, C3H$_A$$H_B$), 1.42 – 1.28 (2H, m, $C4H_2$), 1.23 (2H, sext., *J* = 7.1 Hz, $C5H_2$), 0.82 (3H, t, *J* = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 204.1 (C1=O), 139.9 (2C, 2 × C12), 139.3 (C7), 131.6 (2C, 2 × C8), 130.7 (C10H), 129.3 (2C, 2 × C14H), 128.6 (2C, 2 × C9H), 128.4 (2C, 2 × C13H), 126.3 (C15H), 54.2 (C2H), 35.6 ($C11H_2$), 28.95 ($C3H_2$), 28.92 ($C4H_2$), 22.9 ($C5H_2$), 14.0 ($C6H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 357.0784; $C_{19}H_{20}{}^{35}Cl_2ONa$ requires 357.0783, Δ 0.08 ppm.

2-Benzyl-1-(2,6-dichlorophenyl)-3-phenylpropan-1-one (93)



1-(2,6-Dichlorophenyl)-3-phenylpropan-1-one [*] (83.8 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **93** (59.0 mg, 0.150 mmol, 50%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3027, 2924, 1706, 1603, 1582, 1560, 1496, 1454, 1428, 1221, 1197, 1104, 1084, 1029, 941.

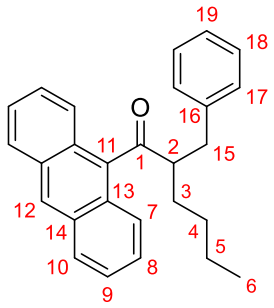
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.30 – 7.21 (7H, m, 2 × C6H, C7H and 4 × C10H), 7.23 – 7.17 (2H, m, 2 × C11H), 7.18 – 7.13 (4H, m, 4 × C9H), 3.74 (1H, tt, J = 7.2, 6.7 Hz, C2H), 3.21 (2H, dd, J = 14.0, 6.7 Hz, 2 × C3H_AH$_B$), 2.72 (2H, dd, J = 14.0, 7.1 Hz, 2 × C3H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.0 (C1=O), 139.4 (2C, 2 × C8), 138.8 (C4), 131.6 (2C, 2 × C5), 130.8 (C7H), 129.3 (4C, 4 × C9H), 128.5 (2C, 2 × C6H), 128.4 (4C, 4 × C10H), 126.3 (2C, 2 × C11H), 56.4 (C2H), 35.6 (2C, 2 × C3H_2).

HRMS (ESI^+) Found $[M+Na]^+$ = 391.0626; $C_{22}H_{18}{}^{35}Cl_2ONa$ requires 391.0627, Δ –0.10 ppm.

[*] The material was provided by Dr. James Frost.

1-(Anthracen-9-yl)-2-benzylhexan-1-one (94)



Ketone **10** (93.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1 → 98:2) afforded ketone **94** (90.1 mg, 0.246 mmol, 82%) as a colourless oil.

m.p. = 144 – 149 °C.

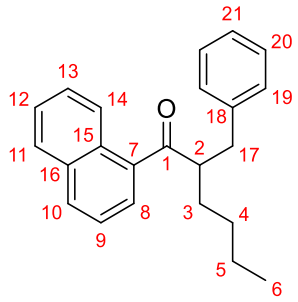
IR (film) ν_{max}/cm^{-1} 3084, 3053, 3027, 2955, 2931, 2859, 1715, 1688, 1624, 1603, 1520, 1496, 1454, 1378, 1262, 1211, 1182, 1160, 1144, 1126, 1090, 1030, 1015, 957, 931, 914, 890.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.46 (1H, s, C12H), 7.99 (2H, d, J = 8.5 Hz, 2 × C10H), 7.44 (2H, t, J = 7.6 Hz, C9H), 7.41 – 7.08 (9H, m, 2 × C7H, 2 × C8H, 2 × C17H, 2 × C18H and C19H), 3.55 (1H, dq, J = 7.7, 5.9 Hz, C2H), 3.39 (1H, dd, J = 13.4, 8.0 Hz, C15H_AH$_B$), 2.87 (1H, dd, J = 13.4, 5.8 Hz, C15H$_A$$H_B$), 1.77 (1H, ddt, J = 13.5, 10.9, 5.6 Hz, C3H_AH$_B$), 1.51 (1H, dddd, J = 13.5, 11.0, 6.6, 4.8 Hz, C3H$_A$$H_B$), 1.47 – 1.38 (1H, m, C4H_AH$_B$), 1.38 – 1.28 (1H, m, C4H$_A$$H_B$), 1.21 – 1.12 (2H, m, C5H_2), 0.76 (3H, t, J = 7.3 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.3 (C1=O), 140.5 (C16), 135.7 (C11), 131.1 (2C, 2 × C14), 129.8 (2C, 2 × C17H), 129.0 (C12H), 128.8 (2C, 2 × C10H), 128.6 (2C, 2 × C18H), 128.3 (2C, 2 × C13), 126.7 (2C, 2 × C7H), 126.4 (C19H), 125.4 (2C, 2 × C9H), 124.9 (2C, 2 × C8H), 57.2 (C2H), 36.0 ($C15H_2$), 30.8 ($C3H_2$), 29.4 ($C4H_2$), 22.8 ($C5H_2$), 13.9 ($C6H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 367.20572; $C_{27}H_{27}O$ requires 367.20572, Δ 0.21 ppm.

2-Benzyl-1-(naphthalen-1-yl)hexan-1-one (95)



Ketone **S17** (78.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **95** (63.5 mg, 0.201 mmol, 67%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3061, 3028, 2955, 2928, 2857, 1677, 1593, 1574, 1508, 1496, 1455, 1377, 1360, 1342, 1273, 1231, 1213, 1170, 1089, 1049, 1029, 971, 930, 865, 794, 777, 745, 700.

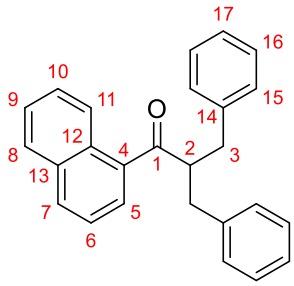
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.36 (1H, ddt, *J* = 8.8, 1.4, 0.8 Hz, C14H), 7.92 (1H, d, *J* = 8.2 Hz, C10H), 7.85 (1H, dd, *J* = 7.8, 1.7 Hz, C11H), 7.55 (1H, ddd, *J* = 8.5, 6.9, 1.7 Hz, C13H), 7.51 (1H, ddd, *J* = 7.7, 6.9, 1.5 Hz, C12H), 7.49 (1H, dd, *J* = 7.2, 1.3 Hz, C8H), 7.39 (1H, dd, *J* = 8.2, 7.2 Hz, C9H), 7.28 – 7.21 (1H, m, 2 × C20H), 7.25 – 7.19 (2H, m, 2 × C19H), 7.20 – 7.13 (1H, m, C21H), 3.68 (1H, tt, *J* = 7.8, 5.8 Hz, C2H), 3.21 (1H, dd, *J* = 13.5, 8.1 Hz, C17H_AH$_B$), 2.83 (1H, dd, *J* = 13.5, 6.0 Hz, C17H$_A$$H_B$), 1.85 (1H, dddd, *J* = 13.5, 9.9, 7.5, 5.9 Hz, C3H_AH$_B$), 1.59 (1H, ddt, *J* = 13.5, 9.9, 5.7 Hz, C3H$_A$$H_B$), 1.38 – 1.27 (2H, m, $C4H_2$), 1.30 – 1.19 (2H, m, $C5H_2$), 0.81 (3H, t, *J* = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.9 (C1=O), 140.3 (C18), 137.5 (C7), 134.0 (C16), 132.3 (C10H), 130.4 (C15), 129.3 (2C, 2 × C19H), 128.56 (2C, 2 × C20H), 128.45 (C11H), 127.8 (C13H), 126.9 (C8H), 126.5 (C12H), 126.3 (C21H), 125.8 (C14H), 124.4 (C9H), 53.0 (C2H), 38.2 ($C17H_2$), 32.4 ($C3H_2$), 29.7 ($C4H_2$), 22.9 ($C5H_2$), 14.0 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 317.19006; $C_{23}H_{25}O$ requires 317.18999, Δ 0.23 ppm.

Note: Unusually, this compound has somewhat poor solubility in pentane.

2-Benzyl-1-(naphthalen-1-yl)-3-phenylpropan-1-one (96)



Ketone **S17** (78.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **96** (49.6 mg, 0.142 mmol, 47%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3061, 3027, 2949, 2923, 2854, 1678, 1603, 1594, 1574, 1508, 1496, 1454, 1397, 1358, 1332, 1273, 1232, 1213, 1170, 1099, 1077, 1047, 1030, 973, 930, 916, 865, 841, 799, 777, 757, 743, 699, 651.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.29 – 8.21 (1H, m, C11H), 7.87 (1H, dt, J = 8.1, 1.1 Hz, C7H), 7.85 – 7.77 (1H, m, C8H), 7.54 – 7.45 (2H, m, C9H and C10H), 7.30 (1H, dd, J = 8.1, 7.2 Hz, C6H), 7.25 (1H, dd, J = 7.5, 1.6 Hz, C5H), 7.25 – 7.14 (8H, m, 4 × C15H and 4 × C16H), 7.17 – 7.10 (2H, m, 2 × C17H), 3.98 (1H, tt, J = 8.0, 6.3 Hz, C2H), 3.21 (2H, dd, J = 13.6, 8.0 Hz, 2 × C3H_AH$_B$), 2.84 (2H, dd, J = 13.6, 6.3 Hz, 2 × C3H$_A$$H_B$).

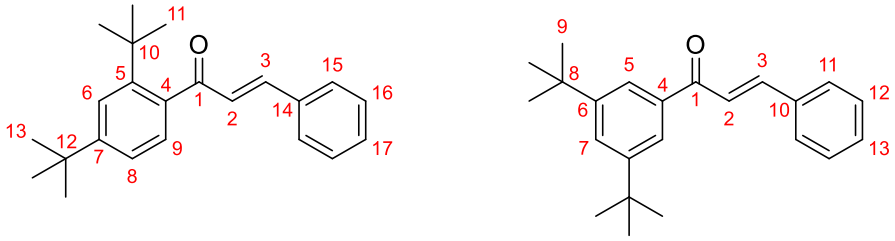
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.0 (C1=O), 139.7 (2C, 2 × C14), 137.2 (C4), 133.9 (C13), 132.3 (C7H), 130.3 (C12), 129.3 (4C, 4 × C15H), 128.6 (4C, 4 × C16H), 128.4 (C8H), 127.8 (C10H), 127.0 (C5H), 126.48 (C9H), 126.45 (2C, 2 × C17H), 125.8 (C11H), 124.3 (C6H), 55.2 (C2H), 38.3 (2C, 2 × C3H_2).

HRMS (ESI$^+$) Found $[M+H]^+$ = 351.17447; $C_{26}H_{23}O$ requires 351.17434, Δ 0.36 ppm.

Note: Very unusually, this compound is poorly soluble in pentane.

(*E*)-1-(2,4-Di-*tert*-butylphenyl)-3-phenylprop-2-en-1-one (105, major), and

(*E*)-1-(3,5-Di-*tert*-butylphenyl)-3-phenylprop-2-en-1-one (106, minor)



2.8 : 1

1,3-Di-*tert*-butylbenzene (1.00 g, 5.25 mmol, 1.0 equiv), cinnamoyl chloride (1.09 g, 5.78 mmol, 1.1 equiv), $AlCl_3$ (771 mg, 6.57 mmol, 1.25 equiv) and DCM (26 mL, 0.2 M) were subjected to **General Procedure B** for 2 h. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded a yellow viscous oil (92.2 mg) that contained an inseparable 2.8:1 mixture of enones **105** (0.212 mmol, 4.0%) and **106** (75.7 μmol, 1.4%).

IR (film) ν_{max}/cm^{-1} 3061, 3028, 2962, 2906, 2868, 1648, 1625, 1604, 1576, 1494, 1476, 1461, 1449, 1395, 1364, 1328, 1298, 1286, 1248, 1203, 1181, 1157, 1129, 1052, 1029, 1014, 981, 895, 876, 851, 830, 764, 712, 701, 685, 669, 653.

^{1}H NMR ($CDCl_3$, 500 MHz, major isomer) δ = 7.57 (1H, d, J = 1.9 Hz, C6H), 7.57 – 7.51 (2H, m, 2 × C15H), 7.41 – 7.36 (3H, m, 2 × C16H and C17H), 7.33 (1H, d, J = 16.2 Hz, C3H), 7.25 (1H, dd, J = 8.0, 1.9 Hz, C8H), 7.09 (1H, d, J = 8.0 Hz, C9H), 7.04 (1H, d, J = 16.2 Hz, C2H), 1.39 (9H, s, 2 × $C11H_3$), 1.36 (9H, s, 2 × $C13H_3$).

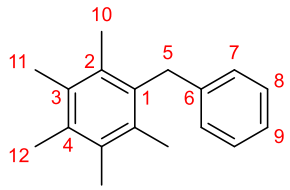
^{13}C NMR ($CDCl_3$, 126 MHz, major isomer) δ = 201.1 (C1=O),152.0 (C7), 147.9 (C5), 146.6 (C3H), 136.9 (C4), 134.7 (C14), 130.8 (C17H), 129.22 (C2H), 129.09 (2C, 2 × C16H), 128.58 (2C, 2 × C15H), 127.7 (C9H), 124.5 (C6H), 122.1 (C8H), 36.6 (C10), 35.07 (C12), 32.4 (3C, 3 × $C11H_3$), 31.46 (3C, 3 × $C13H_3$).

^{1}H NMR ($CDCl_3$, 500 MHz, minor isomer) δ = 7.84 (2H, d, J = 1.8 Hz, 2 × C5H), 7.80 (1H, d, J = 15.7 Hz, C3H), 7.67 (1H, t, J = 1.9 Hz, C7H), 7.68 – 7.63 (2H, m, 2 × C11H), 7.51 (1H, d, J = 15.7 Hz, C2H), 7.46 – 7.41 (1H, m, 2 × C12H and C13H), 1.39 (18H, s, 6 × $C9H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, minor isomer) δ = 191.8 (C1=O), 151.4 (2C, 2 × C6), 144.6 (C3H), 138.1 (C4), 135.2 (C10), 130.6 (C13H), 129.11 (2C, 2 × C16H), 128.55 (2C, 2 × C11H), 127.2 (C7H), 123.02 (C2H), 122.90 (2C, 2 × C5H), 35.18 (2C, 2 × C8), 31.57 (6C, 6 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 321.22131; $C_{23}H_{29}O$ requires 321.22129, Δ 0.07 ppm.

1-Benzyl-2,3,4,5,6-pentamethylbenzene (108)



Pentamethylbenzene (666 mg, 1.50 mmol, 1.0 equiv), 2-benzyloxyacetyl chloride (260 µL, 305 mg, 1.65 mmol, 1.1 equiv), $AlCl_3$ (250 mg, 1.88 mmol, 1.25 equiv) and DCM (7.5 mL, 0.2 M) were subjected to **General Procedure B** for 3 h. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99.2:0.8) afforded diarylmethane **108** (257 mg, 1.08 mmol, 72%) as a colourless solid.

m.p. = 112 – 114 °C.

IR (film) ν_{max}/cm^{-1} 3024, 2992, 2925, 1603, 1492, 1451, 1377, 1068, 1029.

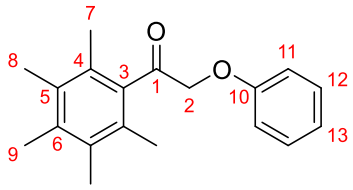
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.29 – 7.22 (2H, m, C8H), 7.21 – 7.13 (1H, m, C9H), 7.09 – 7.02 (2H, m, 2 × C7H), 4.14 (2H, s, $C5H_2$), 2.30 (3H, s, $C12H_3$), 2.27 (6H, s, 2 × $C10H_3$), 2.19 (6H, s, 2 × $C11H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 140.7 (C6), 133.9 (C12), 133.3 (C1), 132.9 (2C, 2 × C3), 132.6 (2C, 2 × C2), 128.4 (C9H), 128.1 (2C, 2 × C8H), 125.7 (2C, 2 × C7H), 36.3 ($C9H_2$), 17.12 ($C12H_3$), 17.02 (2C, 2 × $C11H_3$), 17.00 (2C, 2 × $C10H_3$).

HRMS (EI) Found $[M]^{\bullet+}$ = 238.1717; $C_{18}H_{22}$ requires 238.1716, Δ 0.41 ppm.

Note: No acylation product was observed. The analytical data are identical to those reported in literature.[15]

1-(2,3,4,5,6-Pentamethylphenyl)-2-phenoxyethan-1-one (110)



To a solution of 2-bromo-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (134 mg, 0.500 mmol, 1.0 equiv) in anhydrous DMF (2.5 mL, 0.2 M) was added potassium phenoxide (165 mg, 1.25 mmol, 1.5 equiv) at RT and stirred for 24 h. The reaction was diluted with H_2O (10 mL), brine (10 mL) and Et_2O (10 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 5 mL) and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography (Pentane:Et_2O, 99:1) afforded α-phenoxyketone **110** (25.2 mg, 89.2 μmol, 8.9%) as a colourless solid.

m.p. = 66 – 68 °C.

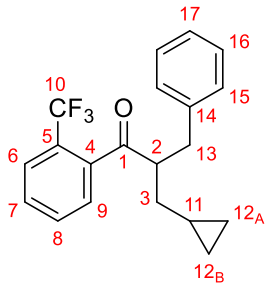
IR (film) ν_{max}/cm^{-1} 2922, 1719, 1599, 1494, 1456, 1425, 1383, 1356, 1301, 1243, 1220, 1156, 1121, 1079, 1065, 1032, 991, 921, 884, 865, 812, 784, 753, 691.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.33 – 7.28 (2H, m, 2 × C12H), 7.01 (1H, tt, J = 7.4, 1.1 Hz, C13H), 6.98 – 6.94 (2H, m, 2 × C12H), 4.85 (2H, s, $C2H_2$), 2.26 (3H, s, $C9H_3$), 2.21 (6H, s, 2 × $C8H_3$), 2.18 (6H, s, 2 × $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.9 (C1=O), 158.1 (C10), 136.66 (C6), 136.64 (C3), 133.4 (2C, 2 × C5), 129.7 (2C, 2 × C12H), 128.6 (2C, 2 × C4), 121.9 (C13H), 115.2 (2C, 2 × C11H), 74.3 ($C2H_2$), 17.5 (2C, 2 × $C7H_3$), 16.9 ($C9H_3$), 16.1 ($C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 283.16934; $C_{19}H_{23}O_2$ requires 283.16926, Δ 0.30 ppm.

2-Benzyl-3-cyclopropyl-1-(2-(trifluoromethyl)phenyl)propan-1-one (111)



Ketone **S2** (83.5 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and cyclopropylmethanol (240 μL, 216 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **111** (66.6 mg, 0.200 mmol, 67%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3028, 3003, 2918, 2853, 1701, 1604, 1581, 1497, 1445, 1362, 1312, 1273, 1166, 1141, 1063, 1036, 941.

^{1}H{^{19}F} NMR ($CDCl_3$, 400 MHz) δ = 7.76 – 7.68 (1H, m, C6H), 7.57 – 7.48 (2H, m, C7H and C8H), 7.34 – 7.22 (3H, m, C9H and 2 × C16H), 7.22 – 7.14 (3H, m, 2 × C15H and C17H), 3.55 (1H, quint., J = 7.0 Hz, C2H), 3.13 (1H, dd, J = 13.7, 7.0 Hz, C13$H_A$$H_B$), 2.82 (1H, dd, J = 13.7, 7.2 Hz, C2$H_A$$H_B$), 1.68 (1H, dt, J = 13.9, 6.9 Hz, C2$H_A$$H_B$), 1.34 (1H, dt, 13.8, 6.8 Hz, C2$H_A$$H_B$), 0.72 (1H, ttt, J = 8.0, 7.0, 4.9 Hz, C11H), 0.49 – 0.34 (2H, m, C12$_A$$H_{cis}$$H_{trans}$ and C12$_B$$H_{cis}$$H_{trans}$), 0.06 – –0.09 (2H, m, C12$_B$$H_{cis}$$H_{trans}$ and C12$_B$$H_{cis}$$H_{trans}$).

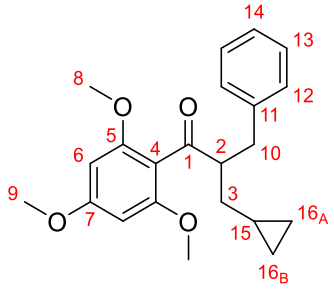
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 205.9 (C1=O), 139.93 (C14), 139.91 (q, $^3J_{CF}$ = 2.5 Hz, C4), 131.7 (C7H), 130.5 (C8H), 129.2 (2C, 2 × C15H), 128.6 (2C, 2 × C16H), 128.1 (C9H), 128.0 (q, $^2J_{CF}$ = 32.1 Hz, C5), 127.2 (q, $^3J_{CF}$ = 5.2 Hz, C6H), 126.4 (C17H), 123.6 (q, $^1J_{CF}$ = 274.0 Hz, $C10F_3$), 54.1 (C2H), 37.2 ($C13H_2$), 36.0 ($C3H_2$), 9.4 (C11H), 5.13 ($C12_AH_2$), 5.08 ($C12_BH_2$).

^{19}F NMR ($CDCl_3$, 377 MHz) δ = –57.7 (3F, s, $C10F_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 355.1279; $C_{20}H_{19}F_3ONa$ requires 355.1280, Δ –0.34 ppm.

Note: *cis* and *trans* with respect to C11H.

2-Benzyl-3-cyclopropyl-1-(2,4,6-trimethoxyphenyl)propan-1-one (112)



1-(2,4,6-Trimethoxyphenyl)-3-phenylpropan-1-one [*] (90.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and cyclopropylmethanol (240 μL, 216 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **112** (79.0 mg, 0.209 mmol, 70%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3001, 2937, 2920, 2841, 1692, 1603, 1586, 1495, 1455, 1438, 1413, 1337, 1227, 1205, 1153, 1125, 1034, 1016, 952.

[*] The material was provided by Dr. James Frost.

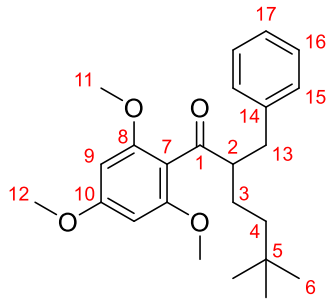
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.26 – 7.21 (2H, m, 2 × C13H), 7.20 – 7.12 (3H, m, 2 × C12H and C14H), 6.07 (2H, s, C6H), 3.81 (3H, s, $C9H_3$), 3.70 (6H, s, 2 × $C8H_3$), 3.44 (1H, tt, J = 7.5, 6.3 Hz, C2H), 3.16 (1H, dd, J = 13.9, 6.4 Hz, C10H_AH$_B$), 2.71 (1H, dd, J = 13.9, 7.7 Hz, C10H$_A$$H_B$), 1.68 (1H, dt, J = 14.0, 7.0 Hz, C3H_AH$_B$), 1.23 (1H, ddd, J = 14.0, 7.1, 5.6 Hz, C3H$_A$$H_B$), 0.72 (1H, ttt, J = 7.9, 6.9, 4.9 Hz; C15H), 0.39 – 0.29 (2H, m, C16$_A$$H_{cis}H_{trans}$ and C16$_B$$H_{cis}H_{trans}$), 0.01 – –0.07 (1H, m, C16$_A$H$_{cis}$$H_{trans}$), –0.07 – –0.14 (1H, m, C16$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 206.4 (C1=O), 162.4 (C7), 158.7 (2C, 2 × C5), 141.0 (C11), 129.3 (2C, 2 × C12H), 128.1 (2C, 2 × C13H), 125.7 (C14H), 113.7 (C4), 90.7 (2C, 2 × C6H), 55.8 (2C, 2 × $C8H_3$), 55.5 ($C9H_3$), 55.2 (C2H), 36.8 ($C10H_2$), 35.8 ($C3H_2$), 9.3 (C15H), 5.1 ($C16_AH_2$), 4.9 ($C16_BH_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 377.1724; $C_{22}H_{26}O_4Na$ requires 377.1723, Δ 0.25 ppm.

Note: *cis* and *trans* with respect to C15H.

2-Benzyl-5,5-dimethyl-1-(2,4,6-trimethoxyphenyl)hexan-1-one (113)



1-(2,4,6-Trimethoxyphenyl)-3-phenylpropan-1-one * (90.1 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and neopentylmethanol (360 μL, 307 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **113** (63.5 mg, 0.165 mmol, 55%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2952, 1694, 1605, 1588, 1456, 1414, 1363, 1337, 1228, 1206, 1155, 1129, 1036, 959.

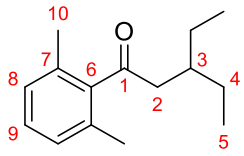
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.27 – 7.21 (2H, m, 2 × C16H), 7.21 – 7.12 (3H, m, 2 × C15H and C17H), 6.06 (2H, s, 2 × C9H), 3.81 (3H, s, $C12H_3$), 3.68 (6H, s, 2 × $C11H_3$), 3.25 (1H, dtd, J = 7.6, 6.6, 4.9 Hz, C2H), 3.15 (1H, dd, J = 13.6, 6.3 Hz, C13H_AH_B), 2.64 (1H, dd, J = 13.7, 7.6 Hz, C13H_AH_B), 1.64 (1H, tdd, J = 12.8, 6.8, 4.3 Hz, C3H_AH_B), 1.41 (1H, tt, J = 13.0, 4.6 Hz, C3H_AH_B), 1.26 (1H, td, J = 12.9, 4.3 Hz, C4H_AH_B), 1.14 (1H, td, J = 12.9, 4.4 Hz, C4H_AH_B), 0.79 (9H, s, 3 × $C6H_3$).

* The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 206.7 (C1=O), 162.4 (C10), 158.6 (2C, 2 × C8), 141.2 (C14), 129.4 (2C, 2 × C15H), 128.1 (2C, 2 × C16H), 125.8 (C17H), 113.8 (C7), 90.7 (2C, 2 × C9H), 55.7 (2C, 2 × $C11H_3$), 55.5 ($C12H_3$), 55.0 (C2H), 40.6 ($C4H_2$), 36.4 ($C13H_2$), 30.3 (C5), 29.4 (3C, 3 × $C6H_3$), 25.6 ($C3H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 407.2198; $C_{24}H_{32}O_4Na$ requires 407.2193, Δ 1.24 ppm.

1-(2,6-Dimethylphenyl)-3-ethylpentan-1-one (126)



1-(2,6-Dimethylphenyl)ethan-1-one (88.9 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), pentan-3-ol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **126** (126 mg, 0.575 mmol, 96%) as a colourless oil.

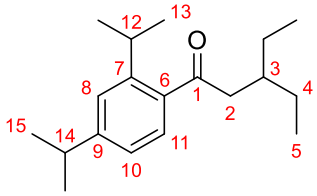
IR (film) ν_{max}/cm^{-1} 3064, 3021, 2961, 2933, 2920, 2876, 1702, 1596, 1582, 1461, 1424, 1401, 1381, 1365, 1336, 1265, 1209, 1165, 1097, 1036, 1003, 955, 913, 886, 770, 712.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.14 (1H, dd, J = 8.0, 7.2 Hz, C9H), 7.00 (2H, d, J = 7.6 Hz, 2 × C8H), 2.66 (2H, d, J = 6.3 Hz, $C2H_2$), 2.23 (6H, s, $C10H_3$), 2.00 (1H, sept., J = 6.3 Hz, C3H), 1.50 – 1.31 (4H, m, 2 × $C4H_2$), 0.90 (6H, t, J = 7.4 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.4 (C1=O), 142.8 (C6), 132.5 (2C, 2 × C7), 128.5 (C9H), 127.9 (2C, 2 × C8H), 48.9 ($C2H_2$), 35.4 (C3H), 25.8 (2C, 2 × $C4H_2$), 19.3 (2C, 2 × $C10H_3$), 11.0 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 219.17458; $C_{15}H_{23}O$ requires 219.17434, Δ 1.07 ppm.

1-(2,4-Diisopropylphenyl)-3-ethylpentan-1-one (128)



Ketone **S5** (123 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), pentan-3-ol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **128** (86.6 mg, 0.316 mmol, 53%) as a colourless oil.

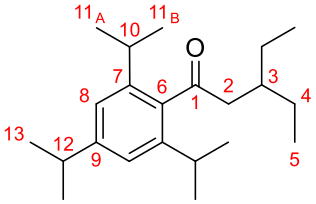
IR (film) ν_{max}/cm^{-1} 2960, 2929, 2874, 1682, 1607, 1562, 1493, 1461, 1414, 1382, 1362, 1336, 1282, 1251, 1214, 1185, 1164, 1149, 1085, 1055, 1007, 962, 923, 893, 820, 780, 754, 697, 679, 651.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 (1H, d, J = 8.0 Hz, C11H), 7.25 (1H, d, J = 1.8 Hz, C8H), 7.08 (1H, dd, J = 8.0, 1.8 Hz, C10H), 3.39 (1H, sept., J = 6.9 Hz, C12H), 2.92 (1H, sept., J = 6.9 Hz, C14H), 2.77 (2H, d, J = 6.7 Hz, $C2H_2$), 1.95 (1H, sept., J = 6.4 Hz, C3H), 1.40 (2H, dqd, J = 13.7, 7.5, 6.2 Hz, 2 × C4H_AH_B), 1.35 (2H, dqd, J = 13.6, 7.3, 6.2 Hz, 2 × C4H_AH_B), 1.26 (6H, d, J = 6.9 Hz, 2 × $C15H_3$), 1.24 (6H, d, J = 6.9 Hz, 2 × $C13H_3$), 0.88 (6H, t, J = 7.4 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 206.4 (C1=O), 151.8 (C9), 148.0 (C7), 137.3 (C6), 127.6 (C11H), 124.9 (C8H), 123.3 (C10H), 47.0 ($C2H_2$), 37.2 (C3H), 34.4 (C14H), 29.5 (C12H), 26.0 (2C, 2 × $C4H_2$), 24.5 (2C, 2 × $C13H_3$), 23.9 (2C, 2 × $C15H_3$), 11.0 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 275.26388; $C_{19}H_{31}O$ requires 275.23694, Δ –0.23 ppm.

3-Ethyl-1-(2,4,6-triisopropylphenyl)pentan-1-one (129)



1-(2′,4′,6′-Triisopropylphenyl)ethan-1-one (148 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), pentan-3-ol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **129** (118 mg, 0.373 mmol, 62%) as a colourless oil.

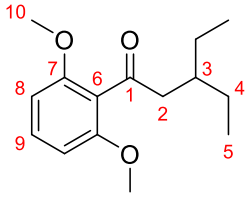
IR (film) ν_{max}/cm^{-1} 2961, 2930, 2873, 1701, 1607, 1571, 1461, 1428, 1402, 1383, 1364, 1335, 1317, 1300, 1266, 1244, 1212, 1171, 1153, 1097, 1070, 1055, 1006, 960, 936, 924, 877.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.99 (2H, s, 2 × C8), 2.88 (1H, sept., J = 6.9 Hz, C12H), 2.67 (2H, sept., J = 6.6 Hz, 2 × C10H), 2.65 (2H, d, J = 6.2 Hz, $C2H_2$), 2.02 (1H, sept., J = 6.2 Hz, C3H), 1.49 – 1.34 (4H, m, 2 × $C4H_2$), 1.25 (6H, d, J = 6.9 Hz, 2 × $C13H_3$), 1.23 (12H, br. s, 4 × $C11H_3$), 0.90 (6H, t, J = 7.4 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.8 (C1=O), 149.4 (C9), 143.5 (2C, 2 × C7), 138.4 (C6), 121.2 (2C, 2 × C8H), 50.6 ($C2H_2$), 35.3 (C3H), 34.5 (C12H), 31.0 (2C, 2 × C10H), 25.6 (2C, 2 × $C4H_2$), 25.2 (2C, v. br. s, 2 × $C11_AH_3$), 24.20 (2C, v. br. s, 2 × $C11_BH_3$), 24.14 (2C, 2 × $C13H_3$), 10.9 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 317.28384; $C_{22}H_{37}O$ requires 317.28389, Δ –0.15 ppm.

1-(2,6-Dimethoxyphenyl)-3-ethylpentan-1-one (130)



1-(2′,6′-Dimethoxyphenyl)ethan-1-one (108 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), pentan-3-ol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 97:3 → 95:5) afforded ketone **130** (40.4 mg, 0.161 mmol, 27%) as a colourless oil.

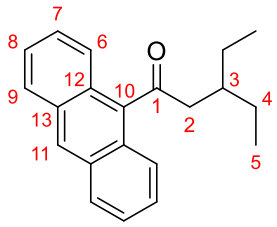
IR (film) ν_{max}/cm^{-1} 3005, 2962, 2934, 2876, 2839, 1710, 1666, 1594, 1472, 1433, 1307, 1286, 1253, 1114, 1009, 781, 734.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.25 (1H, t, J = 8.4 Hz, C9H), 6.55 (2H, d, J = 8.4 Hz, 2 × C8H), 3.78 (6H, s, 2 × C10H_3), 2.69 (2H, d, J = 6.5 Hz, C2H_2), 1.91 (1H, sept., J = 6.3 Hz, C3H), 1.37 (4H, app. qdd, J = 7.2, 6.2, 1.1 Hz, 2 × C4H_2), 0.86 (6H, t, J = 7.4 Hz, 2 × C5H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.4 (C1=O), 156.8 (2C, 2 × C7), 130.4 (C9H), 121.6 (C6), 104.1 (2C, 2 × C8H), 55.9 (2C, 2 × C10H_3), 49.0 (C2H_2), 36.2 (C3H), 25.9 (2C, 2 × C4H_2), 10.9 (2C, 2 × C5H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 251.16429; $C_{15}H_{23}O_3$ requires 251.16417, Δ 0.48 ppm.

1-(Anthracen-9-yl)-3-ethylpentan-1-one (132)



9-Acetylanthracene (132 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), pentan-3-ol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99.5:0.5 → 99:1 → 98:2) afforded ketone **132** (29.7 mg, 0.102 mmol, 17%) as a yellow oil.

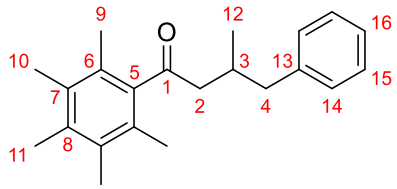
IR (film) ν_{max}/cm^{-1} 3054, 2960, 2932, 2875, 1696, 1624, 1521, 1460, 1445, 1400, 1381, 1367, 1314, 1263, 1177, 1162, 1138, 1088, 1014, 953, 930, 888, 842, 791, 760, 734.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.48 (1H, s, C11H), 8.05 – 7.97 (2H, m, 2 × C9H), 7.86 – 7.80 (2H, m, 2 × C6H), 7.55 – 7.45 (4H, m, 2 × C7H and 2 × C8H), 3.03 (2H, d, J = 6.3 Hz, $C2H_2$), 2.20 (1H, sept., J = 6.3 Hz, C3H), 1.61 – 1.45 (4H, m, 2 × $C4H_2$), 0.94 (6H, t, J = 7.4 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.4 (C1=O), 137.1 (C10), 131.2 (2C, 2 × C13), 129.0 (2C, 2 × C9H), 128.2 (C11H), 127.1 (2C, 2 × C12), 126.8 (2C, 2 × C7H), 125.6 (2C, 2 × C8H), 124.5 (2C, 2 × C6H), 50.6 ($C2H_2$), 36.1 (C3H), 25.9 (2C, 2 × $C4H_2$), 11.0 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 291.17447; $C_{21}H_{23}O$ requires 291.17434, Δ 0.44 ppm.

3-Methyl-1-(2,3,4,5,6-pentamethylphenyl)-4-phenylbutan-1-one (136)[6]



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), 1-phenylpropan-2-ol (122 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **136** (123 mg, 0.399 mmol, 66%) as a colourless solid.

m.p. = 61 – 63 °C.

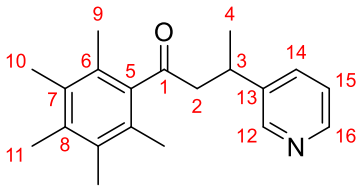
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3026, 2952, 2925, 2873, 1699, 1604, 1576, 1495, 1454, 1400, 1380, 1359, 1330, 1310, 1270, 1229, 1178, 1148, 1115, 1084, 1030, 999.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.26 (2H, m, 2 × C15H), 7.21 – 7.17 (3H, m, 2 × C14H and C16), 2.75 – 2.65 (2H, m, C2$H_A$$H_B$ and C4$H_A$$H_B$), 2.58 – 2.49 (3H, m, C2$H_A$$H_B$, C3H and C4$H_A$$H_B$), 2.23 (3H, s, C11$H_3$), 2.17 (6H, s, 2 × C10$H_3$), 2.02 (6H, br. s, 2 × C9H_3), 1.07 (3H, d, J = 5.7 Hz, C12H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.2 (C1=O), 140.77 (C5), 140.74 (C13), 135.4 (C8), 133.2 (2C, 2 × C7), 129.3 (2C, 2 × C14H), 128.4 (2C, 2 × C15H), 127.4 (2C, 2 × C6), 126.1 (C16H), 52.0 (C2H_2), 43.3 (C4H_2), 30.1 (C3H), 20.3 (C12H_3), 17.0 (2C, 2 × C9H_3), 16.8 (C11H_3), 16.1 (2C, 2 × C10H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 309.22141; $C_{22}H_{29}O$ requires 309.22129, Δ 0.37 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)-3-(pyridin-3-yl)butan-1-one (140)[6]



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), NaO*t*-Bu (173 mg, 1.80 mmol, 3.0 equiv), 1-(pyridin-3-yl)ethan-1-ol (148 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 60:40) afforded ketone **140** (133 mg, 0.451 mmol, 75%) as a colourless solid.

m.p. = 89 – 91 °C.

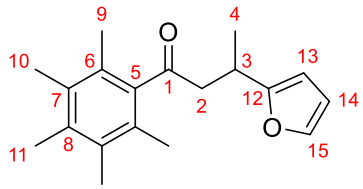
IR (film) ν_{max}/cm^{-1} 3025, 2960, 2928, 2877, 1701, 1589, 1575, 1455, 1425, 1402, 1382, 1344, 1303, 1278, 1191, 1122, 1068, 1024, 997.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.55 (1H, dd, J = 2.4, 0.8 Hz, C12H), 8.45 (1H, dd, J = 4.8, 1.6 Hz, C16H), 7.58 (1H, dt, J = 7.9, 2.0 Hz, C14H), 7.22 (1H, ddd, J = 7.9, 4.8, 0.8 Hz, C15H), 3.57 (1H, sext., J = 6.9 Hz, C3H), 3.06 – 2.91 (2H, m, $C2H_2$), 2.22 (3H, s, $C11H_3$), 2.15 (6H, s, 2 × $C10H_3$), 1.97 (6H, br. s, 2 × $C9H_3$), 1.40 (3H, d, J = 7.0 Hz, $C4H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.6 (C1=O), 149.2 (C16H), 147.9 (C12H), 141.8 (C13), 140.2 (C3), 135.7 (C8), 134.8 (C14H), 133.3 (2C, 2 × C7), 127.4 (2C, 2 × C6), 123.5 (C15H), 53.5 ($C2H_2$), 32.1 (C3H), 22.1 ($C4H_3$), 17.1 (2C, 2 × $C9H_3$), 16.8 ($C11H_3$), 16.1 (2C, 2 × $C10H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 296.20099; $C_{20}H_{26}NO$ requires 296.20089, Δ 0.33 ppm.

3-(Furan-2-yl)-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (142)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 1-(furan-2-yl)ethan-1-ol (135 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **142** (45.0 mg, 0.158 mmol, 26%) as a yellow solid.

m.p. = 67 – 69 °C.

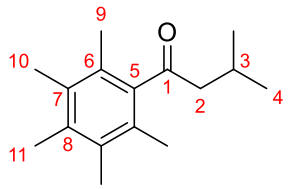
IR (film) ν_{max}/cm^{-1} 3012, 2987, 2963, 2928, 2877, 1700, 1593, 1507, 1457, 1403, 1383, 1350, 1325, 1304, 1277, 1232, 1214, 1174, 1148, 1121, 1078, 1010, 924.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.30 (1H, dd, J = 1.9, 0.8 Hz, C15H), 6.28 (1H, dd, J = 3.2, 1.9 Hz, C14H), 6.04 (1H, dt, J = 3.2, 0.9 Hz, C13H), 3.62 (1H, dqdd, J = 7.8, 7.0, 5.2, 0.7 Hz, C3H), 3.14 (1H, dd, J = 19.0, 5.1 Hz, C2H_AH$_B$), 2.82 (1H, dd, J = 19.0, 8.0 Hz, C2H$_A$$H_B$), 2.23 (3H, s, C11$H_3$), 2.18 (6H, s, 2 × C10$H_3$), 2.06 (6H, s, 2 × C9$H_3$), 1.39 (3H, d, J = 6.9 Hz, C4H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.8 (C1=O), 159.3 (C12), 141.0 (C15H), 140.4 (C6), 135.6 (C8), 133.2 (2C, 2 × C7), 127.5 (2C, 2 × C6), 110.1 (C14H), 104.1 (C13H), 51.2 (C2H_2), 28.1 (C3H), 19.4 (C4H_3), 17.0 (2C, 2 × C9H_3), 16.8 (C11H_3), 16.1 (2C, 2 × C10H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 307.16678; $C_{19}H_{24}O_2Na$ requires 307.16685, Δ –0.24 ppm.

3-Methyl-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (144)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 1-(benzyloxy)propan-2-ol (199 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **144** (2.6 mg, 11 μmol, 1.9%) as a colourless solid.

m.p. = 62 – 64 °C.

IR (film) ν_{max}/cm^{-1} 2955, 2926, 2871, 1737, 1700, 1575, 1467, 1401, 1382, 1357, 1331, 1306, 1284, 1220, 1169, 1146, 1093, 1022, 1001.

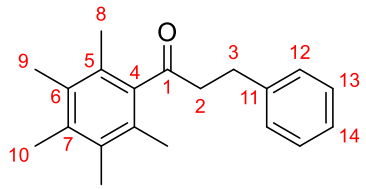
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.57 (2H, d, J = 6.5 Hz, C2H_2), 2.32 (1H, non., J = 6.6 Hz, C3H), 2.23 (3H, s, C11H_3), 2.18 (6H, s, 2 × C10H_3), 2.10 (6H, s, 2 × C9H_3), 1.02 (6H, d, J = 6.7 Hz, 2 × C4H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.4 (C1=O), 140.9 (C5), 135.4 (C8), 133.2 (2C, 2 × C7), 127.4 (2C, 2 × C6), 54.6 (C2H_2), 23.5 (C3H), 22.9 (2C, 2 × C4H_3), 17.2 (2C, 2 × C9H_3), 16.8 (C11H_3), 16.1 (2C, 2 × C10H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 233.19023; $C_{16}H_{25}O$ requires 233.18999, Δ 1.03 ppm.

The analytical data are identical to those reported in literature.[16]

1-(2,3,4,5,6-Pentamethylphenyl)-3-phenylpropan-1-one (145)[5]



Enone **S8** (6.00 g, 21.6 mmol, 1.0 equiv), $Pd(OH)_2/C$ (150 mg, 2.5 wt%) and EtOAc (108 mL, 0.2 M) were subjected to **General Procedure C** for 2.5 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **145** (6.01 g, 21.5 mmol, 100%) as a colourless solid.

m.p. = 76 – 78 °C.

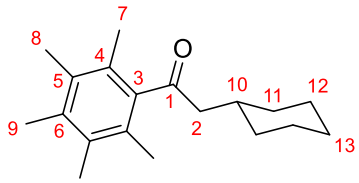
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 2982, 2924, 1699, 1604, 1576, 1496, 1454, 1404, 1382, 1354, 1306, 1261, 1115, 1074, 1029, 990, 935, 910.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.31 – 7.26 (2H, m, 2 × C13H), 7.26 – 7.22 (2H, m, 2 × C12H), 7.22 – 7.17 (1H, m, C14H), 3.10 – 3.03 (2H, m, $C2H_2$), 3.03 – 2.97 (2H, m, $C3H_2$), 2.23 (3H, s, $C10H_3$), 2.17 (6H, s, 2 × $C9H_3$), 2.04 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.0 (C1=O), 141.1 (C11), 140.5 (C4), 135.6 (C7), 133.2 (2C, 2 × C6), 128.61 (2C, 2 × C12H), 128.56 (2C, 2 × C13H), 127.5 (2C, 2 × C5), 126.2 (C14H), 47.2 ($C2H_2$), 29.5 ($C3H_2$), 17.2 (2C, 2 × $C8H_3$), 16.8 ($C10H_3$), 16.1 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 281.19003; $C_{20}H_{25}O$ requires 281.18999, Δ 0.15 ppm.

2-Cyclohexyl-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (147)[6]



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), cyclohexanol (120 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **147** (143 mg, 0.526 mmol, 88%) as a colourless solid.

m.p. = 110 – 112 °C.

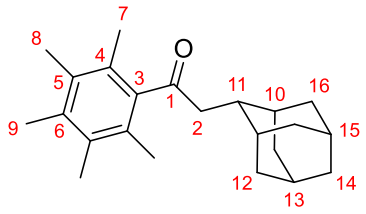
IR (film) ν_{max}/cm^{-1} 2984, 2918, 2848, 1696, 1573, 1447, 1400, 1378, 1354, 1303, 1283, 1259, 1173, 1133, 1110, 1089, 1069, 1025, 1002, 928, 913.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 2.57 (2H, d, J = 6.4 Hz, C2H_2), 2.23 (3H, s, C9H_3), 2.18 (6H, s, 2 × C8H_3), 2.11 (6H, s, 2 × C7H_3), 2.09 – 1.99 (1H, m, C10H), 1.91 – 1.82 (2H, m, 2 × C11$H_{ax}H_{eq}$), 1.69 (3H, m, 2 × C12$H_{ax}H_{eq}$ and C13$H_{ax}H_{eq}$), 1.36 (2H, qt, J = 13.4, 3.6 Hz, 2 × C12$H_{ax}$$H_{eq}$), 1.24 – 1.11 (1H, m, C13$H_{ax}$$H_{eq}$), 0.99 (2H, qd, J = 12.3, 3.3 Hz, 2 × C11$H_{ax}$$H_{eq}$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.2 (C1=O), 141.0 (C3), 135.4 (C6), 133.2 (2C, 2 × C5), 127.4 (2C, 2 × C4), 53.3 (C2H_2), 33.5 (2C, 2 × C11H_2), 32.5 (C10H), 26.5 (C13H_2), 26.3 (2C, 2 × C12H_2), 17.1 (2C, 2 × C7H_3), 16.8 (C9H_3), 16.1 (2C, 2 × C8H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 273.22134; $C_{19}H_{29}O$ requires 273.22129, Δ 0.19 ppm.

2-(Adamantan-2-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (148)[6]



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 2-adamantanol (183 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5) afforded ketone **148** (163 mg, 0.504 mmol, 84%) as a colourless solid.

m.p. = 147 – 150 °C.

IR (film) ν_{max}/cm^{-1} 2904, 2852, 1702, 1575, 1453, 1400, 1382, 1366, 1349, 1326, 1314, 1269, 1237, 1165, 1116, 1096, 1065.

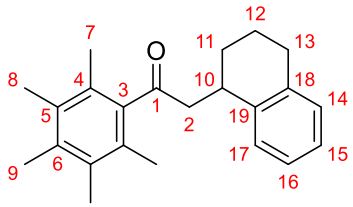
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.83 (2H, d, J = 6.5 Hz, C2H_2), 2.54 (1H, t, J = 6.5 Hz, C11H), 2.24 (3H, s, C9H_3), 2.19 (6H, s, 2 × C8H_3), 2.11 (6H, s, 2 × C7H_3), 1.96 – 1.88 (3H, m, C15H and 2 × C16H_{anti}H$_{syn}$), 1.88 – 1.83 (2H, m, 2 × C16H$_{anti}H_{syn}$), 1.83 – 1.77 (5H, m, 2 × C10H, C13H and 2 × C12H$_{anti}H_{syn}$), 1.75 (2H, s, C14H_2), 1.63 – 1.53 (2H, m, 2 × C12H_{anti}H$_{syn}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.4 (C1=O), 141.1 (C3), 135.4 (C6), 133.2 (2C, 2 × C5), 127.4 (2C, 2 × C4), 49.5 (C2H_2), 39.1 (2C, 2 × C16H_2), 38.38 (C14H_2), 38.35 (C11H), 32.27 (2C, 2 × C10H), 32.13 (2C, 2 × C12H_2), 28.1 (2C, C13H and C15H), 17.1 (2C, 2 × C7H_3), 16.8 (C9H_3), 16.1 (2C, 2 × C8H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 325.25262; $C_{23}H_{33}O$ requires 325.25259, Δ 0.10 ppm.

Note: *syn* and *anti* with respect to C2H_2.

1-(2,3,4,5,6-Pentamethylphenyl)-2-(1,2,3,4-tetrahydronaphthalen-1-yl)ethan-1-one (151)[6]



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), tetralin-1-ol (178 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **151** (114 mg, 0.357 mmol, 60%) as a pale yellow solid.

m.p. = 120 – 122 °C.

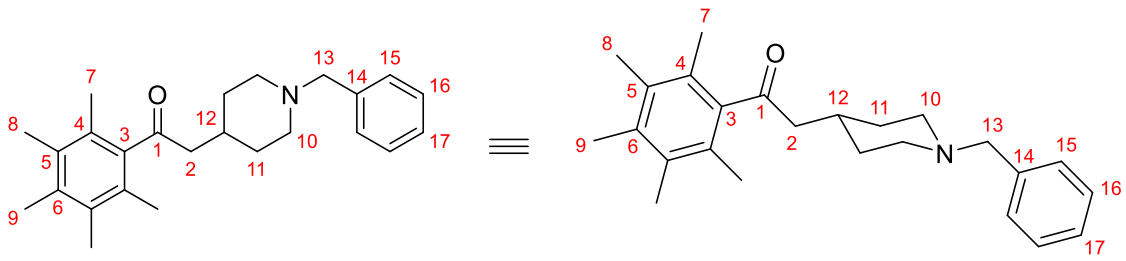
IR (film) ν_{max}/cm^{-1} 3058, 3014, 2927, 2865, 1700, 1602, 1578, 1490, 1450, 1398, 1383, 1347, 1305, 1279, 1162, 1113, 1085, 1070, 1038, 1025, 998, 940, 925.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.21 – 7.16 (1H, m, C17H), 7.15 – 7.10 (1H, m, C16H), 7.10 – 7.04 (2H, m, C14H and C15H), 3.66 (1H, quint., J = 5.8 Hz, C10H), 3.05 – 3.01 (2H, m, $C2H_2$), 2.78 (2H, t, J = 6.1 Hz, $C13H_2$), 2.23 (3H, s, $C9H_3$), 2.18 (6H, s, 2 × $C8H_3$), 2.13 (6H, s, 2 × $C7H_3$), 2.14 – 2.04 (1H, m, $C11H_AH_B$), 1.89 – 1.77 (3H, m, $C11H_AH_B$ and $C12H_2$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.6 (C1=O), 140.5 (C3), 140.3 (C19), 137.3 (C18), 135.5 (C6), 133.2 (2C, 2 × C5), 129.3 (C14H), 128.6 (C17H), 127.4 (2C, 2 × C4), 125.95 (C16H), 125.87 (C15H), 53.6 ($C2H_2$), 32.3 (C10H), 29.7 ($C13H_2$), 28.7 ($C11H_2$), 19.8 ($C12H_2$), 17.2 (2C, 2 × $C7H_3$), 16.8 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 321.22125; $C_{23}H_{29}O$ requires 321.22129, Δ –0.12 ppm.

2-(1-Benzylpiperidin-4-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (155)[6]



Ketone **122** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), *N*-benzyl-4-hydroxypiperidine (230 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 75:25) afforded ketone **155** (187 mg, 0.514 mmol, 86%) as a colourless solid.

m.p. = 114 – 115 °C.

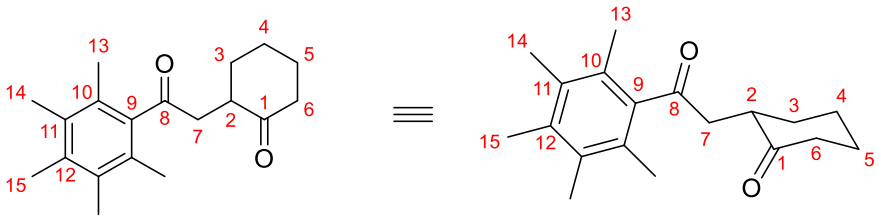
IR (film) ν_{max}/cm^{-1} 3085, 3061, 3027, 2917, 2800, 2755, 1699, 1604, 1576, 1494, 1465, 1452, 1446, 1398, 1382, 1367, 1350, 1314, 1305, 1271, 1225, 1196, 1169, 1120, 1093, 1073, 1028, 977, 928.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 – 7.28 (4H, m, 2 × C15H and 2 × C16H), 7.28 – 7.21 (1H, m, C17H), 3.50 (2H, s, $C13H_2$), 2.88 (2H, dt, J = 11.9, 3.3 Hz, 2 × $C10H_{ax}H_{eq}$), 2.62 (2H, d, J = 6.5 Hz, $C2H_2$), 2.23 (3H, s, $C9H_3$), 2.18 (6H, s, 2 × $C8H_3$), 2.09 (6H, s, 2 × $C7H_3$), 2.05 (3H, m, 2 × $C10H_{ax}H_{eq}$ and C12H), 1.84 (2H, dddd, J = 12.3, 5.1, 3.6, 2.9 Hz, 2 × $C11H_{ax}H_{eq}$), 1.33 (2H, dtd, J = 13.0, 11.8, 3.7 Hz, 2 × $C11H_{ax}H_{eq}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.0 (C1=O), 140.7 (C14), 138.7 (C3), 135.5 (C6), 133.2 (2C, 2 × C5), 129.3 (2C, 2 × C15H), 128.3 (2C, 2 × C16H), 127.4 (2C, 2 × C4), 127.0 (C17H), 63.7 ($C13H_2$), 53.8 (2C, 2 × $C10H_2$), 52.4 ($C2H_2$), 32.4 (C12H), 30.6 (2C, 2 × $C11H_2$), 17.1 (2C, 2 × $C7H_3$), 16.8 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 364.26294; $C_{25}H_{34}NO$ requires 364.26349, Δ –1.51 ppm.

2-(2-Oxo-2-(2,3,4,5,6-pentamethylphenyl)ethyl)cyclohexan-1-one (162)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 2-oxocyclohexanol dimer (137 mg, 1.20 mmol (monomer), 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded dione **162** (16.0 mg, 55.9 μmol, 9.3%) as a pale yellow solid.

m.p. = 112 – 115 °C.

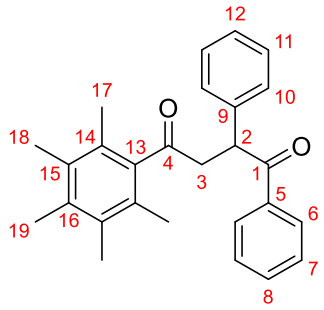
IR (film) ν_{max}/cm^{-1} 2929, 2861, 1702, 1598, 1574, 1448, 1385, 1338, 1309, 1272, 1225, 1124, 1069.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 3.31 (1H, dd, J = 19.5, 6.4 Hz, C7H_AH$_B$), 3.10 (1H, dq, J = 11.7, 5.7 Hz, C2H), 2.51 (2H, dd, J = 19.6, 5.1 Hz, C7H$_A$$H_B$), 2.49 – 2.44 (2H, m, C6H_2), 2.28 – 2.21 (2H, m, C3H$_{ax}$$H_{eq}$), 2.23 (3H, s, C15$H_3$), 2.18 (6H, s, 2 × C14$H_3$), 2.17 – 2.12 (1H, m, C5H$_{ax}$$H_{eq}$), 2.15 (6H, s, 2 × C13$H_3$), 1.91 (1H, m, C4H$_{ax}$$H_{eq}$), 1.80 (1H, qt, J = 12.8, 3.4 Hz, C4H_{ax}H$_{eq}$), 1.74 – 1.63 (1H, m, C5H_{ax}H$_{eq}$), 1.47 (1H, qd, J = 12.7, 3.9 Hz, C3H_{ax}H$_{eq}$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.5 (C1=O), 209.8 (C8=O), 140.3 (C9), 135.5 (C12), 133.2 (2C, 2 × C11), 127.6 (br. s, 2C, 2 × C10), 45.6 (C7H_2), 45.3 (C2H), 42.2 (C6H_2), 34.3 (C3H_2), 28.1 (C5H_2), 25.6 (C4H_2), 17.1 (2C, 2 × C13H_3), 16.8 (C15H_3), 16.1 (2C, 2 × C14H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 287.20074; $C_{19}H_{27}O_2$ requires 287.20056, Δ 0.65 ppm.

4-(2,3,4,5,6-Pentamethylphenyl)-1,2-diphenylbutane-1,4-dione (163)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), benzoin (255 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded dione **163** (94.0 mg, 0.245 mmol, 41%) as an off-white solid.

m.p. = 152 – 153 °C.

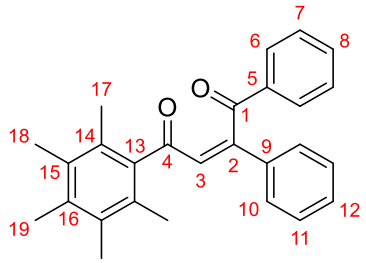
IR (film) ν_{max}/cm^{-1} 3085, 3061, 3027, 3002, 2924, 2911, 1699, 1682, 1598, 1581, 1493, 1448, 1389, 1358, 1326, 1285, 1262, 1238, 1176, 1117, 1076, 1030, 1001, 979, 948, 934, 910.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 8.11 – 8.03 (2H, m, 2 × C6H), 7.54 – 7.46 (1H, m, C8H), 7.46 – 7.37 (2H, m, 2 × C7H), 7.35 – 7.30 (2H, m, 2 × C10H), 7.30 – 7.25 (2H, m, 2 × C11H), 7.23 – 7.16 (1H, m, C12H), 5.30 (1H, dd, *J* = 9.6, 3.7 Hz, C2H), 3.92 (1H, dd, *J* = 19.4, 9.6 Hz, C3H_AH_B), 3.06 (1H, dd, *J* = 19.4, 3.7 Hz, C3H_AH_B), 2.22 (3H, s, C19H_3), 2.17 (6H, s, 2 × C18H_3), 2.11 (6H, s, 2 × C17H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.6 (C4=O), 198.9 (C1=O), 139.6 (C13), 138.6 (C9), 136.7 (C5), 135.6 (C16), 133.2 (2C, 2 × C15), 133.0 (C8H), 129.2 (2C, 2 × C11H), 129.1 (2C, 2 × C6H), 128.6 (2C, 2 × C7H), 128.4 (2C, 2 × C10H), 127.8 (2C, br. s, 2 × C14), 127.4 (C12H), 50.4 ($C3H_2$), 48.0 (C2H), 17.1 (2C, 2 × $C17H_3$), 16.8 ($C19H_3$), 16.1 (2C, 2 × $C18H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 407.19793; $C_{27}H_{28}O_2Na$ requires 407.19815, Δ –0.55 ppm.

(*Z*)-4-(2,3,4,5,6-Pentamethylphenyl)-1,2-diphenylbut-2-ene-1,4-dione (164)



In the preparation of ketone **163**, enedione **164** (13.5 mg, 35.3 μmol, 5.9%) was also isolated as a yellow solid.

m.p. = 166 – 168 °C.

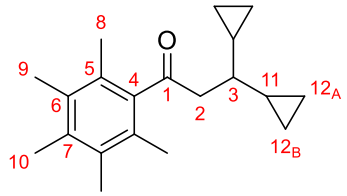
IR (film) ν_{max}/cm^{-1} 3083, 3060, 3027, 2979, 2924, 1670, 1647, 1581, 1568, 1494, 1447, 1382, 1348, 1312, 1273, 1245, 1216, 1175, 1125, 1073, 1040, 1022, 997, 956, 910.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.85 – 7.77 (2H, m, 2 × C6H), 7.55 – 7.49 (3H, m, C8H and 2 × C10H), 7.42 – 7.38 (3H, m, 2 × C7H and C12H), 7.38 – 7.33 (2H, m, 2 × C11H), 6.98 (1H, s, C3H), 2.18 (3H, s, $C19H_3$), 2.10 (6H, br. s, 2 × $C18H_3$), 2.06 (6H, s, 2 × $C17H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 199.1 (C4=O), 196.8 (C1=O), 154.4 (C2), 138.9 (C13), 136.18 (C16), 136.06 (C5), 134.8 (C9), 133.4 (C8H), 133.1 (2C, 2 × C15), 130.8 (C12H), 129.3 (2C, 2 × C11H), 129.1 (2C, 2 × C14), 128.7 (2C, 2 × C6H), 128.5 (2C, 2 × C7H), 127.4 (2C, 2 × C10H), 126.7 (C3H), 17.5 (2C, 2 × C17H_3), 16.9 (C19H_3), 16.0 (2C, 2 × C18H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 405.18118; $C_{27}H_{26}O_2Na$ requires 405.18250, Δ –3.25 ppm.

3,3-Dicyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (165)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), dicyclopropylmethanol (135 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded a colourless oil (96.4 mg) containing a mixture of ketones **121** (96.7 μmol, 16%), **165** (14.6 μmol, 2.4%), **166** (0.192 mmol, 32%) and a fourth isomeric ketone (67.0 μmol assuming identical molecular mass, 11%).

When the reaction was repeated at 105 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a colourless solid (128 mg) containing a mixture of ketones **165** (38.3 μmol, 6.4%), **166** (0.333 mmol, 56%) and a fourth isomeric ketone (76.6 μmol assuming identical molecular mass, 13%).

An analytically pure sample was prepared by preparative TLC (Pentane:Et_2O, 95:5) to give ketone **165** as a colourless solid.

m.p. = 69 – 72 °C.

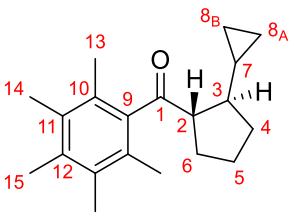
IR (film) ν_{max}/cm^{-1} 3076, 3000, 2953, 2926, 2872, 1702, 1575, 1461, 1429, 1384, 1347, 1302, 1271, 1172, 1107, 1069, 1045, 1015, 935.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 2.89 (2H, d, J = 5.7 Hz, C2H_2), 2.24 (3H, s, C10H_3), 2.19 (6H, s, 2 × C9H_3), 2.15 (6H, s, 2 × C8H_3), 1.04 (1H, tt, J = 8.9, 5.7 Hz, C3H), 0.83 (2H, qt, J = 8.4, 5.1 Hz, 2 × C11H), 0.55 – 0.44 (2H, m, 2 × C12$_A$$H_AH_B$), 0.42 – 0.34 (2H, m, 2 × C12$_B$$H_AH_B$), 0.32 – 0.21 (4H, m, 2 × C12$_A$H$_A$$H_B$ and C12$_B$H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.0 (C1=O), 141.0 (C4), 135.3 (C7), 133.2 (2C, 2 × C6), 127.4 (2C, 2 × C5), 52.1 (C2H_2), 41.3 (C3H), 17.1 (2C, 2 × C8H_3), 16.8 (C10H_3), 16.1 (2C, 2 × C9H_3), 15.7 (2C, 2 × C4H), 4.2 (2C, 2 × C12$_A$H$_2$), 2.9 (2C, 2 × C12$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 307.20325; $C_{20}H_{28}ONa$ requires 307.20324, Δ 0.03 ppm.

***rel*-((1*S*,2*R*)-2-Cyclopropylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (166)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), dicyclopropylmethanol (135 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded a colourless oil (96.4 mg) containing a mixture of ketones **121** (96.7 μmol, 16%), **165** (14.6 μmol, 2.4%), **166** (0.192 mmol, 32%) and a fourth isomeric ketone (67.0 μmol assuming identical molecular mass, 11%).

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a colourless solid (128 mg) containing a mixture of ketones **165** (38.3 μmol, 6.4%), **166** (0.333 mmol, 56%) and a fourth isomeric ketone (76.6 μmol assuming identical molecular mass, 13%).

An analytically pure sample was prepared by preparative TLC (Pentane:Et_2O, 95:5) to give ketone **166** as a colourless solid.

m.p. = 48 – 51 °C.

IR (film) ν_{max}/cm^{-1} 3077, 2999, 2949, 2869, 1689, 1573, 1449, 1382, 1344, 1304, 1265, 1169, 1121, 1068, 1044, 1015, 1000.

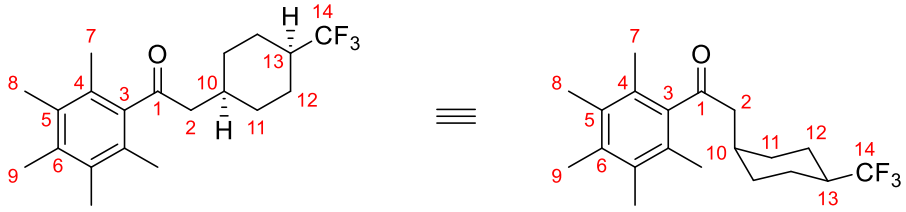
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.11 (1H, ddd, J = 8.6, 7.4, 6.2 Hz, C2H), 2.24 (3H, s, $C15H_3$), 2.19 (6H, s, 2 × $C14H_3$), 2.15 (6H, br. s, 2 × $C13H_3$), 1.96 – 1.82 (3H, m, C3H, $C4H_AH_B$ and $C6H_AH_B$), 1.81 (1H, dq, J = 12.7, 7.4 Hz, $C6H_AH_B$), 1.88 – 1.77 (2H, m, $C6H_2$), 1.69 – 1.60 (2H, m, $C5H_2$), 1.53 – 1.38 (1H, m, $C4H_AH_B$), 0.68 (1H, qt, J = 8.2, 5.0 Hz, C7H), 0.47 – 0.29 (2H, m, $C8_AH_{cis}H_{trans}$ and $C8_BH_{cis}H_{trans}$), 0.21 – 0.07 (2H, m, $C8_AH_{cis}H_{trans}$ and $C8_BH_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.8 (C1=O), 140.8 (C9), 135.4 (C12), 133.1 (2C, 2 × C11), 128.2 (2C, 2 × C10), 60.8 (C2H), 45.5 (C3H), 32.0 ($C4H_2$), 30.4 ($C6H_2$), 25.1 ($C5H_2$), 18.0 (2C, 2 × $C13H_3$), 16.8 ($C15H_3$), 16.6 (C7H), 16.2 (2C, 2 × $C14H_3$), 4.5 ($C8_AH_2$), 3.7 ($C8_BH_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 285.22134; $C_{20}H_{29}O$ requires 285.22129, Δ 0.18 ppm.

Note: *cis* and *trans* with respect to C7H.

***cis*-1-(2,3,4,5,6-Pentamethylphenyl)-2-(4-(trifluoromethyl)cyclohexyl)ethan-1-one (*cis*-168)[6]**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 4-(trifluoromethyl)cyclohexanol (202 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1 → 98:2) afforded ketone *cis*-**168** (110 mg, 0.324 mmol, 64%) as a colourless solid.

m.p. = 72 – 74 °C.

IR (film) ν_{max}/cm^{-1} 2943, 2873, 1699, 1576, 1456, 1397, 1372, 1358, 1336, 1308, 1278, 1259, 1232, 1201, 1170, 1145, 1115, 1088, 1066, 1035, 1005, 946, 926.

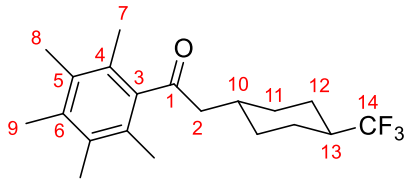
^{1}H{^{19}F} NMR ($CDCl_3$, 500 MHz) δ = 2.72 (2H, d, J = 6.7 Hz, C2H$_2$), 2.51 (1H, ttt, J = 11.1, 6.6, 4.8 Hz, C3H), 2.24 (3H, s, C9H$_3$), 2.20 (6H, s, 2 × C8H$_3$), 2.11 (6H, s, C7H$_3$), 2.10 (1H, tt, J = 9.4, 4.2 Hz, C13H), 1.75 (2H, dq, J = 13.6, 4.6 Hz, 2 × C12H$_{ax}$*H$_{eq}$*), 1.66 (4H, m, 2 × C11H$_2$), 1.54 (2H, dtt, J = 14.0, 9.6, 4.9 Hz, 2 × C12*H$_{ax}$*H$_{eq}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.7 (C1=O), 140.7 (C3), 135.6 (C6), 133.3 (2C, 2 × C5), 128.1 (q, $^1J_{CF}$ = 279.1 Hz, C14F$_3$), 127.3 (2C, 2 × C4), 48.5 (C2H$_2$), 40.6 (q, $^2J_{CF}$ = 26.2 Hz, C13H), 28.7 (2C, 2 × C11H$_2$), 27.6 (C10H), 21.0 (2C, q, J = 2.5 Hz, 2 × C12H$_2$), 17.1 (2C, 2 × C7H$_3$), 16.8 (C9H$_3$), 16.1 (2C, 2 × C8H$_3$).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –72.2 (3F, br. s, C14F$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 341.20883; $C_{20}H_{28}F_3O$ requires 341.20868, Δ 0.45 ppm.

***trans*-1-(2,3,4,5,6-Pentamethylphenyl)-2-(4-(trifluoromethyl)cyclohexyl)ethan-1-one (*trans*-168)[6]**



In the preparation of ketone *cis*-**168**, ketone *cis*-**168** (13.3 mg, 39.1 μmol, 6.5%) was also isolated as a colourless solid.

m.p. = 131 – 133 °C.

IR (film) ν_{max}/cm^{-1} 2979, 2937, 2874, 1696, 1573, 1453, 1392, 1382, 1358, 1337, 1304, 1288, 1272, 1250, 1225, 1196, 1171, 1142, 1125, 1112, 1077, 1025, 977, 928.

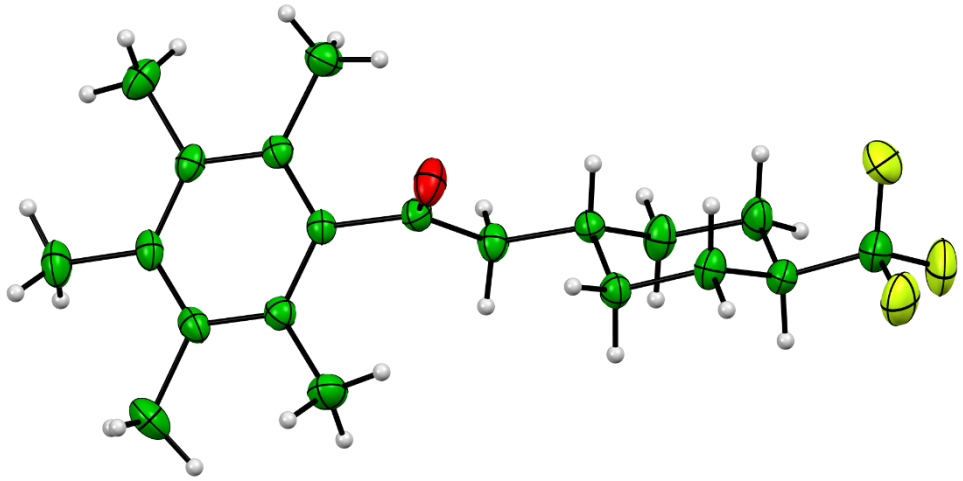
^{1}H{^{19}F} NMR ($CDCl_3$, 500 MHz) δ = 2.58 (2H, d, J = 5.9 Hz, C2H$_2$), 2.23 (3H, s, C9H$_3$), 2.18 (6H, s, 2 × C8H$_3$), 2.10 (6H, s, 2 × C7H$_3$), 2.07 – 2.00 (3H, m, C10H and 2 × C11H$_{ax}$*H$_{eq}$*), 2.00 – 1.93 (3H, m, 2 × C12H$_{ax}$*H$_{eq}$* and C13H), 1.42 (2H, qd, J = 12.7, 3.1 Hz, 2 × C12*H$_{ax}$*H$_{eq}$), 1.02 (2H, qd, J = 12.9, 2.9 Hz, 2 × C11*H$_{ax}$*H$_{eq}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.7 (C1=O), 140.6 (C3), 135.6 (C6), 133.3 (2C, 2 × C5), 127.9 (q, $^{1}J_{CF}$ = 278.6 Hz, C14F$_3$), 127.4 (2C, 2 × C4), 52.6 (C2H$_2$), 41.9 (q, $^{2}J_{CF}$ = 26.5 Hz, C13H), 31.9 (C10H), 31.6 (2C, 2 × C11H$_2$), 25.0 (2C, q, $^{3}J_{CF}$ = 2.6 Hz, 2 × C12H$_2$), 17.2 (2C, 2 × C7H$_3$), 16.8 (C9H$_3$), 16.1 (2C, 2 × C8H$_3$).

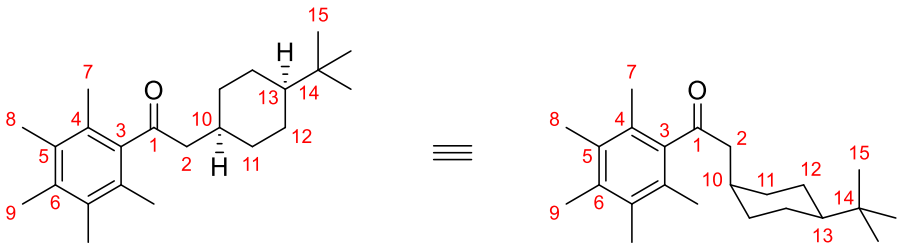
^{19}F NMR ($CDCl_3$, 471 MHz) δ = –73.8 (3F, d, $^{3}J_{HF}$ = 8.2 Hz, C14F$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 341.20862; $C_{20}H_{28}F_3O$ requires 341.20868, Δ –0.17 ppm.

The relative stereochemistry of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



***cis*-2-(4-(*tert*-Butyl)cyclohexyl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (*cis*-169)[6]**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 4-(*tert*-butyl)cyclohexanol (188 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone *cis*-**169** (179 mg, 0.545 mmol, 91%, d.r. > 95:5) as a colourless solid.

m.p. = 74 – 78 °C.

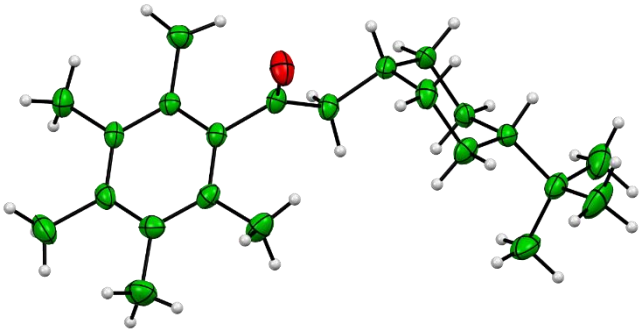
IR (film) ν_{max}/cm^{-1} 2936, 2865, 1701, 1576, 1468, 1453, 1400, 1377, 1365, 1330, 1304, 1281, 1238, 1178, 1142, 1104, 1070, 1021, 1000.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.75 (2H, d, J = 6.7 Hz, $C2H_2$), 2.55 (1H, ttt, J = 7.0, 4.9, 2.4 Hz, C10H), 2.24 (3H, s, $C9H_3$), 2.20 (6H, s, 2 × $C8H_3$), 2.12 (6H, s, 2 × $C7H_3$), 1.74 (2H, m, 2 × $C11H_{ax}H_{eq}$), 1.63 – 1.50 (4H, m, 2 × $C11H_{ax}H_{eq}$ and 2 × $C12H_{ax}H_{eq}$), 1.11 – 1.00 (2H, m, 2 × $C12H_{ax}H_{eq}$), 1.04 – 0.91 (1H, m, C13H), 0.82 (9H, s, 3 × $C15H_3$).

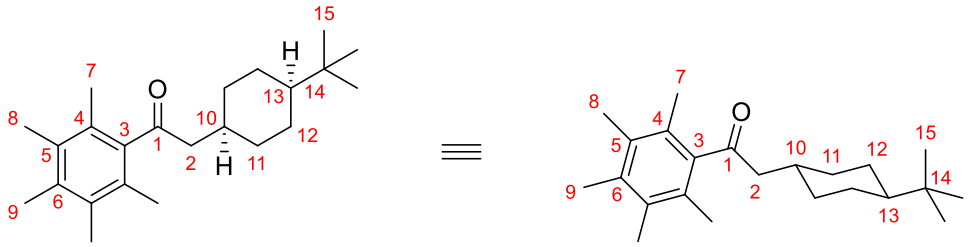
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.4 (C1=O), 141.1 (C3), 135.5 (C6), 133.3 (2C, 2 × C5), 127.5 (2C, 2 × C4), 48.4 (C13H), 47.8 ($C2H_2$), 32.7 (C14), 31.0 (2C, 2 × $C11H_2$), 27.6 (3C, 3 × $C15H_3$), 26.9 C10H), 22.1 (2C, 2 × $C12H_2$), 17.1 (2C, 2 × $C7H_3$), 16.8 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 329.28394; $C_{23}H_{37}O$ requires 329.28389, Δ 0.13 ppm.

The relative stereochemistry of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



***trans*-2-(4-(*tert*-Butyl)cyclohexyl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (*trans*-169)[6]**



In the preparation of ketone *cis*-**169** using NaO*t*-Bu as the base, ketone *trans*-**169** (50.1 mg, 0.152 mmol, 25%) was also isolated as a colourless solid.

m.p. = 127 – 130 °C.

IR (film) ν_{max}/cm^{-1} 2937, 2916, 2855, 1699, 1573, 1479, 1466, 1447, 1399, 1379, 1363, 1304, 1283, 1262, 1231, 1142, 1116, 1102, 1068, 1022, 1004, 980, 927, 909.

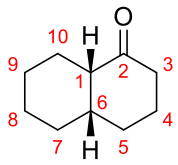
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.56 (2H, d, J = 5.9 Hz, C2H_2), 2.23 (3H, s, C9H_3), 2.18 (6H, s, 2 × C8H_3), 2.10 (6H, s, 2 × C7H_3), 2.00 – 1.89 (3H, m, C102H and 2 × C11H_{ax}*H*$_{eq}$), 1.84 – 1.74 (2H, m, 2 × C12H_{ax}*H*$_{eq}$), 1.10 (2H, qd, J = 12.8, 2.8 Hz, 2 × C12*H*$_{ax}$H$_{eq}$), 1.03 – 0.91 (3H, m, 2 × C11*H*$_{ax}$H$_{eq}$ and C13H), 0.85 (9H, s, 3 × C15H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.3 (C1=O), 141.0 (C3), 135.4 (C6), 133.2 (2C, 2 × C5), 127.4 (2C, 2 × C4), 53.3 (C2H_2), 48.1 (C10H), 33.9 (2C, 2 × C11H_2), 32.8 (C13H), 32.6 (C13), 27.7 (3C, 3 × C15H_3), 27.3 (2C, 2 × C12H_2), 17.2 (2C, 2 × C7H_3), 16.8 (C9H_3), 16.1 (2C, 2 × C8H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 329.28381; $C_{23}H_{37}O$ requires 329.28389, Δ –0.24 ppm.

***rel*-(1*S*,6*S*)-Bicyclo[4.4.0]decan-2-one (*cis*-174), or**

***rel*-(4a*S*,8a*S*)-Octahydronaphthalen-1(2*H*)-one (*cis*-174), or *cis*-Decal-1-one (*cis*-174)**



cis-Decalin-1-ol (309 mg, 2.00 mmol, 1.0 equiv), PCC (647 mg, 3.00 mmol, 1.5 equiv), Celite® (647 mg, 100 wt% to PCC) and DCM (40 mL, 0.05 M) were subjected to **General Procedure M** for 5.5 h, but eluting with pentane:EtOAc (9:1). The filtrate was concentrated *in vacuo* to directly afford *cis*-decal-1-one ***cis*-174** (235 mg, 1.54 mmol, 77%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2929, 2852, 1706, 1461, 1446, 1426, 1371, 1349, 1315, 1288, 1249, 1231, 1186, 1153, 1133, 1102, 1088, 1051, 1008, 986, 944, 877, 840, 827.

^{1}H NMR (C_6D_6, 500 MHz) δ = 2.17 (1H, dt, J = 14.1, 5.0 Hz, C3H_AH$_B$), 2.14 – 2.08 (2H, m, C1H and C10H_AH$_B$), 1.86 (1H, dddd, J = 14.1, 11.1, 6.0, 1.0 Hz, C3H$_A$$H_B$), 1.70 (1H, app. ddq, J = 7.2, 6.7, 4.8 Hz, C6H), 1.63 (1H, qt, J = 10.6, 3.5 Hz, C9H_AH$_B$), 1.59 – 1.45 (2H, m, C4H_AH$_B$ and C8H_AH$_B$), 1.40 – 1.31 (2H, m, C4H$_A$$H_B$ and C9H$_A$$H_B$), 1.31 – 1.26 (2H, m, C5H$_2$), 1.15 – 1.06 (3H, m, C7H$_2$ and C8H$_A$$H_B$), 1.02 (1H, dddd, J = 14.6, 10.4, 5.7, 4.0 Hz, C10H$_A$$H_B$).

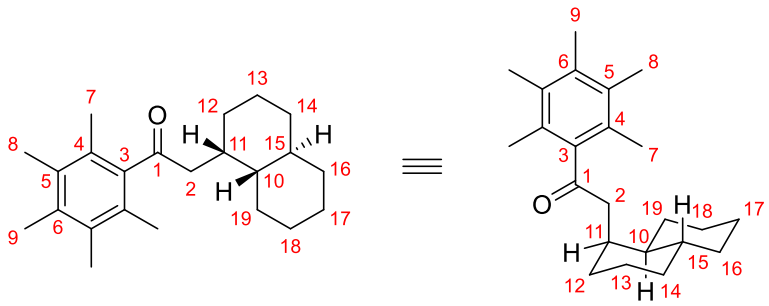
^{13}C NMR (C_6D_6, 126 MHz) δ = 210.3 (C2=O), 50.4 (C1H), 41.0 (C3H$_2$), 39.5 (C6H), 29.8 (br. s, C5H$_2$), 29.2 (C7H$_2$), 25.58 (C10H$_2$), 25.45 (br. s, C8H$_2$), 23.4 (C4H$_2$), 23.2 (C9H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 153.12734; $C_{10}H_{17}O$ requires 153.12739, Δ –0.35 ppm.

The analytical data are identical to those reported in literature.[17]

***rel*-2-((1*S*,2*S*,6*R*)-Bicyclo[4.4.0]decan-2-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (173), or**

***rel*-2-((1*S*,4a*R*,8a*S*)-Decahydronaphthalen-1-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (173)[6]**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), *cis*-decalin-1-ol (185 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **173** (130 mg, 0.398 mmol, 66%, d.r. > 95:5) as a colourless solid.

m.p. = 94 – 97 °C.

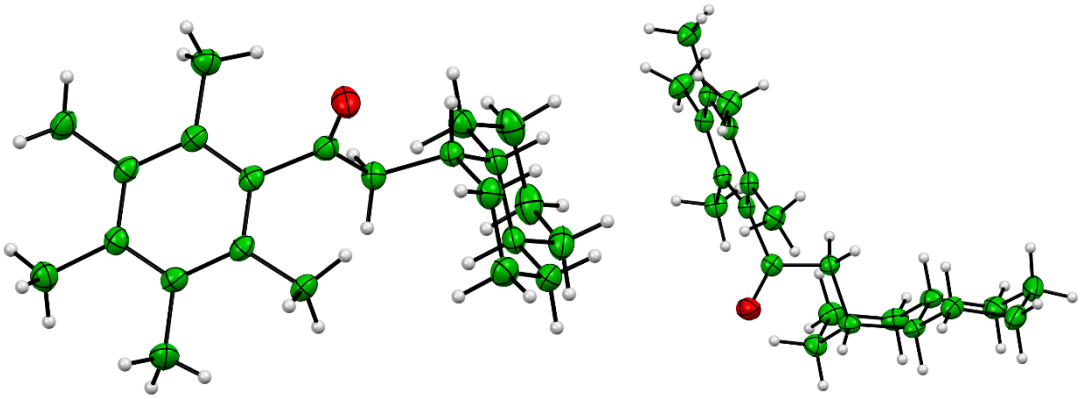
IR (film) ν_{max}/cm^{-1} 2918, 2852, 1701, 1576, 1447, 1403, 1379, 1347, 1307, 1283, 1250, 1157, 1138, 1110, 1068, 999, 956, 929.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.79 (1H, dd, J = 19.4, 9.8 Hz, C2H_AH$_B$), 2.67 (1H, ddd, J = 19.5, 2.8, 1.2 Hz, C2H$_A$$H_B$), 2.43 (1H, dquint., J = 9.4, 3.0 Hz, C11H), 2.24 (3H, s, C9H$_3$), 2.19 (6H, s, 2 × C8H$_3$), 2.11 (6H, s, 2 × C7H$_3$), 1.87 (1H, dddd, J = 13.6, 4.8, 3.5, 2.3 Hz, C12H$_{ax}$$H_{eq}$), 1.71 (1H, dquint.d, J = 12.7, 3.3, 1.8 Hz, C18H$_{ax}$$H_{eq}$), 1.64 (1H, dquint.d, J = 13.0, 3.1, 1.9 Hz, C17H$_{ax}$$H_{eq}$), 1.61 – 1.57 (1H, m, C16H$_{ax}$$H_{eq}$), 1.57 – 1.52 (2H, m, C12H_{ax}H$_{eq}$ and C14H$_{ax}$$H_{eq}$), 1.52 – 1.49 (1H, m, C13H$_{ax}$$H_{eq}$), 1.49 – 1.43 (1H, m, C19H$_{ax}$$H_{eq}$), 1.40 (1H, app. qt, J = 13.2, 3.7 Hz, C13H_{ax}H$_{eq}$), 1.26 (1H, qt, J = 12.2, 3.1 Hz, C18H_{ax}H$_{eq}$), 1.25 – 1.15 (1H, m, C10H), 1.10 (1H, qt, J = 12.7, 3.3 Hz, C17H_{ax}H$_{eq}$), 1.07 (1H, qd, J = 12.2, 3.6 Hz, C19H_{ax}H$_{eq}$), 1.01 – 0.91 (1H, m, C15H), 0.90 (1H, qd, J = 11.9, 3.5 Hz, C14H_{ax}H$_{eq}$), 0.88 (1H, qd, J = 12.6, 3.6 Hz, C16H_{ax}H$_{eq}$).

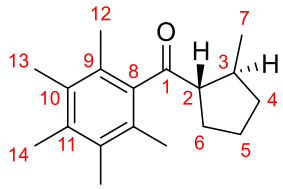
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.8 (C1=O), 141.3 (C3), 135.4 (C6), 133.2 (2C, 2 × C5), 127.3 (2C, 2 × C4), 46.0 (C10H), 43.3 (C2H$_2$), 37.0 (C15H), 35.0 (C16H$_2$), 34.7 (C14H$_2$), 32.6 (C11H), 31.1 (C19H$_2$), 30.9 (C12H$_2$), 27.0 (C18H$_2$), 26.7 (C17H$_2$), 21.0 (C13H$_2$), 17.2 (2C, 2 × C7H$_3$), 16.8 (C9H$_3$), 16.1 (2C, 2 × C8H$_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 349.25015; $C_{23}H_{34}ONa$ requires 349.25019, Δ –0.10 ppm.

The relative stereochemistry of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



***rel*-((1*S*,2*S*)-2-Methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (*trans*-176)[6]**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), pentane-1,4-diol (125 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure E** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone *trans*-**176** (57.1 mg, 0.221 mmol, 37%, d.r. > 95:5) as a colourless solid.

Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropylethan-1-ol (103 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded a colourless solid (126 mg) containing a 1:2.3 mixture of ketones **196** (0.148 mmol, 25%) and *trans*-**176** (0.338 mmol, 56%, d.r. > 95:5).

An identical repeat of the reaction gave a colourless solid (128 mg) containing a 1:1.9 mixture of ketones **196** (0.165 mmol, 28%) and *trans*-**176** (0.312 mmol, 52%, d.r. > 95:5). A second purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded *trans*-**176** (50.0 mg) as a colourless solid, as well as a colourless solid (71.7 mg) containing a 1.16:1 mixture of ketones **196** and *trans*-**176**. This mixture was further purified by preparative TLC (Pentane:Et_2O, 95:5) to give ketone *trans*-**176** (30.5 mg) containing 7% of ketone **196**. The combined isolated mass is 80.5 mg, and the corrected yield is 0.303 mmol, 51%.

m.p. = 53 – 55 °C.

IR (film) ν_{max}/cm^{-1} 2951, 2869, 1688, 1573, 1450, 1381, 1341, 1306, 1256, 1172, 1119, 1069, 1021, 999.

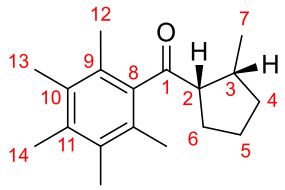
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 2.78 (1H, q, J = 7.9 Hz, C2H), 2.37 (1H, qq, J = 7.9, 6.7 Hz, C3H), 2.24 (3H, s, C14H_3), 2.19 (6H, s, 2 × C13H_3), 2.12 (6H, s, 2 × C12H_3), 1.99 – 1.82 (3H, m, C4$H_{cis}H_{trans}$ and C6H_2), 1.74 – 1.60 (2H, m, C5H_2), 1.25 (1H, dq, J = 12.5, 7.9 Hz, C4H_{cis}H$_{trans}$), 1.01 (3H, d, J = 6.7 Hz, C7H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 214.6 (C1=O), 141.2 (C8), 135.4 (C11), 133.2 (2C, 2 × C10), 128.0 (2C, br. s, 2 × C9), 61.9 (C2H), 37.2 (C3H), 35.3 (C4H_2), 30.2 (C6H_2), 24.9 (C5H_2), 20.8 (2C, br. s, 2 × C12H_3), 18.0 (C14H_3), 16.9 (2C, 2 × C13H_3), 16.2 (C7H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 259.20578; $C_{18}H_{27}O$ requires 259.20564, Δ 0.53 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-((1*S*,2*R*)-2-Methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (*cis*-176)**



Enone **177** (25.8 mg, 0.101 mmol, 1.0 equiv), $Pd(OH)_2/C$ (5.2 mg, 20 wt%) and EtOAc (2.0 mL, 0.05 M) were subjected to a modification of **General Procedure C** for 24 h at 40 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a colourless solid (11.2 mg) that contained an inseparable 1:1.5 mixture of ketones *cis*-**176** (17.3 μmol, 17%) and *trans*-**176** (26.0 μmol, 26%).

IR (film) ν_{max}/cm^{-1} 2952, 2927, 2869, 1736, 1688, 1573, 1454, 1381, 1356, 1306, 1258, 1174, 1118, 1069, 1021, 999, 940, 880, 855, 826, 705.

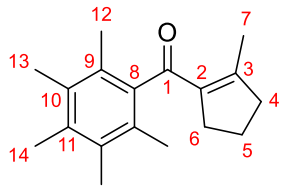
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.16 (1H, ddd, J = 9.5, 7.6, 5.8 Hz, C2H), 2.37 (1H, sext.d, J = 6.6, 3.9 Hz, C3H), 2.02 (1H, ddd, J = 9.6, 6.6, 3.2 Hz, C6H_{cis}H$_{trans}$), 1.87 – 1.78 (2H, m, C5H$_{cis}$$H_{trans}$ and C6H$_{cis}$$H_{trans}$), 1.80 – 1.71 (1H, m, C4H$_{cis}$$H_{trans}$), 1.68 – 1.59 (1H, m, C5H_{cis}H$_{trans}$), 1.61 – 1.52 (1H, m, C4H_{cis}H$_{trans}$), 1.09 (3H, d, J = 7.0 Hz, C7H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.14 (C1=O), 141.87 (C8), 135.43 (C11), 133.22 (2C, 2 × C10), 128.16 (2C, v. br. s, 2 × C9), 57.95 (C2H), 37.21 (C3H), 34.41 (C4H$_2$), 27.74 (C6H$_2$), 21.93 (C5H$_2$), 17.68 (2C, br. s, 2 × C12H$_3$), 16.88 (C14H$_3$), 16.18 (2C, 2 × C13H$_3$), 15.80 (C7H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 259.20566; $C_{18}H_{27}O$ requirees 259.20564, Δ 0.08 ppm.

Note: *cis* and *trans* with respect to C2H. The final *cis*:*trans* ratio is 1:1.5.

(2-Methylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (177)[6]



In the preparation of skipped enone **293**, enone **177** (25.8 mg, 0.101 mmol, 13%) was also isolated as a colourless solid.

m.p. = 92 – 95 °C.

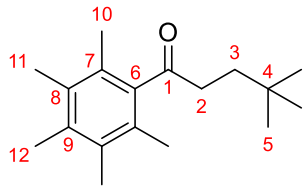
IR (film) ν_{max}/cm^{-1} 2924, 2856, 1735, 1663, 1635, 1621, 1431, 1379, 1352, 1307, 1270, 1235, 1174, 1111, 1069, 1025, 866.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.68 (2H, tsext., J = 7.6, 1.9 Hz, C6H$_2$), 2.55 (2H, ddtq, J = 8.1, 7.5, 2.1, 1.1 Hz, C4H$_2$), 2.23 (3H, s, C14H$_3$), 2.17 (6H, s, 2 × C13H$_3$), 2.05 (6H, s, 2 × C12H$_3$), 1.82 (2H, quint., J = 7.7 Hz, C5H$_2$), 1.57 (3H, s, C7H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.7 (C1=O), 156.8 (C3), 140.8 (C8), 137.7 (C2), 135.0 (C11), 133.0 (2C, 2 × C10), 128.1 (2C, 2 × C9), 42.4 ($C4H_2$), 33.6 ($C6H_2$), 21.1 ($C5H_2$), 17.1 (2C, 2 × $C12H_3$), 16.8 ($C14H_3$), 16.09 (2C, 2 × $C13H_3$), 16.01 ($C7H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 257.19013; $C_{18}H_{25}O$ requires 257.18999, Δ 0.53 ppm.

4,4-Dimethyl-1-(2,3,4,5,6-pentamethylphenyl)pentan-1-one (178)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (9.56 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), pentan-3-ol (106 mg, 1.20 mmol, 2.0 equiv) and neopentyl alcohol (150 μL, 122 mg, 1.39 mmol, 2.3 equiv) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **178** (156 mg, 0.599 mmol, 100%) as a colourless solid.

m.p. = 116 – 117 °C.

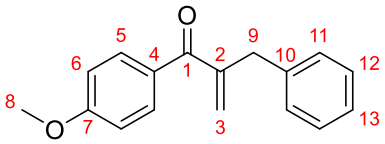
IR (film) ν_{max}/cm^{-1} 2952, 2865, 1698, 1575, 1471, 1448, 1414, 1390, 1364, 1305, 1285, 1248, 1198, 1147, 1114, 1068, 1018, 998, 934, 688.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.70 – 2.59 (2H, m, $C2H_2$), 2.24 (3H, s, $C12H_3$), 2.19 (6H, s, 2 × $C11H_3$), 2.10 (6H, s, 2 × $C10H_3$), 1.69 – 1.61 (2H, m, $C3H_2$), 0.91 (9H, s, 3 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.9 (C1=O), 141.3 (C6), 135.5 (C9), 133.2 (2C, 2 × C8), 127.4 (2C, 2 × C7), 41.5 ($C2H_2$), 37.0 ($C3H_2$), 29.9 (C4), 29.3 (3C, 3 × $C5H_3$), 17.4 (2C, 2 × $C10H_3$), 16.8 ($C12H_3$), 16.1 (2C, 2 × $C11H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 261.22107; $C_{18}H_{29}O$ requires 261.22129, Δ –0.85 ppm.

2-Benzyl-1-(4-methoxyphenyl)prop-2-en-1-one (179)[18]



In the preparation of ketone **180**, enone **179** (111 mg, 0.440 mmol, 14%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3028, 2959, 2840, 1649, 1599, 1573, 1508, 1495, 1454, 1420, 1310, 1257, 1217, 1159, 1030, 985.

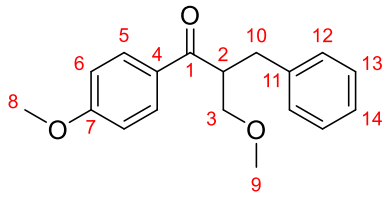
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.77 (2H, d, J = 9.0 Hz, 2 × C5H), 7.32 – 7.27 (2H, m, 2 × C12H), 7.27 – 7.23 (2H, m, 2 × C11H), 7.23 – 7.14 (1H, m, C13H), 6.90 (2H, d, J = 9.0 Hz, 2 × C6H), 5.66 (1H, td, J = 1.5, 0.9 Hz, C3H$_{syn}$*H*$_{anti}$), 5.60 (1H, q, J = 0.9 Hz, C3*H*$_{syn}$H$_{anti}$), 3.85 (3H, s, C8H_3), 3.79 (2H, s, C9H_2).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 196.6 (C1=O), 163.3 (C7), 147.9 (C2), 138.8 (C10), 132.1 (2C, 2 × C5H), 130.3 (C4), 129.3 (2C, 2 × C11H), 128.6 (2C, 2 × C12H), 126.5 (C13H), 124.9 (C3H_2), 113.6 (2C, 2 × C6H), 55.6 (C8H_3), 39.0 (C9H_2).

HRMS (ESI$^+$) Found $[M+H]^+$ = 253.12231; $C_{17}H_{17}O_2$ requires 253.12231, Δ 0.00 ppm.

Note: *syn* and *anti* with respect to C1.

2-Benzyl-3-methoxy-1-(4-methoxyphenyl)propan-1-one (180)[18]



To a 10 – 20 mL microwave vial was added ketone **41** (727 mg, 3.00 mmol, 1.0 equiv), paraformaldehyde (135 mg, 4.50 mmol, 1.5 equiv), K_2CO_3 (622 mg, 4.50 mmol, 1.5 equiv) and MeOH (15 mL, 0.2 M). The vial was sealed with a microwave vial cap, then heated to 65 °C for 16 h. The reaction mixture was cooled to RT, then poured into Et_2O (100 mL) and the resulting suspension filtered, eluting with Et_2O. The filtrate was concentrated *in vacuo* and purified by flash column chromatography (Pentane:EtOAc, 95:5 → 90:10) to afford ketone **180** (733 mg, 2.58 mmol, 87%) as a colourless oil.

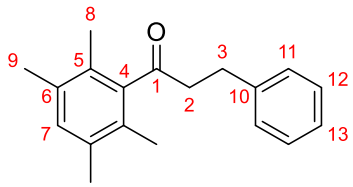
IR (film) ν_{max}/cm^{-1} 3027, 2928, 2893, 1671, 1599, 1574, 1509, 1455, 1366, 1309, 1255, 1223, 1171, 1115, 1030, 970, 947.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.88 (2H, d, J = 8.9 Hz, 2 × C5H), 7.26 – 7.20 (2H, m, 2 × C13H), 7.19 – 7.11 (3H, m, 2 × C12H and C14H), 6.88 (2H, d, J = 8.9 Hz, 2 × C6H), 3.96 (1H, tdd, J = 7.5, 6.8, 5.4 Hz, C2H), 3.84 (3H, s, C8H_3), 3.70 (1H, dd, J = 9.0, 7.5 Hz, C3H_AH$_B$), 3.50 (1H, dd, J = 9.0, 5.4 Hz, C3H$_A$$H_B$), 3.27 (3H, s, C9$H_3$), 3.04 (1H, dd, J = 13.7 Hz, 7.5 Hz, C10H_AH$_B$), 2.87 (1H, dd, J = 13.7, 6.7 Hz, C10H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 200.6 (C1=O), 163.6 (C7), 139.4 (C11), 130.8 (2C, 2 × C5H), 130.5 (C4), 129.1 (2C, 2 × C12H), 128.5 (2C, 2 × C13H), 126.4 (C14H), 113.8 (2C, 2 × C6H), 73.7 (C3H_2), 59.2 (C9H_3), 55.6 (C8H_3), 48.4 (C2H), 35.6 (C10H_2).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 307.1308; $C_{18}H_{20}O_3$ requires 307.1305, Δ 0.98 ppm.

3-Phenyl-1-(2,3,5,6-tetramethylphenyl)propan-1-one (181)



Enone **345** (1.53 g, 5.79 mmol, 1.0 equiv), $Pd(OH)_2/C$ (15.3 mg, 1.0 wt%) and EtOAc (30 mL, 0.2 M) were subjected to **General Procedure C** for 16 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **181** (1.38 g, 5.18 mmol, 90%) as a colourless solid.

m.p. = 68 – 70 °C.

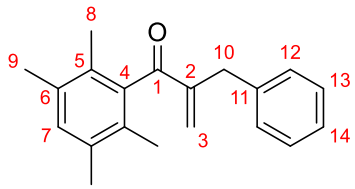
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3027, 3003, 2923, 2866, 1700, 1604, 1496, 1470, 1454, 1400, 1354, 1306, 1232, 1112, 1075, 1017, 973.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.32 – 7.27 (2H, m, 2 × C12H), 7.26 – 7.23 (2H, m, 2 × C11H), 7.23 – 7.17 (1H, m, C13H), 6.95 (1H, s, C7H), 3.11 – 3.04 (2H, m, $C3H_2$), 3.04 – 2.98 (2H, m, $C2H_2$), 2.20 (6H, s, 2 × $C9H_3$), 2.01 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.8 (C1=O), 142.7 (C4), 141.1 (C10), 134.5 (2C, 2 × C6), 131.7 (C7H), 128.64 (2C, 2 × C11H), 128.58 (2C, 2 × C12H), 128.1 (2C, 2 × C5), 126.2 (C13H), 46.9 ($C2H_2$), 29.5 ($C3H_2$), 19.6 (2C, 2 × $C9H_3$), 16.0 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 267.17441; $C_{19}H_{23}O$ requires 267.17434, Δ 0.25 ppm.

2-Benzyl-1-(2,3,5,6-tetramethylphenyl)prop-2-en-1-one (182)



To a 10 – 20 mL microwave vial was added ketone **181** (1.00 g, 3.75 mmol, 1.0 equiv), paraformaldehyde (169 mg, 5.63 mmol, 1.5 equiv), K_2CO_3 (778 mg, 5.63 mmol, 1.5 equiv) and MeOH (19 mL, 0.2 M). The vial was sealed with a microwave vial cap, then heated to 65 °C for 16 h. The reaction mixture was cooled to RT, then poured into Et_2O (150 mL) and the resulting suspension filtered, eluting with Et_2O. The filtrate was concentrated *in vacuo* and purified by flash column chromatography (Pentane:Et_2O, 99:1) to afford enone **182** (910 mg, 3.27 mmol, 87%) as a pale yellow solid.

m.p. = 54 – 56 °C.

IR (film) ν_{max}/cm^{-1} 3085, 3062, 3028, 3003, 2922, 2865, 1664, 1625, 1603, 1585, 1495, 1470, 1454, 1431, 1399, 1387, 1376, 1342, 1325, 1308, 1254, 1227, 1170, 1089, 1030, 1009, 976, 949, 871, 860, 824, 777, 754, 733, 701.

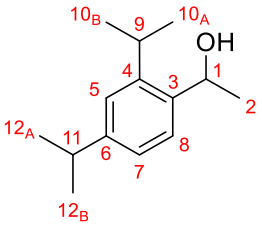
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 – 7.29 (2H, m, 2 × C13H), 7.29 – 7.25 (2H, m, 2 × C12H), 7.25 – 7.20 (1H, m, C14H), 6.94 (1H, s, C7H), 5.75 (1H, q, J = 1.3 Hz, $C3H_{syn}H_{anti}$), 5.69 (1H, q, J = 0.9 Hz, $C3H_{syn}H_{anti}$), 3.78 (2H, s, $C10H_2$), 2.18 (6H, s, 2 × $C9H_3$), 1.92 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.1 (C1=O), 149.4 (C2), 139.9 (C4), 139.1 (C11), 134.1 (2C, 2 × C6), 131.7 (C7H), 130.7 ($C3H_2$), 129.9 (2C, 2 × C5), 129.5 (2C, 2 × C12H), 128.6 (2C, 2 × C13H), 126.4 (C14H), 36.1 ($C10H_2$), 19.6 (2C, 2 × $C9H_3$), 16.2 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 279.17444; $C_{20}H_{23}O$ requires 279.17434, Δ 0.35 ppm.

Note: *syn* and *anti* with respect to C1.

1-(2,4-Diisopropylphenyl)ethan-1-ol (183)



In the preparation of ketone **128**, benzylic alcohol **183** (9.8 mg, 47 μmol, 7.9%) was also isolated as a yellow oil.

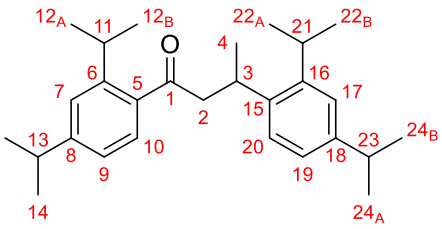
IR (film) ν_{max}/cm^{-1} 3348 (br.), 2961, 2926, 2870, 1718, 1612, 1572, 1497, 1461, 1418, 1382, 1364, 1288, 1260, 1231, 1207, 1180, 1157, 1104, 1068, 1006, 928, 891, 830, 804, 646.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.44 (1H, d, J = 8.0 Hz, C8H), 7.13 (1H, d, J = 1.9 Hz, C5H), 7.10 (1H, dd, J = 8.0, 1.9 Hz, C7H), 5.24 (1H, q, J = 6.4 Hz, C1H), 3.26 (1H, sept., J = 6.9 Hz, C9H), 2.89 (1H, sept., J = 6.9 Hz, C11H), 1.55 (1H, br. s, OH), 1.50 (3H, d, J = 6.4 Hz, $C2H_3$), 1.27 (3H, d, J = 6.8 Hz, $C10_AH_3$), 1.25 (3H, d, J = 7.0 Hz, $C11_AH_3$), 1.25 (3H, d, J = 6.9 Hz, $C11_BH_3$), 1.24 (3H, d, J = 6.9 Hz, $C10_BH_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 148.2 (C6), 145.4 (C4), 139.9 (C3), 125.0 (C8H), 124.1 (C7H), 123.7 (C5H), 66.2 (C1H), 34.1 (C11H), 28.3 (C9H), 25.0 ($C2H_3$), 24.5 ($C10_AH_3$), 24.22 ($C11_AH_3$), 24.19 ($C11_BH_3$), 24.15 ($C10_BH_3$).

Note: A stable molecular ion could not be detected by ESI, APCI or EI.

1,3-Bis(2,4-diisopropylphenyl)butan-1-one (184)



In the preparation of ketone **128**, ketone **184** (24.2 mg, 62.3 μmol, 21%) was also isolated as a pale yellow oil.

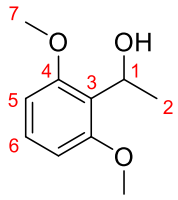
IR (film) ν_{max}/cm^{-1} 2960, 2927, 2870, 1737, 1684, 1607, 1562, 1497, 1461, 1416, 1382, 1362, 1330, 1286, 1258, 1208, 1183, 1163, 1091, 1073, 1055, 1014, 990, 927, 892, 823, 802, 753, 677, 646.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 (1H, d, J = 8.0 Hz, C10H), 7.20 (1H, d, J = 1.7 Hz, C7H), 7.14 (1H, d, J = 8.0 Hz, C20H), 7.08 (1H, d, J = 2.0 Hz, C17H), 7.05 (2H, dd, J = 8.0, 1.8 Hz, C9H), 7.01 (1H, dd, J = 8.0, 2.0 Hz, C19H), 3.80 (1H, dquint., J = 8.2, 6.8 Hz, C3H), 3.26 (1H, sept., J = 6.8 Hz, C21H), 3.21 (1H, sept., J = 6.8 Hz, C11H), 3.15 (1H, dd, J = 16.5, 8.3 Hz, C2H_AH$_B$), 3.11 (1H, dd, J = 16.5, 6.0 Hz, C2H$_A$$H_B$), 2.90 (1H, sept., J = 6.8 Hz, C13H), 2.86 (1H, sept., J = 7.0 Hz, C23H), 1.28 (3H, d, J = 6.9 Hz, C4H$_3$), 1.25 (6H, d, J = 7.1 Hz, 2 × C14H$_3$), 1.23 (3H, d, J = 6.7 Hz, C24$_A$H$_3$), 1.23 (3H, d, J = 6.9 Hz, C24$_B$H$_3$), 1.21 (3H, d, J = 6.9 Hz, C22$_A$H$_3$), 1.16 (3H, d, J = 6.8 Hz, C12$_A$H$_3$), 1.14 (3H, d, J = 6.8 Hz, C22$_B$H$_3$), 1.11 (3H, d, J = 6.9 Hz, C12$_B$H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.2 (C1), 152.0 (C8), 148.2 (C6), 146.6 (C18), 145.7 (C16), 140.5 (C15), 136.9 (C5), 127.6 (C10H), 125.7 (C20H), 124.9 (C7H), 123.8 (C19H), 123.7 (C17H), 123.2 (C9H), 51.1 (C2H$_2$), 34.4 (C13H), 34.0 (C23H), 29.9 (C3H), 29.3 (C11H), 28.3 (C21H), 24.51 (C12$_A$H$_3$), 24.49 (C22$_A$H$_3$), 24.20 (C24$_A$H$_3$), 24.19 (C12$_B$H$_3$), 24.17 (C24$_B$H$_3$), 23.97 (C22$_B$H$_3$), 23.93 (2C, 2 × C14H$_3$), 22.7 (C4H$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 393.31439; $C_{28}H_{41}O$ requires 393.31519, Δ –2.03 ppm.

1-(2,6-Dimethoxyphenyl)ethan-1-ol (185)



In the preparation of ketone **131**, benzylic alcohol **185** (18.1 mg, 99.6 μmol, 17%) was also isolated as a pale yellow solid.

m.p. = 52 – 55 °C.

IR (film) ν_{max}/cm^{-1} 3562, 2966, 2932, 2838, 1594, 1475, 1437, 1409, 1365, 1344, 1308, 1271, 1232, 1196, 1178, 1106, 1078, 1061, 1035, 1006, 900, 891, 782, 728, 692, 624.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.17 (1H, t, J = 8.4 Hz, C6H), 6.57 (2H, d, J = 8.3 Hz, 2 × C5H), 5.33 (1H, q, J = 6.7 Hz, C1H), 3.84 (6H, s, 2 × C7H_3), 3.81 (1H, v. br. s, OH), 1.50 (3H, d, J = 6.7 Hz, C2H_3).

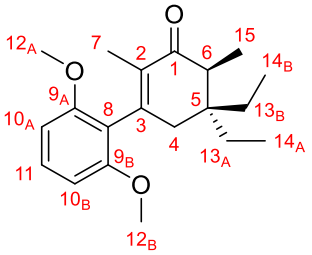
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 157.6 (2C, 2 × C4), 128.2 (C6H), 121.1 (C3), 104.5 (2C, 2 × C5H), 64.2 (C1H), 55.9 (2C, 2 × C7H_3), 23.7 (C2H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 205.08375; $C_{10}H_{14}O_3Na$ requires 205.08352, Δ 1.14 ppm.

The analytical data are identical to those reported in literature.[19]

5,5-Diethyl-3-(2,6-dimethoxyphenyl)-2,6-dimethylcyclohex-2-en-1-one (186), or

5,5-Diethyl-2′,6′-dimethoxy-2,4-dimethyl-5,6-dihydro-[1,1′-biphenyl]-3(4*H*)-one (186)



In the preparation of ketone **131**, enone **186** (4.8 mg, 15 μmol, 2.5%) was also isolated as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 2964, 2940, 2921, 2879, 2837, 1665, 1639, 1591, 1470, 1433, 1377, 1356, 1326, 1304, 1285, 1251, 1216, 1110, 1037, 980, 781, 729.

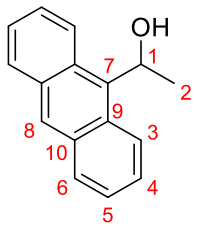
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.23 (1H, t, J = 8.3 Hz, C11H), 6.58 (2H, dq_{AB}, J = 8.4 Hz, J_{AB} = 0.9 Hz, Δ_{AB} = 2.4 Hz, $C10_AH$ and $C10_BH$), 3.76 (3H, s, $C12_AH_3$), 3.75 (3H, s, $C12_BH_3$), 2.43 (1H, q, J = 7.1 Hz, C6H), 2.36 (1H, dq, J = 18.7, 1.8 Hz, C4H_{cis}H$_{trans}$), 2.27 (1H, dq, J = 18.6, 2.1 Hz, C4H$_{cis}$$H_{trans}$), 1.55 (1H, dq, J = 14.8, 7.4 Hz, $C13_AH_AH_B$), 1.50 (3H, t, J = 1.9 Hz, $C7H_3$), 1.43 (1H, dq, J = 15.0, 7.5 Hz, $C13_BH_AH_B$), 1.39 (1H, dq, J = 14.5, 7.5 Hz, $C13_AH_AH_B$), 1.31 (1H, dq, J = 14.6, 7.4 Hz, $C13_BH_AH_B$), 1.11 (3H, d, J = 7.1 Hz, $C15H_3$), 0.83 (3H, t, J = 7.4 Hz, $C14_AH_3$), 0.78 (3H, t, J = 7.5 Hz, $C14_BH_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 204.4 (C1=O), 156.45 ($C9_A$), 156.38 ($C9_B$), 148.2 (C3), 131.4 (C2), 129.0 (C11H), 118.8 (C8), 104.01 ($C10_AH$), 103.97 ($C10_BH$), 55.92 ($C12_AH_3$), 55.83 ($C12_AH_3$), 48.8 (C6H), 40.4 (C5), 37.3 ($C4H_2$), 26.9 ($C13_AH_2$), 26.1 ($C13_BH_2$), 12.5 ($C7H_3$), 11.2 ($C15H_3$), 8.0 ($C14_AH_3$), 7.1 ($C14_BH_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 339.19318; $C_{20}H_{28}O_3Na$ requires 339.19307, Δ 0.33 ppm.

Note: *cis* and *trans* with respect to C6H.

1-(Anthracen-9-yl)ethan-1-ol (187)



In the preparation of ketone **133**, benzylic alcohol **187** (13.0 mg, 58.4 μmol, 9.7%) was also isolated as a yellow solid.

m.p. = 88 – 92 °C.

IR (film) ν_{max}/cm^{-1} 3404, 3050, 2982, 2970, 2929, 1699, 1670, 1623, 1602, 1523, 1462, 1448, 1372, 1321, 1303, 1285, 1260, 1230, 1186, 1159, 1115, 1070, 1045, 1018, 975, 933, 909, 887, 842, 813, 791, 761, 731, 704.

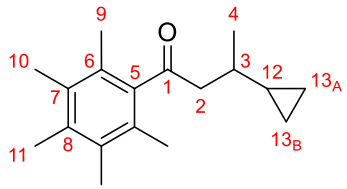
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.69 (2H, d, J = 8.8 Hz, 2 × C6), 8.40 (1H, s, C8H), 8.07 – 7.94 (2H, m, 2 × C3H), 7.50 (2H, ddd, J = 8.9, 6.5, 1.7 Hz, 2 × C5H), 7.46 (2H, ddd, J = 7.8, 6.5, 1.3 Hz, 2 × C4H), 6.50 (1H, q, J = 6.8 Hz, C1H), 2.23 (1H, s, OH), 1.94 (3H, d, J = 6.8 Hz, $C2H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 135.9 (C7), 131.9 (2C, 2 × C10), 129.5 (2C, 2 × C3H), 128.9 (2C, 2 × C9), 128.1 (C8H), 125.7 (2C, 2 × C5H), 124.93 (2C, 2 × C4H), 124.91 (2C, br. s, 2 × C3H), 67.5 (C1H), 23.7 ($C2H_3$).

HRMS (EI) Found $[M]^+$ = 222.1036; $C_{16}H_{14}O$ requires 222.1039, Δ –1.35 ppm.

The spectroscopic data are identical to those reported in literature.[20]

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (196)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropylethan-1-ol (103 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded a colourless solid (126 mg) containing a 1:2.3 mixture of ketones **196** (0.148 mmol, 25%) and *trans*-**176** (0.338 mmol, 56%, d.r. > 95:5).

An analytically pure sample was prepared by preparative TLC (Pentane:Et_2O, 95:5) to give ketone **196** as a colourless solid. Pure samples may also be readily obtained by performing **General Procedure F** in the absence of catalyst followed by identical purification conditions.

m.p. = 48 – 50 °C.

IR (film) ν_{max}/cm^{-1} 3075, 2994, 2981, 2953, 2925, 2873, 1700, 1575, 1457, 1427, 1401, 1383, 1350, 1313, 1270, 1129, 1096, 1070, 1045, 1015, 985, 952, 934, 892, 871, 821, 794, 688.

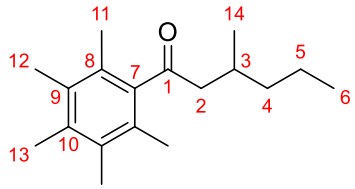
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.88 (1H, dd, J = 19.0, 4.1 Hz, C2H_AH$_B$), 2.65 (1H, dd, J = 19.0, 8.4 Hz, C2H$_A$$H_B$), 2.23 (3H, s, C11H$_3$), 2.19 (6H, s, 2 × C10H$_3$), 2.12 (6H, s, 2 × C9H$_3$), 1.48 (1H, tqd, J = 8.7, 6.8, 4.2 Hz, C3H), 1.13 (3H, d, J = 6.7 Hz, C4H$_3$), 0.64 (1H, dtt, J = 9.6, 8.0, 5.0 Hz, C12H), 0.50 – 0.41 (1H, m, C13$_A$$H_{cis}H_{trans}$), 0.44 – 0.36 (1H, m, C13$_B$$H_{cis}H_{trans}$), 0.23 – 0.11 (2H, m, C13$_A$H$_{cis}$$H_{trans}$ and C13$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.3 (C1=O), 141.0 (C5), 135.4 (C8), 133.2 (2C, 2 × C7), 127.4 (2C, 2 × C6), 53.1 ($C2H_2$), 33.5 (C3H), 20.1 ($C4H_3$), 18.2 (C12H), 17.1 (2C, 2 × $C9H_3$), 16.8 ($C11H_3$), 16.1 (2C, 2 × $C10H_3$), 4.3 ($C13_BH_2$), 4.1 ($C13_AH_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 259.20560; $C_{18}H_{27}O$ requires 259.20564, Δ –0.17 ppm.

Note: *cis* and *trans* with respect to C12H.

3-Methyl-1-(2,3,4,5,6-pentamethylphenyl)hexan-1-one (197)[6]



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Rh(COD)Cl]_2$ (5.92 mg, 12.0 μmol, 2 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 1-cyclopropylethan-1-ol (103 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **197** (58.1 mg, 0.223 mmol, 37%) as a colourless solid.

m.p. = 20 – 22 °C.

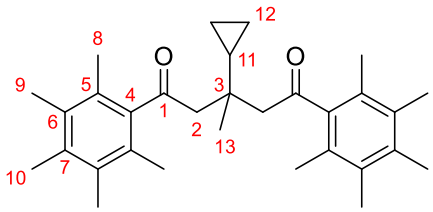
IR (film) ν_{max}/cm^{-1} 2956, 2927, 2872, 1699, 1575, 1456, 1400, 1380, 1357, 1311, 1267, 1143, 1097, 1069, 1018, 998, 930, 889, 870, 795, 741, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.68 (1H, dd, J = 18.8, 4.9 Hz, $C2H_AH_B$), 2.52 (1H, dd, J = 18.8, 7.9 Hz, $C2H_AH_B$), 2.24 (3H, s, $C13H_3$), 2.25 – 2.15 (1H, m, C3H), 2.19 (6H, s, 2 × $C12H_3$), 2.11 (6H, s, 2 × $C11H_3$), 1.42 – 1.30 (3H, m, $C4H_AH_B$ and $C5H_2$), 1.24 – 1.18 (1H, m, $C4H_AH_B$), 1.03 (3H, d, J = 6.6 Hz, $C14H_3$), 0.92 (3H, t, J = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.5 (C1=O), 141.0 (C7), 135.4 (C10), 133.2 (2C, 2 × C9), 127.4 (2C, 2 × C8), 53.1 ($C2H_2$), 39.2 ($C4H_2$), 27.8 (C3H), 20.20 ($C5H_2$), 20.12 ($C14H_3$), 17.2 (2C, 2 × $C11H_3$), 16.8 ($C13H_3$), 16.1 (2C, 2 × $C12H_3$), 14.4 ($C14H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 261.22122; $C_{18}H_{29}O$ requires 261.22129, Δ –0.27 ppm.

3-Cyclopropyl-3-methyl-1,5-bis(2,3,4,5,6-pentamethylphenyl)pentane-1,5-dione (199)



In the optimisation process for the synthesis of ketone **176**, dione **199** (typically <5 mg, c.a. 11 μmol, approx. 2%) has also isolated as a colourless solid.

m.p. = 226 – 229 °C.

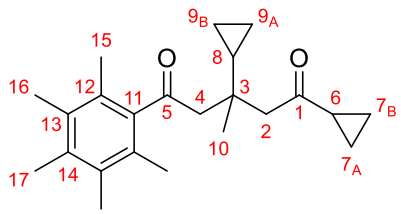
IR (film) ν_{max}/cm^{-1} 3079, 2999, 2924, 2901, 1699, 1575, 1458, 1384, 1365, 1345, 1301, 1251, 1229, 1197, 1173, 1106, 1070, 1046, 1017, 1002, 933, 910, 884, 845, 831, 804, 732, 703.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.38 (4H, q_{AB}, J_{AB} = 20.0 Hz, Δ_{AB} = 45.2 Hz, 2 × $C2H_2$), 2.24 (6H, s, 2 × $C10H_3$), 2.19 (12H, s, 4 × $C9H_3$), 2.17 (12H, s, 4 × $C8H_3$), 1.40 (1H, quint., J = 7.1 Hz, C11H), 0.84 (3H, s, $C13H_3$), 0.32 (4H, d, J = 7.2 Hz, 2 × $C12H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.2 (2C, 2 × C1=O), 141.0 (2C, 2 × C4), 135.3 (2C, 2 × C7), 133.1 (4C, 4 × C6), 127.6 (4C, 4 × C5), 53.3 (2C, 2 × $C2H_2$), 33.9 (C3), 20.32 (C11H), 20.23 ($C13H_3$), 17.0 (4C, 4 × $C8H_3$), 16.8 (2C, 2 × $C10H_3$), 16.1 (4C, 4 × $C9H_3$), 0.5 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 447.32559; $C_{31}H_{43}O_2$ requires 447.32576, Δ –0.37 ppm.

1,3-Dicyclopropyl-3-methyl-5-(2,3,4,5,6-pentamethylphenyl)pentane-1,5-dione (200)



In the optimisation process for the synthesis of ketone **176**, dione **200** (typically <5 mg, c.a. 15 μmol, approx. 2%) has also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3081, 3008, 2922, 1700, 1585, 1457, 1384, 1346, 1302, 1261, 1194, 1169, 1102, 1074, 1018, 918, 893, 803.

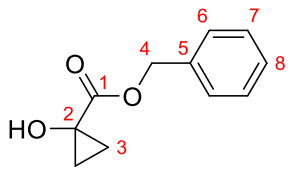
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.16 (2H, q_{AB}, J_{AB} = 16.1 Hz, Δ_{AB} = 40.4 Hz, $C2H_2$), 3.00 (2H, q_{AB}, J_{AB} = 19.8 Hz, Δ_{AB} = 9.7 Hz, $C4H_2$), 2.22 (3H, s, $C17H_3$), 2.17 (6H, s, 2 × $C16H_3$), 2.11 (6H, s, 2 × $C15H_3$), 2.01 (1H, tt, J = 8.0, 4.6 Hz, C6H), 1.33 (1H, tt, J = 8.5, 5.9 Hz, C8H), 1.01 – 0.97 (2H, m, $C7_AH_{cis}H_{trans}$ and $C7_BH_{cis}H_{trans}$), 0.84 (2H, app. dq, J = 6.9, 2.9 Hz, $C7_AH_{cis}H_{trans}$ and $C7_BH_{cis}H_{trans}$), 0.79 (3H, s, $C10H_3$), 0.39 – 0.22 (4H, m, $C9_AH_2$ and $C9_BH_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.5 (C5), 211.2 (C1), 141.0 (C11), 135.3 (C14), 133.1 (2C, 2 × C13), 127.5 (2C, 2 × C12), 53.7 ($C4H_2$), 51.5 ($C2H_2$), 34.4 (C3), 22.1 (C6H), 20.35 ($C10H_3$), 20.19 (C8H), 16.92 (2C, 2 × $C15H_3$), 16.82 ($C17H_3$), 16.1 (2C, 2 × $C16H_3$), 10.99 ($C7_AH_2$), 10.94 ($C7_BH_2$), 0.8 ($C9_AH_2$), 0.5 ($C9_BH_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 341.24753; $C_{23}H_{33}O_2$ requires 341.24751, Δ 0.06 ppm.

Note: *cis* and *trans* with respect to C6H or C8H.

Benzyl 1-hydroxycyclopropane-1-carboxylate (202)[21]



To a solution of carboxylic acid **201** (1.53 g, 15.0 mmol, 1.0 equiv) in anhydrous THF (15 mL, 1 M) was added Et_3N (4.2 mL, 30.0 mmol, 2.0 equiv) and BnBr (2.5 mL, 3.59 mmol, 1.4 equiv) at RT, and stirred for 23 h. The reaction was quenched with sat. aq. NH_4Cl (15 mL), then diluted with H_2O (10 mL) and Et_2O (30 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 20 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography (Pentane:Et_2O, 95:5 → 85:15) afforded α-hydroxyester **202** (2.11 g, 11.0 mmol, 73%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3416 (br.), 3091, 3066, 3034, 3017, 2955, 1722, 1498, 1456, 1383, 1323, 1260, 1215, 1153, 1082, 1059, 1027, 994, 961, 908, 887, 843, 749, 697.

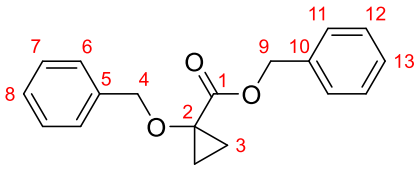
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.34 (3H, m, 2 × C7H and C8H), 7.35 – 7.31 (2H, m, 2 × C6H), 5.18 (2H, s, $C4H_2$), 3.01 (1H, br. s, OH), 1.36 – 1.30 (2H, m, 2 × $C3H_{syn}\mathit{H}_{anti}$), 1.20 – 1.14 (2H, m, 2 × $C3\mathit{H}_{syn}H_{anti}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 174.9 (C1=O), 135.6 (C5), 128.8 (2C, 2 × C7H), 128.6 (C8H), 128.3 (2C, 2 × C6H), 67.3 ($C4H_2$), 55.3 (C2), 16.9 (2C, 2 × $C3H_2$).

HRMS ($APCI^+$) Found $[M+H]^+$ = 191.07118; $C_{11}H_{11}O_3$ requires 191.07137, Δ –0.97 ppm.

Note: *syn* and *anti* with respect to OH.

Benzyl 1-(benzyloxy)cyclopropane-1-carboxylate (203)[22]



Ester **202** (2.11 g, 11.0 mmol, 1.0 equiv), NaH (484 mg, 60% dispersion in mineral oil, 12.1 mmol, 1.1 equiv), tetrabutylammonium iodide (406 mg, 1.50 mmol, 10 mol%), BnBr (1.57 mL, 2.26 g, 13.2 mmol, 1.2 equiv) and DMF (55 mL, 0.2 M) were subjected to **General Procedure G** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1 → 98:2) afforded α-benzyloxyester **203** (1.64 g, 5.80 mmol, 53%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3090, 3065, 3032, 2948, 2872, 1728, 1607, 1587, 1497, 1455, 1408, 1382, 1321, 1274, 1213, 1146, 1082, 1046, 1028, 1003, 967, 944, 912, 848, 826, 786, 735, 696.

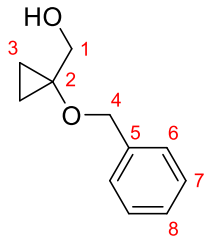
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.40 – 7.36 (4H, m, 2 × C11H and 2 × C12H), 7.39 – 7.31 (1H, m, C13H), 7.34 – 7.29 (4H, m, 2 × C6H and 2 × C7H), 7.32 – 7.24 (1H, m, C8H), 5.22 (2H, s, $C9H_2$), 4.66 (2H, s, $C4H_2$), 1.43 – 1.37 (2H, m, 2 × $C3H_{syn}H_{anti}$), 1.30 – 1.24 (2H, m, $C3H_{syn}H_{anti}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.4 (C1=O), 137.8 (C5), 135.9 (C10), 128.7 (2C, 2 × C12H), 128.48 (2C, 2 × C7H), 128.45 (C13H), 128.33 (2C, 2 × C11H), 128.1 (2C, 2 × C6H), 127.9 (C8H), 72.2 ($C4H_2$), 67.0 ($C9H_2$), 60.8 (C2), 16.9 (2C, 2 × $C3H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 305.11481; $C_{18}H_{18}O_3Na$ requires 305.11482, Δ –0.03 ppm.

Note: *syn* and *anti* with respect to OBn.

(1-(Benzyloxy)cyclopropyl)methanol (204)



Ester **203** (450 mg, 1.59 mmol, 1.0 equiv), DIBAL-H (2.4 mL, 1.0 M in DCM, 2.40 mmol, 1.5 equiv) and DCM (5.3 mL, 0.3 M) were subjected to **General Procedure H**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded alcohol **204** (217 mg, 1.22 mmol, 76%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3396, 3089, 3065, 3031, 3008, 2919, 2869, 1497, 1454, 1418, 1382, 1308, 1286, 1212, 1083, 1040, 1028, 971, 899, 847, 829, 733, 696.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 – 7.30 (4H, m, 2 × C6H and 2 × C7H), 7.32 – 7.25 (1H, m, C8H), 4.61 (2H, s, $C4H_2$), 3.72 (2H, s, 2 × $C1H_2$), 1.84 (1H, s, OH), 1.04 – 0.90 (2H, m, 2 × C3H_{syn}H$_{anti}$), 0.74 – 0.58 (2H, m, 2 × C3H$_{syn}$$H_{anti}$).

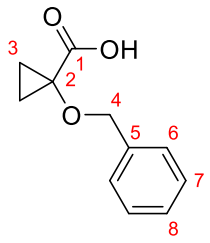
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 138.5 (C5), 128.6 (2C, 2 × C7H), 127.8 (C8H), 127.6 (2C, 2 × C6H), 70.0 ($C4H_2$), 65.7 ($C1H_2$), 63.4 (C2), 11.3 (2C, 2 × $C3H_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 201.08879; $C_{11}H_{14}O_2Na$ requires 201.08860, Δ 0.94 ppm.

Note: *syn* and *anti* with respect to OBn.

The analytical data are identical to those reported in literature. [23]

1-(Benzyloxy)cyclopropane-1-carboxylic acid (207)



To a solution of benzyl ester **203** (1.57 g, 5.57 mmol, 1.0 equiv) in MeOH:H_2O (1:1, 28 mL, 0.2 M) was added LiOH (160 mg, 6.68 mmol, 1.2 equiv), and the reaction stirred at RT for 24 h. The reaction mixture was diluted with brine (80 mL) and DCM (20 mL), and the layers separated. The organic layer was extracted with H_2O (20 mL), and the organic layer discarded. The combined aqueous layers were acidified with 1 M aq. HCl (30 mL), extracted with DCM (3 × 30 mL). and the combined organics dried (Na_2SO_4) and concentrated *in vacuo* to directly afford carboxylic acid **207** (1.02 g, 5.29 mmol, 95%) as a colourless solid.

m.p. = 86 – 88 °C.

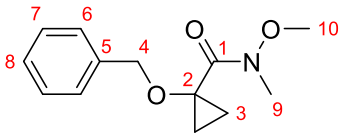
IR (film) ν_{max}/cm^{-1} 3062, 3027, 2932, 2880, 2852, 2714, 2594, 2492, 1702, 1494, 1466, 1441, 1414, 1391, 1304, 1273, 1230, 1189, 1172, 1080, 1066, 1046, 1028, 996, 916, 886, 833, 812, 774, 743, 696, 628.

^{1}H NMR (DMSO-d_6, 500 MHz) δ = 12.69 (1H, s, OH), 7.36 – 7.28 (4H, m, 2 × C6H and 2 × C7H), 7.31 – 7.23 (1H, m, C8H), 4.60 (2H, s, C4H_2), 1.24 – 1.14 (4H, m, 2 × C3H_2).

^{13}C NMR (DMSO-d_6, 126 MHz) δ = 174.4 (C1=O), 138.1 (C5), 128.1 (2C, 2 × C7H), 127.6 (2C, 2 × C6H), 127.4 (C5H), 70.8 (C4H_2), 59.7 (C2), 15.7 (2C, 2 × C3H_2).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 215.06781; $C_{11}H_{12}O_3Na$ requires 215.06787, Δ –0.26 ppm.

1-(Benzyloxy)-*N*-methoxy-*N*-methylcyclopropane-1-carboxamide (208)



Carboxylic acid **207** (1.00 g, 5.20 mmol, 1.0 equiv), CDI (928 mg, 5.72 mmol, 1.1 equiv), *N*,*O*-dimethylhydroxylamine·HCl (558 mg, 7.28 mmol, 1.4 equiv), Et_3N (870 µL, 632 mg, 7.28 mmol, 1.4 equiv) and DCM (13 mL, 0.4 M) were subjected to **General Procedure I**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 70:30) afforded Weinreb amide **208** (1.16 g, 4.93 mmol, 95%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3089, 3064, 3032, 3009, 2971, 2933, 2903, 2868, 2818, 1664, 1497, 1455, 1441, 1419, 1380, 1260, 1172, 1094, 1039, 1028, 944, 917, 901, 845, 816, 778, 738, 699, 609.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 – 7.31 (2H, m, 2 × C7H), 7.32 – 7.25 (3H, m, 2 × C6H and C8H), 4.55 (2H, s, C4H_2), 3.70 (3H, s, C10H_3), 3.38 (3H, s, C9H_3), 1.25 – 1.19 (2H, m, 2 × C3H$_{syn}$*H$_{anti}$*), 1.11 – 1.05 (2H, m, 2 × C3*H$_{syn}$*H$_{anti}$).

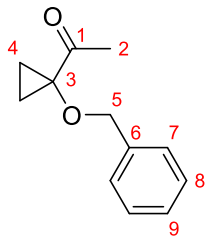
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 169.9 (v. br. s, C1=O), 137.5 (C5), 128.6 (2C, 2 × C7H), 128.01 (2C, 2 × C6H), 128.00 (C8H), 71.9 (C4H_2), 62.8 (C2), 61.1 (C10H_3), 35.5 (br. s, C9H_3), 13.2 (2C, 2 × C3H_2).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 186.3 (N–O).

HRMS (ESI$^+$) Found $[M+H]^+$ = 236.12819; $C_{13}H_{18}NO_3$ requires 236.12812, Δ 0.29 ppm.

Note: *syn* and *anti* with respect to OBn.

1-(1-(Benzyloxy)cyclopropyl)ethan-1-one (209)



Weinreb amide **208** (1.13 g, 4.80 mmol, 1.0 equiv), MeLi (3.0 mL, 1.6 M in Et_2O, 4.80 mmol, 1.0 equiv) and Et_2O (24 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded α-benzyloxyketone **209** (904 mg, 4.75 mmol, 99%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3090, 3065, 3032, 3012, 2919, 2868, 1699, 1497, 1455, 1428, 1406, 1382, 1357, 1311, 1261, 1212, 1135, 1082, 1043, 1028, 979, 937, 912, 875, 855, 824, 736, 698, 680.

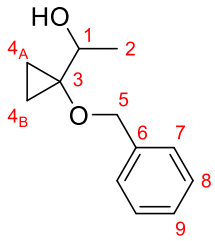
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.40 – 7.32 (4H, m, 2 × C7H and 2 × C8H), 7.34 – 7.27 (1H, m, C9H), 4.59 (2H, s, C5H_2), 2.33 (3H, s, C2H_3), 1.41 – 1.35 (2H, m, 2 × C4$H_{syn}H_{anti}$), 1.31 – 1.25 (2H, m, 2 × C4$H_{syn}$$H_{anti}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.9 (C1=O), 137.4 (CC6), 128.6 (2C, 2 × C8H), 128.0 (C9H), 127.6 (2C, 2 × C7H), 72.3 (C5H_2), 68.8 (C3), 26.3 (C2H_3), 18.1 (2C, 2 × C4H_2).

HRMS (ESI^+) Found $[M+Na]^+$ = 213.08870; $C_{12}H_{14}O_2Na$ requires 213.08860, Δ 0.46 ppm.

Note: *syn* and *anti* with respect to OBn.

1-(1-(Benzyloxy)cyclopropyl)ethan-1-ol (206)



Ketone **209** (904 mg, 4.79 mmol, 1.0 equiv), $NaBH_4$ (362 mg, 9.58 mmol, 2.0 equiv) and MeOH:THF (1:1, 24 mL, 0.2 M) were subjected to **General Procedure K**. Purification by flash column chromatography (Pentane:Et_2O, 60:40 → 40:60) afforded alcohol **206** (890 mg, 4.63 mmol, 98%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3420 (br.), 3089, 3065, 3031, 3008, 2977, 2929, 2872, 1497, 1454, 1417, 1369, 1289, 1219, 1159, 1085, 1053, 1027, 976, 918, 904, 866, 828, 733, 697.

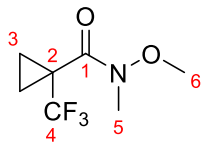
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.37 – 7.30 (2H, m, 2 × C8H), 7.34 – 7.27 (2H, m, 2 × C7H), 7.32 – 7.23 (1H, m, C9H), 4.76 (1H, d, J = 11.5 Hz, C5H_AH$_B$), 4.56 (1H, d, J = 11.5 Hz, C5H$_A$$H_B$), 3.92 (1H, q, J = 6.4 Hz, C1H), 1.94 (1H, br. s, OH), 1.26 (3H, d, J = 6.4 Hz, C2H_3), 0.98 – 0.86 (2H, m, C4$_A$$H_{cis}H_{trans}$ and C4$_B$$H_{cis}H_{trans}$), 0.76 – 0.63 (2H, m, C4$_A$H$_{cis}$$H_{trans}$ and C4$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 138.8 (C6), 128.6 (2C, 2 × C8H), 127.7 (C9H), 127.5 (2C, 2 × C7H), 71.0 (C5H_2), 70.3 (C1H), 66.0 (C3), 19.0 (C2H_3), 10.50 (C4$_A$$H_2$), 10.46 (C4$_B$$H_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 215.10423; $C_{12}H_{16}O_2Na$ requires 215.10425, Δ –0.08 ppm.

Note: *syn* and *anti* with respect to OBn.

***N*-Methoxy-*N*-methyl-1-(trifluoromethyl)cyclopropane-1-carboxamide (211)**



Carboxylic acid **210** (1.54 g, 10.0 mmol, 1.0 equiv), CDI (2.19 g, 13.5 mmol, 1.35 equiv), *N*,*O*-dimethylhydroxylamine·HCl (1.37 g, 14.0 mmol, 1.4 equiv), Et_3N (1.95 mL, 1.42 g, 14.0 mmol, 1.4 equiv) and DCM (25 mL, 0.4 M) were subjected to **General Procedure I**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded Weinreb amide **211** (567 mg, 2.88 mmol, 58%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2981, 2946, 1790, 1659, 1464, 1425, 1384, 1350, 1290, 1133, 1082, 1044, 1005, 947, 899, 822, 781, 734, 701, 634.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.73 (3H, s, C6H_3), 3.27 (3H, s, C5H_3), 1.32 – 1.27 (2H, m, 2 × C3H_{syn}H$_{anti}$), 1.27 – 1.21 (2H, m, 2 × C3H$_{syn}$$H_{anti}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 165.1 (q, $^3J_{CF}$ = 2.4 Hz, C1=O), 125.0 (q, $^1J_{CF}$ = 273.9 Hz, C4F_3), 61.0 (q, $^6J_{CF}$ = 1.1 Hz, C6H_3), 34.2 (C5H_3), 28.1 (q, $^2J_{CF}$ = 34.9 Hz, C2), 10.0 (2C, q, $^3J_{CF}$ = 2.4 Hz, 2 × C3H_2).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 188.3 (N–O).

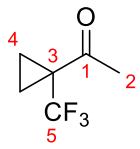
^{19}F NMR ($CDCl_3$, 471 MHz) δ = –66.2 (3F, s, C4F_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 198.07368; $C_7H_{11}F_3NO_2$ requires 198.07364, Δ 0.23 ppm.

Note: *syn* and *anti* with respect to C4F_3.

The analytical data are identical to those reported in literature. [24]

1-(1-(Trifluoromethyl)cyclopropyl)ethan-1-one (212)



Weinreb amide **211** (146 mg, 0.741 mmol, 1.0 equiv), MeLi (475 μL, 1.6 M in Et_2O, 0.740 mmol, 1.0 equiv) and Et_2O (3.7 mL, 0.2 M) were subjected to **General Procedure J**, with the dried organic extracts blown down with a *gentle* stream of Ar over an ice bath until approximately three quarters of the solvent has evaporated. The concentrate was diluted with pentane (15 mL), further blown down with Ar until approximately 5 – 10 mL of solution remained, then passed through a silica plug pre-equilibrated with pentane and eluting with Pentane:Et_2O (9:1, 15 mL). The eluent was then blown down with Ar to afford ketone **212** (57.5 mg, 0.378 mmol, 51%) as a highly volatile colourless oil with a very pleasant and sweet fragrance.

IR (film) ν_{max}/cm^{-1} 2956, 2918, 2850, 1707, 1463, 1376, 1313, 1261, 1232, 1154, 1109, 908, 731.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.41 (3H, q, J = 1.2 Hz, C2H_3), 1.45 – 1.38 (2H, m, 2 × C4$H_{syn}$$H_{anti}$), 1.35 – 1.29 (2H, m, 2 × C4$H_{syn}$$H_{anti}$).

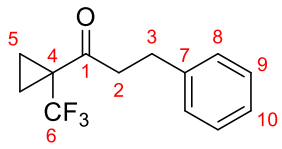
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.0 (C1=O), 125.9 (q, $^1J_{CF}$ = 272.5 Hz, C5F_3), 33.9 (q, $^2J_{CF}$ = 33.1 Hz, C3), 28.7 (q, $^4J_{CF}$ = 2.8 Hz, C2H_3), 15.3 (2C, q, $^3J_{CF}$ = 2.1 Hz, 2 × C4H_2).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –64.9 (3F, s, C5F_3).

HRMS (CH_4 CI^+) Found $[M+H]^+$ = 153.0524; $C_6H_8F_3O$ requires 153.0522, Δ –1.47 ppm.

Note: *syn* and *anti* with respect to C5F_3.

3-Phenyl-1-(1-(trifluoromethyl)cyclopropyl)propan-1-one (213)



Weinreb amide **211** (375 mg, 1.90 mmol, 1.0 equiv), phenethylmagnesium chloride (1.0 M in THF, 1.9 mL, 1.90 mmol, 1.0 equiv) and THF (10 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **213** (166 mg, 0.683 mmol, 36%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3064, 3029, 2929, 2858, 1704, 1604, 1496, 1454, 1412, 1373, 1308, 1288, 1183, 1155, 1132, 1067, 1030, 1020, 966, 909, 748, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.33 – 7.27 (2H, m, 2 × C9H), 7.25 – 7.17 (3H, m, 2 × C8H and C10H), 3.07 (2H, t, J = 7.5 Hz, $C2H_2$), 2.92 (2H, t, J = 7.5 Hz, $C3H_2$), 1.44 – 1.37 (2H, m, 2 × $C5H_{syn}H_{anti}$), 1.34 – 1.27 (2H, m, 2 × $C5H_{syn}H_{anti}$).

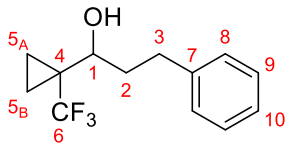
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.1 (C1=O), 140.8 (C7), 128.7 (2C, 2 × C9H), 128.5 (2C, 2 × C8H), 126.4 (C10H), 125.9 (q, $^1J_{CF}$ = 272.7 Hz, $C6F_3$), 42.1 (q, $^4J_{CF}$ = 2.7 Hz, $C2H_2$), 33.7 (q, $^2J_{CF}$ = 33.2 Hz, C4), 29.6 ($C3H_2$), 15.1 (q, $^3J_{CF}$ = 2.1 Hz, 2 × $C5H_2$).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –64.3 (3F, s, $C6F_3$).

HRMS (APCI$^-$) Found $[M\text{-}H]^+$ = 241.08440; $C_{13}H_{12}F_3O$ requires 241.08457, Δ –0.73 ppm.

Note: *syn* and *anti* with respect to $C6F_3$.

3-Phenyl-1-(1-(trifluoromethyl)cyclopropyl)propan-1-ol (214)



Ketone **213** (166 mg, 0.683 mmol, 1.0 equiv), $NaBH_4$ (51.7 mg, 1.37 mmol, 2.0 equiv) and MeOH:THF (1:1, 3.4 mL, 0.2 M) were subjected to **General Procedure K**. Purification by flash column chromatography (Pentane:Et_2O, 85:15) afforded alcohol **214** (131 mg, 0.537 mmol, 79%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3420, 3087, 3064, 3028, 2957, 2928, 2864, 1604, 1496, 1455, 1415, 1384, 1359, 1338, 1303, 1272, 1249, 1172, 1126, 1068, 1044, 986, 946, 822, 749, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 – 7.27 (2H, m, 2 × C9H), 7.24 – 7.17 (3H, m, 2 × C8H and C10H), 3.49 (1H, dtq, J = 8.8, 4.1 Hz, $^4J_{HF}$ = 1.0 Hz, C1H), 2.88 (1H, dddq, J = 13.5, 9.6, 5.4 Hz, $^6J_{HF}$ = 0.4 Hz, C3H_AH$_B$), 2.69 (1H, dddq, J = 13.8, 9.4, 7.0 Hz, $^6J_{HF}$ = 0.4 Hz, C3H$_A$$H_B$), 1.96 (1H, ddddq, J = 13.8, 10.5, 7.1, 3.9 Hz, $^5J_{HF}$ = 0.5 Hz, C2H_AH$_B$), 1.89 (1H, dtdq, J = 13.9, 9.5, 5.4 Hz, $^5J_{HF}$ = 1.1 Hz, C2H$_A$$H_B$), 1.73 (1H, br. d, J = 5.4 Hz, OH), 1.04 (1H, ddd, J = 9.7, 6.1, 4.7 Hz, C5$_A$$H_{syn}H_{anti}$), 0.97 (1H, ddd, J = 10.2, 6.0, 4.7 Hz, C5$_B$$H_{syn}H_{anti}$), 0.80 (1H, dddq, J = 9.2, 6.1, 4.7 Hz, $^4J_{HF}$ = 1.6 Hz, C5$_A$H$_{syn}$$H_{anti}$), 0.73 (1H, dddq, J = 9.4, 6.3, 4.6 Hz, $^4J_{HF}$ = 1.5 Hz, C5$_B$H$_{syn}$$H_{anti}$).

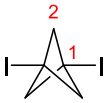
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 141.6 (C7), 128.63 (2C, 2 × C9H), 128.57 (2C, 2 × C8H), 127.3 (q, $^1J_{CF}$ = 274.8 Hz, C6F_3), 126.2 (C10H), 72.2 (q, $^3J_{CF}$ = 0.7 Hz, C1H), 36.2 (q, $^4J_{CF}$ = 1.1 Hz, C2H_2), 32.6 (C3H_2), 27.7 (q, $^2J_{CF}$ = 30.0 Hz, C4), 8.0 (q, $^3J_{CF}$ = 2.8 Hz, C5$_A$$H_2$), 7.2 (q, $^3J_{CF}$ = 2.5 Hz, C5$_B$$H_2$).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –66.3 (3F, s, C6F_3).

HRMS (NH_3 CI^+) Found $[M+NH_4]^+$ = 262.1417; $C_{13}H_{19}F_3O$ requires 262.1413, Δ –1.54 ppm.

Note: *syn* and *anti* with respect to C6F_3.

1,3-Diiodobicyclo[1.1.1]pentane (218)[25]



A solution of cyclopropane **215** (5.94 g, 20.0 mmol, 1.0 equiv) in anhydrous Et_2O (20 mL, 1 M) was cooled to –40 °C, then MeLi·LiBr (20 mL, 2.2 M in Et_2O, 44.0 mmol, 2.2 equiv) was added dropwise over 20 – 30 min. The reaction was warmed to 0 °C and stirred for 2.5 h, followed by the addition of I_2 (5.58 g, 11.0 mmol, 1.1 equiv). The reaction was then warmed to RT and stirred for 16 h, The reaction mixture was diluted with EtOAc (50 mL) and quenched with sat. aq. Na_2SO_3 (100 mL). The layers were separated, the aqueous layer extracted with EtOAc (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*, ensuring that the H_2O bath temperature does not rise above 40 °C to minimise sublimation of the product. The brown residue was resuspended in a minimum amount of cold EtOAc, and quickly filtered. The residue was rinsed with cold EtOAc (2 × 5 mL), then dried *in vacuo* to give BCP **218** (4.29 g, 13.4 mmol, 67%) as a colourless to off-white solid.

m.p. = >80 °C (rapid decomposition).

IR (film) ν_{max}/cm^{-1} 3015, 2969, 2915, 2878, 1444, 1190, 1140, 1037, 840.

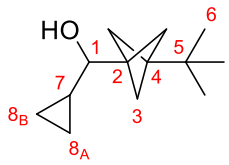
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.68 (6H, s, 3 × C2H_2).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 68.3 (3C, 3 × C2H_2), –1.6 (2C, 2 × C1).

HRMS (EI) Found $[M]^+$ = 319.8564; $C_5H_6I_2$ requires 319.8553, Δ –3.32 ppm.

Note: The HRMS was collected with an ionisation energy of 35 eV. In addition, the filtrate can be further concentrated and the same process repeated to obtain a second and third crop of product. The use of Et_2O for dissolution, evaporation and washing gives a much finer powder and does not adequately wash off the brown impurities. DCM dissolves the product too readily. Evaporation of an EtOAc solution gives large crystalline flakes that are significantly easier to handle and more resistant to excessive dissolution upon washing with cold EtOAc. A long and narrow setup is preferred for filtration to maximise the solvent contact with the residue as the coloured impurities are very soluble in EtOAc.

(3-(*tert*-Butyl)bicyclo[1.1.1]pentan-1-yl)(cyclopropyl)methanol (216)[26]



A solution of BCP **218** (4.29 g, 13.4 mmol, 1.0 equiv) in anhydrous Et_2O (60 mL, 0.22 M) was cooled to –78 °C, then *t*-BuLi (32 mL, 1.66 M in pentane, 53.1 mmol, 4.0 equiv) was carefully added dropwise over 30 min, then stirred at –78 °C for 30 min, followed by the addition of cyclopropanecarboxaldehyde (3.76 g, 53.6 mmol, 4.0 equiv) over 5 min. The reaction mixture was allowed to warm up to RT over 16 h, then quenched with sat. aq. NH_4Cl (15 mL) and diluted with H_2O (15 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1 → 95:5 → 90:10) afforded alcohol **216** (692 mg, 3.56 mmol, 27%) as a colourless solid.

m.p. = 29 – 32 °C.

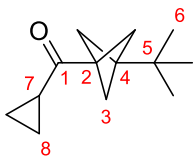
IR (film) ν_{max}/cm^{-1} 3365, 3080, 3006, 2957, 2906, 2867, 1477, 1461, 1448, 1431, 1391, 1361, 1273, 1225, 1195, 1169, 1104, 1063, 1040, 1023, 995, 959, 943, 916, 862, 828, 773, 711.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.83 (1H, d, J = 8.7 Hz, C1H), 1.56 – 1.46 (6H, m, 3 × $C3H_2$), 1.41 (1H, s, OH), 0.84 (9H, s, 3 × $C6H_3$), 0.82 (1H, qt, J = 8.4, 4.9 Hz, C7H), 0.54 – 0.42 (2H, m, $C8_AH_{cis}H_{trans}$ and $C8_BH_{cis}H_{trans}$), 0.30 – 0.22 (1H, m, $C8_BH_{cis}H_{trans}$), 0.20 – 0.12 (1H, m, $C8_AH_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 76.3 (C1H), 47.9 (C4), 44.6 (3C, 3 × $C3H_2$), 39.7 (C2), 29.6 (C5), 26.0 (3C, 3 × $C6H_3$), 14.8 (C7H), 2.3 ($C8_AH_2$), 1.9 ($C8_BH_2$).

Note: *cis* and *trans* with respect to C7H.

(3-(*tert*-Butyl)bicyclo[1.1.1]pentan-1-yl)(cyclopropyl)methanone (219)



In the preparation of alcohol **216**, ketone **219** (473 mg, 2.46 mmol, 18%) was also isolated as a colourless solid.

m.p. = 66 – 68 °C.

IR (film) ν_{max}/cm^{-1} 3012, 2966, 2908, 2870, 1681, 1505, 1470, 1461, 1443, 1412, 1390, 1365, 1272, 1224, 1201, 1146, 1122, 1092, 1083, 1063, 1035, 963, 934, 902, 883, 804, 735, 709.

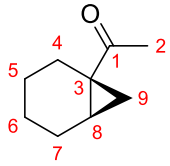
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.08 (1H, tt, J = 7.9, 4.6 Hz, C7H), 1.85 (6H, s, 3 × $C3H_2$), 1.04 – 0.97 (2H, m, 2 × $C8H_{cis}H_{trans}$), 0.86 (2H, dq, J = 6.9, 3.6 Hz, 2 × $C8H_{cis}H_{trans}$), 0.86 (9H, s, 3 × $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.4 (C1=O), 47.89 (C4), 47.80 (3C, 3 × $C3H_2$), 42.2 (C2), 29.5 (C5), 25.9 (3C, 3 × $C6H_3$), 17.2 (C7H), 11.2 (2C, 2 × $C8H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 193.15895; $C_{13}H_{21}O$ requires 193.15869, Δ 1.34 ppm.

Note: *cis* and *trans* with respect to C7H.

1-(Bicyclo[4.1.0]heptan-1-yl)ethan-1-one (220)[27]



1-Acetyl-1-cyclohexene (1.86 g, 15.0 mmol, 1.0 equiv), NaH (720 mg, 60% dispersion in mineral oil, 18.0 mmol, 1.2 equiv), trimethylsulfoxonium iodide (3.96 g, 18.0 mmol, 1.2 equiv) and anhydrous DMSO (30 mL, 0.5 M) were subjected to **General Procedure L**. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1 → 98:2) afforded ketone **220** (1.80 g, 13.0 mmol, 43%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3073, 3000, 2930, 2860, 1681, 1451, 1427, 1384, 1352, 1303, 1292, 1274, 1251, 1239, 1165, 1149, 1130, 1113, 1071, 1030, 977, 938, 925, 902, 833, 799, 748, 662.

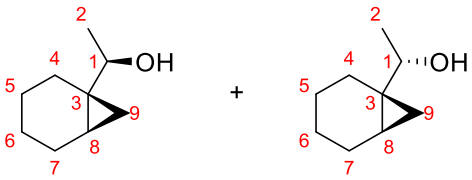
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.49 (1H, dt, J = 13.4, 6.4 Hz, C4$H_{cis}H_{trans}$), 2.04 (3H, s, $C2H_3$), 1.90 (1H, td, J = 13.3, 7.2 Hz, C7$H_{cis}H_{trans}$), 1.76 – 1.69 (1H, m, C7$H_{cis}H_{trans}$), 1.69 – 1.63 (1H, m, C4$H_{cis}H_{trans}$), 1.60 (1H, dtd, J = 9.6, 6.9, 1.8 Hz, C8H), 1.33 (1H, ddd, J = 9.6, 4.4, 0.8 Hz, C9$H_{cis}H_{trans}$), 1.33 – 1.24 (3H, m, $C5H_2$ and C6$H_{cis}H_{trans}$), 1.24 – 1.15 (1H, m, C6$H_{cis}H_{trans}$), 0.72 (1H, dd, J = 6.9, 4.3 Hz, C9$H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.9 (C1=O), 31.5 (C3), 25.5 ($C2H_3$), 24.5 ($C4H_2$), 23.4 ($C7H_2$), 22.8 (C8H), 21.8 ($C9H_2$), 21.4 ($C5H_2$), 20.6 ($C6H_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 139.11176; $C_9H_{15}O$ requires 139.11174, Δ 0.10 ppm.

Note: *cis* and *trans* with respect to C8H. In addition, the product is fairly volatile, and care should be taken when concentrating *in vacuo*.

rel-(*R*)-1-((1*R*,6*R*)-Bicyclo[4.1.0]heptan-1-yl)ethan-1-ol (*rel*-(*R*,*R*,*R*)-221), and *rel*-(*S*)-1-((1*R*,6*R*)-Bicyclo[4.1.0]heptan-1-yl)ethan-1-ol (*rel*-(*S*,*R*,*R*)-221)



Ketone **220** (1.80 g, 13.0 mmol, 1.0 equiv), DIBAL-H (16.3 mL, 1.0 M in DCM, 16.3 mmol, 1.25 equiv) and anhydrous DCM (52 mL) were subjected to **General Procedure H**. Purification by flash column chromatography (Pentane:Et_2O, 50:50) afforded an inseparable mixture of alcohols *rel*-(*R*,*R*,*R*)-**221** and *rel*-(*S*,*R*,*R*)-**221** (1.52 g, 10.7 mmol, 82%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3353 (br.), 3056, 2972, 2926, 2855, 1451, 1403, 1368, 1348, 1327, 1292, 1260, 1219, 1179, 1156, 1108, 1098, 1066, 1024, 1012, 983, 949, 927, 892, 865, 841, 804, 765.

^{1}H NMR ($CDCl_3$, 500 MHz, isomer A) δ = 3.08 (1H, q, J = 6.4 Hz, C1H), 1.96 – 1.87 (1H, m, C4H_{cis}H$_{trans}$), 1.83 – 1.73 (1H, m, C7H_{cis}H$_{trans}$), 1.71 – 1.62 (1H, m, C7H$_{cis}$$H_{trans}$), 1.49 (1H, ddd, J = 13.8, 8.7, 4.9 Hz, C4H$_{cis}$$H_{trans}$), 1.41 (1H, s, OH), 1.33 – 1.19 (2H, m, C5H_AH$_B$ and C6H_{cis}H$_{trans}$), 1.18 (3H, d, J = 6.4 Hz, C2H$_3$), 1.22 – 1.12 (1H, m, C5H$_A$$H_B$), 1.13 – 1.07 (1H, m, C6H$_{cis}$$H_{trans}$), 0.75 (1H, dddd, J = 9.4, 6.8, 5.6, 1.6 Hz, C8H), 0.51 (1H, ddd, J = 9.4, 4.3, 0.8 Hz, C9H_{cis}H$_{trans}$), 0.25 (1H, ddd, J = 5.6, 4.3, 0.5 Hz, C9H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer A) δ = 76.2 (C1H), 24.8 (C3), 23.8 (C4H$_2$), 23.5 (C7H$_2$), 22.19 (C5H$_2$), 21.3 (C6H$_2$), 19.4 (C2H$_3$), 16.5 (C9H$_2$), 15.2 (C8H).

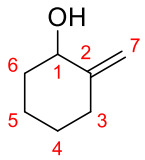
^{1}H NMR ($CDCl_3$, 500 MHz, isomer B) δ = 2.98 (1H, q, *J* = 6.4 Hz, C1H), 1.96 – 1.87 (1H, m, C4H_{cis}H$_{trans}$), 1.83 – 1.73 (1H, m, C7H_{cis}H$_{trans}$), 1.65 – 1.57 (1H, m, C7H$_{cis}$$H_{trans}$), 1.54 (1H, ddd, *J* = 13.4, 6.9, 5.3 Hz, C4H$_{cis}$$H_{trans}$), 1.41 (1H, s, OH), 1.33 – 1.19 (2H, m, C5H_AH$_B$ and C6H_AH$_B$), 1.17 (3H, d, *J* = 6.4 Hz, $C2H_3$), 1.22 – 1.12 (2H, m, C5H$_A$$H_B$ and C6H$_A$$H_B$), 0.82 (1H, dddd, *J* = 9.0, 7.0, 5.5, 1.7 Hz, C8H), 0.40 (1H, ddd, *J* = 9.3, 4.6, 0.8 Hz, C9H_{cis}H$_{trans}$), 0.22 (1H, ddd, *J* = 5.5, 4.5, 0.5 Hz, C9H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer B) δ = 76.7 (C1H), 25.1 (C3), 24.1 ($C7H_2$), 22.7 ($C4H_2$), 22.16 ($C5H_2$), 21.5 ($C6H_2$), 18.7 ($C2H_3$), 17.7 (C8H), 15.0 ($C9H_2$).

HRMS (CH_4 CI^+) Found $[M+H]^+$ = 141.1273; $C_9H_{17}O$ requires 141.1274, Δ –0.65 ppm.

Note: *cis* and *trans* with respect to C8H. In addition, the d.r. is 1.2:1, but it is not possible to distinguish between either isomers.

2-Methylenecyclohexan-1-ol (222)[28,29]



A well-stirred suspension of trimethylsulfonium iodide (20.4 g, 100 mmol, 4.0 equiv) in anhydrous THF (50 mL) was cooled to –10 °C, then *n*-BuLi (61 mL, 1.52 M in hexanes, 92.7 mmol, 3.7 equiv) was carefully added dropwise over 30 min (caution: effervescence and exotherm), then stirred for a further 30 min at the same temperature. A solution of cyclohexene oxide (2.53 mL, 2.45 g, 25.0 mmol, 1.0 equiv) in anhydrous THF (75 mL, final concentration 0.2 M) was added over 5 min, then the reaction was warmed to 0 °C and stirred for 1 h, before warming to RT and stirring for a further 2 h. The reaction mixture was cooled to around –10 to 0 °C, then quenched with sat. aq. NH_4Cl (50 mL) and diluted with H_2O (25 mL) and Et_2O (25 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10 → 85:15) afforded allylic alcohol **222** (900 mg, 8.02 mmol, 32%) as a volatile colourless oil.

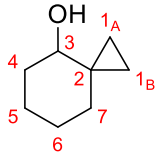
IR (film) ν_{max}/cm^{-1} 3348 (br.), 3089, 2988, 2931, 2857, 1654, 1446, 1397, 1343, 1287, 1245, 1231, 1150, 1120, 1078, 1034, 993, 964, 944, 925, 896, 857, 826.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.88 (1H, q, J = 1.5 Hz, C7H_{syn}H$_{anti}$), 4.75 (1H, quint., J = 1.4 Hz, C7H$_{syn}$$H_{anti}$), 4.09 (1H, dd, J = 9.0, 4.4 Hz, C1H), 2.40 (1H, dddt, J = 13.5, 5.2, 4.0, 1.2 Hz, C3H$_{cis}$$H_{trans}$), 2.05 – 1.99 (1H, m, C3H_{cis}H$_{trans}$), 1.96 (1H, dddd, J = 10.5, 4.6, 3.1, 1.4 Hz, C6H_{cis}H$_{trans}$), 1.81 (1H, dtdd, J = 12.4, 5.4, 3.9, 1.9 Hz, C5H$_{cis}$$H_{trans}$), 1.68 – 1.60 (2H, m, C4H_{cis}H$_{trans}$ and OH), 1.47 (1H, qt, J = 10.4, 3.4 Hz, C5H_{cis}H$_{trans}$), 1.44 – 1.33 (2H, m, C4H$_{cis}$$H_{trans}$ and C6H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 151.8 (C1), 105.2 ($C2H_2$), 72.8 (C2H), 36.8 ($C6H_2$), 33.6 ($C3H_2$), 27.8 ($C4H_2$), 23.9 ($C5H_2$).

Note: *cis* and *trans*, *syn* and *anti* with respect to C2H. In addition, a stable molecular ion could not be detected by ESI, APCI or EI.

Spiro[2.5]octan-4-ol (223)[30]



A solution of Et_2Zn (32 mL, 1.0 M in hexanes, 32.0 mmol, 4.0 equiv) in anhydrous DCM (40 mL) was cooled to –20 °C, then diiodomethane (5.16 mL, 17.1 g, 64.0 mmol, 8.0 equiv) was *very* carefully added over 15 min, during which time voluminous white precipitates gradually formed, then stirred for a further 10 min at the same temperature. A solution of allylic alcohol **222** (900 mg, 8.02 mmol, 1.0 equiv) in anhydrous DCM (10 mL, final concentration 0.1 M) was *very* carefully added over 30 min while ensuring that the reaction temperature does not rise above –10 °C, then stirred for a further 30 min between –20 to –10 °C. The reaction was then warmed to 0 °C and stirred for another 5 h. The reaction was quenched at 0 °C by the *very* careful dropwise addition of sat. aq. NH_4Cl (50 mL), then diluted with H_2O (50 mL). The layers were separated, the aqueous layer extracted with DCM (4 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10) afforded spirocyclic alcohol **223** (901 mg, 7.14 mmol, 89%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3356 (br.), 3071, 2998, 2926, 2853, 1445, 1427, 1349, 1291, 1268, 1216, 1165, 1149, 1138, 1105, 1074, 1044, 1014, 1002, 981, 932, 923, 899, 882, 860, 840, 802, 722, 686.

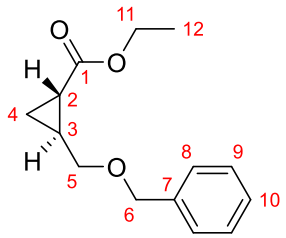
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.19 (1H, br. t, J = 3.8 Hz, C3H), 1.74 (1H, br. t, J = 10.5 Hz, C7H_AH$_B$), 1.71 – 1.68 (1H, m, C5H_AH$_B$), 1.68 – 1.60 (2H, m, C4H$_2$), 1.61 – 1.52 (1H, m, C6H_AH$_B$), 1.52 – 1.45 (1H, m, C5H_AH$_B$), 1.45 – 1.37 (1H, m, C6H_AH$_B$), 1.38 (1H, s, OH), 0.96 (1H, br. dt, J = 13.7, 4.6 Hz, C7H$_A$H$_B$), 0.46 – 0.41 (1H, m, C1$_A$$H_{syn}H_{anti}$), 0.41 – 0.36 (1H, m, C1$_B$$H_{syn}H_{anti}$), 0.28 – 0.24 (1H, m, C1$_A$H$_{syn}$$H_{anti}$), 0.24 – 0.19 (1H, m, C1$_B$H$_{syn}$$H_{anti}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 73.9 (C3H), 32.7 (C4H$_2$), 31.9 (C7H$_2$), 25.1 (C6H$_2$), 23.8 (C2), 21.5 (C5H$_2$), 10.4 (C1$_B$H$_2$), 9.5 (C1$_A$H$_2$).

HRMS (CH_4 CI^+) Found $[M+H]^+$ = 127.1120; $C_8H_{15}O$ requires 127.1117, Δ 2.05 ppm.

Note: *syn* and *anti* with respect to C3H. C1$_A$H$_2$, C1$_B$H$_2$, C3H, C4H$_2$, C5H$_2$ and C7H$_2$ have visibly broader peaks in the ^{13}C NMR spectrum. In addition, care should be taken when preparing the Et_2Zn solution in anhydrous DCM. The flask should be pre-cooled to –20 °C, and white fumes may be emitted when introducing the solution of Et_2Zn into the DCM solution due to the presence of contaminating H_2O.

Ethyl *rel*-(1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropane-1-carboxylate (225)[31]



To a well-stirred two-neck round bottom flask equipped with a water condenser containing a suspension of NaH (2.52 g, 60% dispersion in mineral oil, 63.0 mmol, 2.1 equiv) in toluene (45 mL, 0.67 M) was *very* carefully added triethyl phosphonoacetate (11.9 mL, 13.5 g, 60.0 mmol, 2.0 equiv) dropwise at RT over 30 min (caution: strong effervescence and exotherm), then further stirred for 10 min. To the reaction mixture was added benzyl glycidyl ether **224** (4.93 g, 30.0 mmol, 1.0 equiv) in a single portion, and the reaction mixture was heated to reflux for 14 h. The reaction mixture was cooled to 30 – 40 °C, diluted with Et_2O (100 mL), then carefully quenched with sat. aq. NH_4Cl (50 mL) and further diluted with H_2O (25 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 50 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1 → 97:3) afforded ester **225** (3.55 g, 15.2 mmol, 51%, d.r. > 95:5) as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3088, 3064, 3030, 2981, 2936, 2904, 2859, 1722, 1496, 1454, 1415, 1367, 1320, 1267, 1203, 1179, 1091, 1043, 1028, 935, 908, 888, 860, 738, 698, 608.

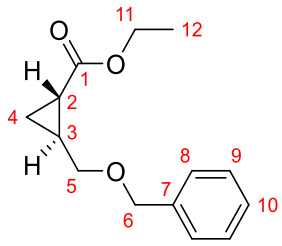
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.30 (4H, m, 2 × C8H and 2 × C9H), 7.32 – 7.25 (1H, m, C10H), 4.53 (2H, s, C6H_2), 4.12 (2H, $q_{AB}q$, J = 7.2 Hz, J_{AB} = 10.8 Hz, Δ_{AB} = 8.3 Hz, C11H_2), 3.44 (1H, dd, J = 10.4, 6.1 Hz, C5H_AH$_B$), 3.37 (1H, dd, J = 10.4, 6.5 Hz, C5H$_A$$H_B$), 1.74 (1H, dqd, J = 8.9, 6.3, 4.0 Hz, C3H), 1.57 (1H, ddd, J = 8.7, 4.9, 4.1 Hz, C2H), 1.26 (3H, t, J = 7.1 Hz, C12H_3), 1.21 (1H, dt, J = 8.9, 4.5 Hz, C4H$_{cis}$$H_{trans}$), 0.86 (1H, ddd, J = 8.4, 6.3, 4.3 Hz, C4H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.9 (C1=O), 138.3 (C7), 128.6 (2C, 2 × C9H), 127.81 (C10H), 127.80 (2C, 2 × C8H), 72.8 ($C6H_2$), 71.7 ($C5H_2$), 60.7 ($C11H_2$), 21.7 (C3H), 18.7 (C2H), 14.4 ($C12H_3$), 13.1 ($C4H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 257.11496; $C_{14}H_{18}O_3Na$ requires 257.11482, Δ 0.56 ppm.

Note: *cis* and *trans* with respect to C2H.

Ethyl (1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropane-1-carboxylate ((*S*,*S*)-225)[31]

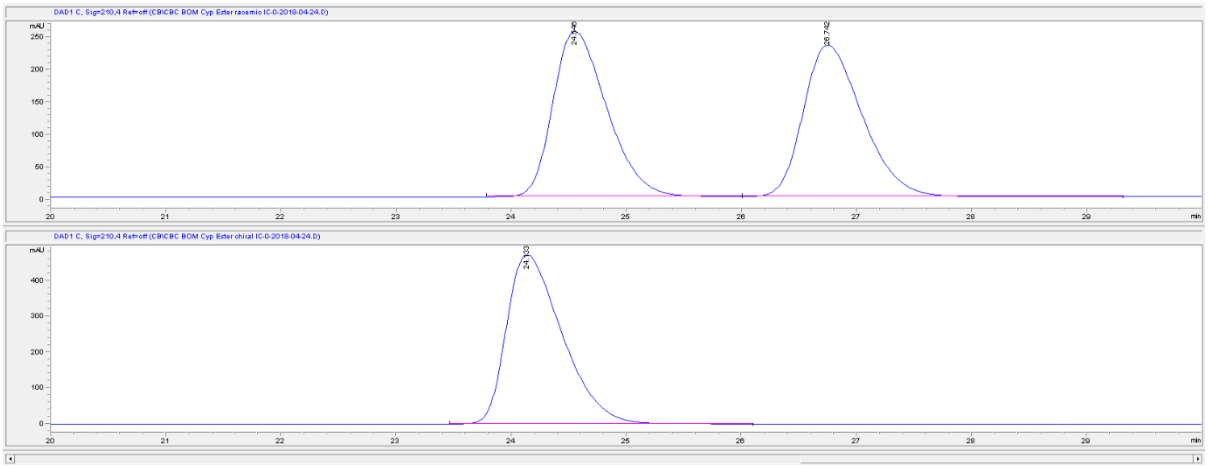


(*S*)-Benzyl glycidyl ether (5.00 g, 30.5 mmol, 1.0 equiv), NaH (2.56 g, 60% dispersion in mineral oil, 64.1 mmol, 2.1 equiv), triethyl phosphonoacetate (12.0 mL, 13.7 g, 60.9 mmol, 2.0 equiv) and toluene (61 mL) were subjected to identical conditions used for the preparation of ester **225**. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1 → 97:3) afforded ester (*S*,*S*)-**225** (2.26 g, 9.66 mmol, 32%, d.r. > 95:5) as a colourless oil. The spectroscopic data were identical to the corresponding racemate.

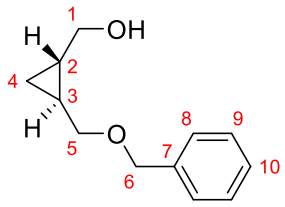
$[\alpha]_D^{25}$ = +73.7 (*c* = 1.0, MeOH). [Lit.: +9.8 (*c* = 1.00, MeOH).][36]

$[\alpha]_D^{25}$ = +34.1 (*c* = 0.44, $CHCl_3$). [Lit.: –77 ((*R*,*R*)-isomer, *c* = 0.44, $CHCl_3$).][32]

Chiral HPLC (Chiralpak® IC with guard column, 99% hexane, 1% isopropanol, 1.0 mL min^{-1}, RT, λ = 210 nm, 10 μL injection) τ_R (*S*,*S*) = 24.5 min, τ_R (*R*,*R*) = 26.7 min; e.e. ≥ 99%.



***rel*-((1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)methanol (*trans*-226)**



Ester **225** (1.17 g, 5.00 mmol, 1.0 equiv), DIBAL-H (12.5 mL, 1.0 M in DCM, 12.5 mmol, 2.5 equiv) and DCM (25 mL, 0.2 M) were subjected to **General Procedure H**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded alcohol *trans*-**226** (950 mg, 4.94 mmol, 99%, d.r. > 95:5) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3392 (br.), 3087, 3065, 3029, 3003, 2918, 2857, 1496, 1454, 1420, 1388, 1363, 1309, 1256, 1236, 1204, 1171, 1091, 1071, 1028, 943, 906, 867, 798, 736, 697, 608.

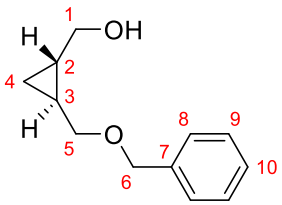
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.31 (4H, m, 2 × C8H and 2 × C9H), 7.33 – 7.25 (1H, m, C10H), 4.53 (2H, s, $C6H_2$), 3.50 (1H, dd, J = 11.2, 6.1 Hz, $C1H_AH_B$), 3.43 (1H, dd, J = 11.4, 6.7 Hz, $C1H_AH_B$), 3.41 (1H, dd, J = 10.2, 6.1 Hz, $C5H_AH_B$), 3.29 (1H, dd, J = 10.2, 6.7 Hz, $C5H_AH_B$), 1.77 (1H, br. dd, J = 9.8, 5.0 Hz, OH), 1.07 – 0.97 (2H, m, C2H and C3H), 0.54 – 0.45 (2H, m, $C4H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 138.5 (C7), 128.5 (2C, 2 × C9H), 127.83 (2C, 2 × C8H), 127.74 (C10H), 73.6 ($C5H_2$), 72.7 ($C6H_2$), 66.5 ($C1H_2$), 19.9 (C2H), 16.9 (C3H), 8.2 ($C4H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 215.10408; $C_{12}H_{16}O_2Na$ requires 215.10425, Δ –0.79 ppm.

The analytical data are identical to those reported in literature.[33]

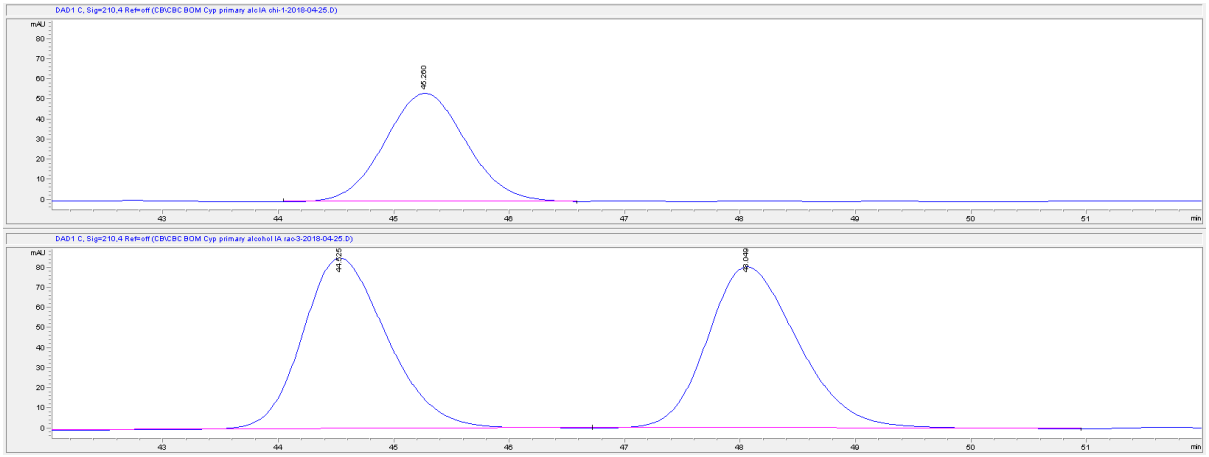
((1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)methanol ((*S*,*S*)-226)



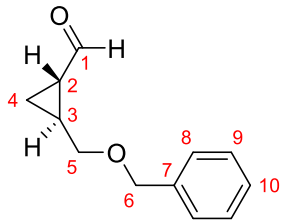
(*S*,*S*)-**225** (1.17 g, 5.00 mmol, 1.0 equiv), DIBAL-H (12.5 mL, 1.0 M in DCM, 12.5 mmol, 2.5 equiv) and DCM (25 mL, 0.2 M) were subjected to **General Procedure H**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded alcohol (*S*,*S*)-**226** (909 mg, 4.73 mmol, 95%, d.r. > 95:5) as a colourless oil. The spectroscopic data were identical to those from the corresponding racemate.

$[\alpha]_D^{25}$ = +11.8 (*c* = 1.00, $CHCl_3$). [Lit.: +10.56 (*c* = 0.44, $CHCl_3$).][34]

Chiral HPLC (Chiralpak® IA with guard column, 99% hexane, 1% isopropanol, 1.0 mL min^{-1}, RT, λ = 210 nm, 10 μL injection) τ_R (*S*,*S*) = 44.5 min, τ_R (*R*,*R*) = 48.0 min; e.e. ≥ 99%.



***rel*-(1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropane-1-carbaldehyde (*trans*-227)**



Alcohol *trans*-**226** (794 mg, 4.13 mmol, 1.0 equiv), PCC (1.34 g, 6.20 mmol, 1.5 equiv), Celite® (1.34 g, 100 wt% to PCC) and anhydrous DCM (83 mL, 0.05 M) were subjected to **General Procedure M**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded aldehyde *trans*-**227** (711 mg, 3.74 mmol, 91%, d.r. > 95:5) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3088, 3063, 3031, 3008, 2925, 2858, 2730, 1704, 1496, 1454, 1394, 1383, 1359, 1309, 1254, 1202, 1167, 1085, 1028, 955, 910, 874, 856, 739, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 9.11 (1H, d, J = 4.9 Hz, C1H), 7.39 – 7.31 (2H, m, 2 × C9H), 7.35 – 7.31 (2H, m, 2 × C8H), 7.31 – 7.26 (1H, m, C10H), 4.52 (2H, s, $C6H_2$), 3.49 (1H, dd, J = 10.3, 5.4 Hz, $C5H_AH_B$), 3.42 (1H, dd, J = 10.4, 5.9 Hz, $C5H_AH_B$), 1.88 – 1.78 (2H, m, C2H and C3H), 1.33 (1H, dt, J = 8.7, 4.9 Hz, $C4H_{cis}H_{trans}$), 1.08 (1H, ddd, J = 7.8, 6.7, 4.8 Hz, $C4H_{cis}H_{trans}$).

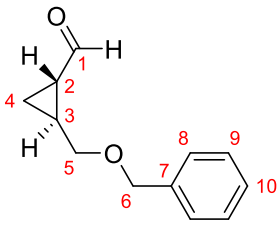
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.5 (C1=O), 138.1 (C7), 128.6 (2C, 2 × C9H), 127.9 (C10H), 127.8 (2C, 2 × C8H), 73.0 ($C6H_2$), 71.1 ($C5H_2$), 28.2 (C2H), 21.7 (C3H), 12.6 ($C4H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 213.08875; $C_{12}H_{14}O_2Na$ requires 213.08860, Δ 0.68 ppm.

Note: *cis* and *trans* with respect to C2H.

The analytical data are identical to those reported in literature.[33]

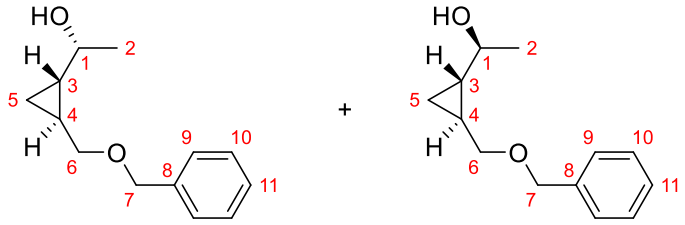
(1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropane-1-carbaldehyde ((*S*,*S*)-227)



Alcohol (*S*,*S*)-**226** (879 mg, 4.57 mmol, 1.0 equiv), PCC (1.48 g, 6.86 mmol, 1.5 equiv), Celite® (1.48 g, 100 wt% to PCC) and DCM (91 mL, 0.05 M) were subjected to **General Procedure M**. The crude material was quickly passed through a silica plug, eluting with DCM, concentrated *in vacuo* to give aldehyde (*S*,*S*)-**227** (680 mg) as a colourless oil that was immediately used for the next reaction. The spectroscopic data were identical to those from the corresponding racemate.

***rel*-(*R*)-1-((1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)ethan-1-ol (*rel*-(*R*)-*trans*-228), and**

***rel*-(*S*)-1-((1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)ethan-1-ol (*rel*-(*S*)-*trans*-228)**



Aldehyde *trans*-**227** (711 mg, 3.74 mmol, 1.0 equiv), MeMgBr (1.35 mL, 3.0 M in Et_2O, 4.05 mmol, 1.2 equiv) and Et_2O (19 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 80:20 → 50:50) afforded an inseparable 1:1 mixture of alcohols *rel*-(*R*,*S*,*S*)-**228** and *rel*-(*S*,*S*,*S*)-**228** (650 mg, 3.15 mmol, 84%, *trans*:*cis* > 95:5) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3397 (br.), 3087, 3065, 3030, 3000, 2968, 2927, 2857, 1496, 1454, 1365, 1306, 1285, 1257, 1203, 1172, 1157, 1419, 1072, 1028, 1001, 965, 921, 895, 849, 806, 736, 697, 609.

^{1}H NMR ($CDCl_3$, 500 MHz, isomer A) δ = 7.37 – 7.32 (4H, m, 2 × C9H and 2 × C10H), 7.32 – 7.27 (1H, m, C11H), 4.53 (2H, s, $C7H_2$), 3.40 (1H, dd, J = 10.1, 6.5 Hz, $C6H_AH_B$), 3.26 (1H, dd, J = 10.1, 7.3 Hz, $C6H_AH_B$), 3.16 (1H, dq, J = 8.0, 6.3 Hz, C1H), 1.76 (1H, v. br. s, OH), 1.25 (3H, d, J = 6.2 Hz, $C2H_3$), 1.09 (1H, ddddd, J = 7.8, 7.2, 6.6, 5.6, 4.3 Hz, C4H), 0.89 – 0.80 (1H, m, C3H), 0.51 – 0.43 (2H, m, $C5H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer A) δ = 138.55 (C8), 128.53 (2C, 2 × C10H), 127.82 (2C, 2 × C9H), 127.73 (C11H), 73.7 ($C6H_2$), 72.73 ($C7H_2$), 71.8 (C1H), 25.74 (C3H), 22.4 ($C2H_3$), 17.1 (C4H), 7.9 ($C5H_2$).

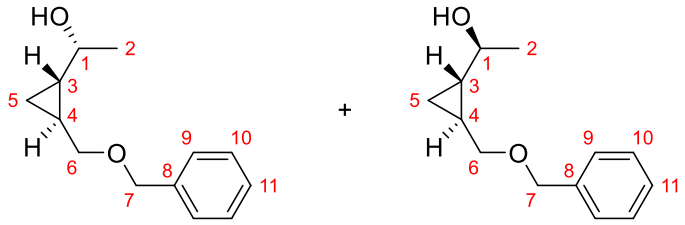
^{1}H NMR ($CDCl_3$, 500 MHz, isomer B) δ = 7.37 – 7.32 (4H, m, 2 × C9H and 2 × C10H), 7.32 – 7.27 (1H, m, C11H), 4.53 (2H, q_{AB}, J_{AB} = 12.2 Hz, Δ_{AB} = 5.0 Hz, $C7H_2$), 3.34 (2H, dq_{AB}, J = 6.8 Hz, J_{AB} = 10.3 Hz, Δ_{AB} = 16.1 Hz, $C6H_2$), 3.25 (1H, dq, J = 8.0, 5.8 Hz, C1H), 1.76 (1H, v. br. s, OH), 1.28 (3H, d, J = 6.2 Hz, $C2H_3$), 1.02 (1H, dtdd, J = 8.4, 6.8, 5.1, 4.3 Hz, C4H), 0.89 – 0.80 (1H, m, C3H), 0.59 (1H, dt, J = 8.5, 5.0 Hz, $C5H_{cis}H_{trans}$), 0.51 – 0.43 (1H, m, $C5H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer B) δ = 138.63 (C8), 128.51 (2C, 2 × C10H), 127.71 (2C, 2 × C9H), 127.68 (C11H), 73.5 ($C6H_2$), 72.62 ($C7H_2$), 71.5 (C1H), 25.31 (C3H), 22.7 ($C2H_3$), 16.1 (C4H), 8.7 ($C5H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 229.11983; $C_{13}H_{18}O_2Na$ requires 229.11990, Δ –0.32 ppm.

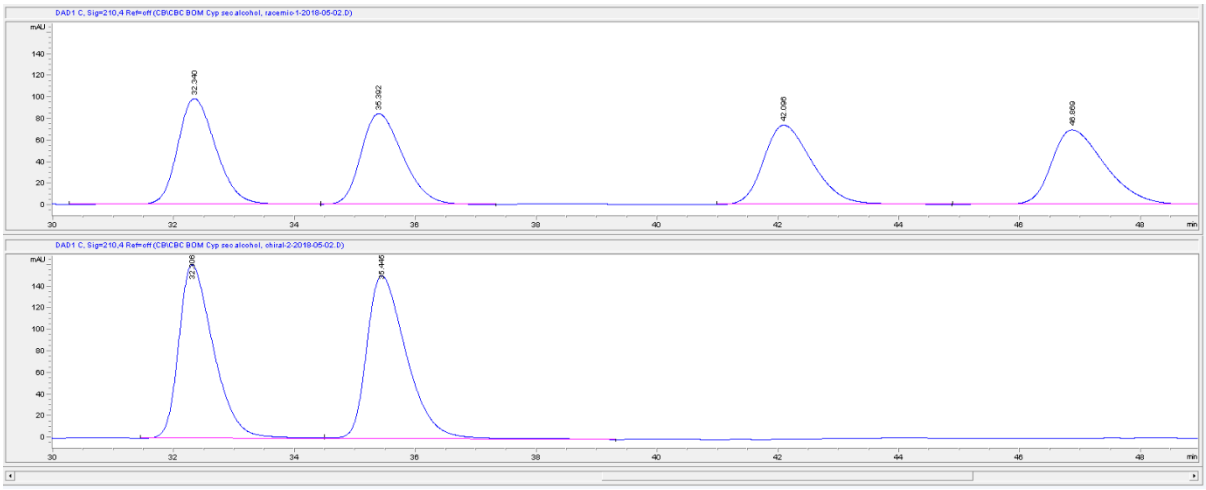
Note: *cis* and *trans* with respect to C3H. In addition, the d.r. is 1:1, but it is not possible to distinguish between either isomers. The analytical data are identical to those reported in literature.[33]

(*R*)-1-((1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)ethan-1-ol ((*R*,*S*,*S*)-228), and (*S*)-1-((1*S*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)ethan-1-ol ((*S*,*S*,*S*)-228)

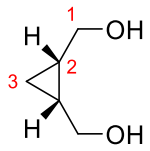


Aldehyde (*S*,*S*)-**227** (680 mg, assumed 3.57 mmol, 1.0 equiv), MeLi (2.4 mL, 1.6 M in Et_2O, 3.84 mmol, 1.1 equiv) and Et_2O (18 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 80:20 → 50:50) afforded an inseparable mixture of alcohols (*R*,*S*,*S*)-**228** and (*S*,*S*,*S*)-**228** (528 mg, 2.56 mmol, 74%, d.r. = 1.1:1, *trans*:*cis* > 95:5) as a colourless oil. The spectroscopic data were identical to those from the corresponding racemate.

Chiral HPLC (Chiralpak® IA with guard column, 99% hexane, 1% isopropanol, 1.0 mL min^{-1}, RT, λ = 210 nm, 10 µL injection) τ_R ((*S*,*S*)-isomer A) = 29.5 min, τ_R ((*S*,*S*)-isomer B) = 32.3 min, τ_R ((*R*,*R*)-isomer A) = 37.3 min, τ_R ((*R*,*R*)-isomer B) = 42.0 min; e.e. (isomer A) ≥ 99%, e.e. (isomer B) ≥ 99%.



***cis*-Cyclopropane-1,2-diyldimethanol (230)[35]**



To a round bottom flask equipped with a water condenser was added $LiAlH_4$ (1.90 g, 50.0 mmol, 2.0 equiv) and THF (100 mL, 0.25 M), and cooled to 0 °C. To the suspension was added anhydride **229** (2.80 g, 25.0 mmol, 1.0 equiv), and the reaction mixture stirred for 10 min. The reaction was then heated to reflux and stirred for 24 h. The reaction mixture was cooled to 0 °C, then quenched by the successive dropwise addition of THF:H_2O (5:1, 12 mL), 15% aq. NaOH (2 mL) and H_2O (6 mL). The mixture was allowed to warm up to RT over 30 min, then $mgSO_4$ (5 – 10 g) was added and the mixture vigorously stirred for a further 30 min. The mixture was filtered under suction through a pad of Celite®, eluting liberally with EtOAc, and concentrated *in vacuo* until most of the solvent had been removed. The concentrate was passed through a silica plug, eluting with EtOAc, and the eluent concentrated *in vacuo* to afford diol **230** (2.55 g, 25.0 mmol, 100%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3316 (br.), 3072, 3004, 2925, 2882, 1673, 1428, 1308, 1249, 1209, 1148, 1014, 932, 828, 770.

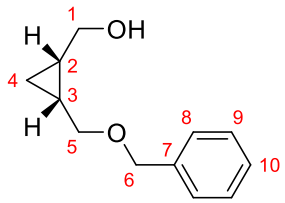
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.13 – 4.06 (2H, m, 2 × C1$H_A$$H_B$), 3.28 – 3.17 (2H, m, 2 × C1$H_A$$H_B$), 3.14 (2H, br. s, OH), 1.32 (2H, ddddd, J = 10.8, 8.8, 8.2, 7.6, 5.3 Hz, 2 × C2H), 0.80 (1H, td, J = 8.2, 5.1 Hz, C3$H_{cis}$$H_{trans}$), 0.21 (1H, q, J = 5.3 Hz, C3$H_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 63.2 (2C, 2 × C1H_2), 17.6 (2C, 2 × C2H), 8.7 (C3H_2).

HRMS (ESI^+) Found $[M+Na]^+$ = 125.05735; $C_5H_{10}O_2Na$ requires 125.05730, Δ 0.39 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-((1*S*,2*R*)-2-((Benzyloxy)methyl)cyclopropyl)methanol (*cis*-226)[36]**



Diol **230** (1.53 g, 15.0 mmol, 1.0 equiv), NaH (660 mg, 60% dispersion in mineral oil, 16.5 mmol, 1.1 equiv), tetrabutylammonium iodide (554 mg, 1.50 mmol, 10 mol%), BnBr (2.14 mL, 3.08 g, 18.0 mmol, 1.2 equiv) and THF (75 mL) were subjected to **General Procedure G** for 48 h. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 95:5 → 85:15 → 75:25) afforded alcohol *cis*-**226** (2.21 g, 11.5 mmol, 77%) as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3443 (br.), 3065, 3027, 3006, 2922, 2865, 1496, 1483, 1454, 1420, 1375, 1344, 1311, 1249, 1208, 1160, 1144, 1087, 1068, 1028, 1005, 906, 832, 772, 738, 698, 609.

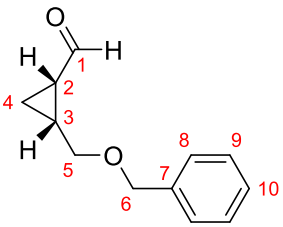
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.31 (4H, m, 2 × C8H and 2 × C9H), 7.33 – 7.26 (1H, m, C10H), 4.55 (2H, q_{AB}, J_{AB} = 11.7 Hz, Δ_{AB} = 31.6 Hz, C6H_2), 3.94 (1H, br. dd, J = 12.3, 5.3 Hz, C1H_AH$_B$), 3.92 (1H, dd, J = 10.5, 5.4 Hz, C5H_AH$_B$), 3.19 (1H, dd, J = 12.1, 10.4 Hz, C1H$_A$$H_B$), 3.16 (1H, t, J = 10.5 Hz, C5H$_A$$H_B$), 3.08 (1H, v. br. s, OH), 1.38 (1H, dtt, J = 10.5, 8.3, 5.3 Hz, C2H), 1.32 (1H, dtt, J = 10.6, 8.3, 5.3 Hz, C3H), 0.81 (1H, td, J = 8.2, 5.1 Hz, C4H_{cis}H$_{trans}$), 0.21 (1H, q, J = 5.3 Hz, C4H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 137.6 (C7), 128.7 (2C, 2 × C9H), 128.09 (2C, 2 × C8H), 128.06 (C10H), 73.2 (C7H_2), 70.9 (C5H_2), 63.2 (C1H_2), 18.6 (C2H), 14.9 (C3H), 8.8 (C4H_2).

HRMS (ESI$^+$) Found [M+Na]$^+$ = 215.10422; $C_{12}H_{16}O_2Na$ requires 215.10425, Δ –0.16 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-(1*S*,2*R*)-2-((Benzyloxy)methyl)cyclopropane-1-carbaldehyde (*cis*-227)**



Alcohol *cis*-**226** (2.21 g, 11.5 mmol, 1.0 equiv), PCC (3.70 g, 17.3 mmol, 1.5 equiv), Celite® (3.70 g, 100 wt% to PCC) and DCM (230 mL, 0.05 M) were subjected to **General Procedure M**. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 80:20) afforded aldehyde *cis*-**227** (1.81 g, 9.51 mmol, 83%) as a yellow oil.

IR (film) ν_{max}/cm^{-1} 3087, 3063, 3030, 2859, 2766, 1698, 1496, 1454, 1398, 1377, 1346, 1319, 1256, 1206, 1173, 1076, 1027, 988, 959, 916, 859, 839, 738, 698, 609.

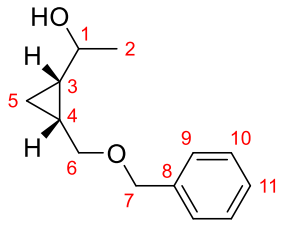
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 9.46 (1H, d, J = 4.6 Hz, C1H), 7.38 – 7.31 (2H, m, 2 × C9H), 7.33 – 7.25 (3H, m, 2 × C8H and C10H), 4.47 (2H, q_{AB}, J_{AB} = 11.8 Hz, Δ_{AB} = 13.7 Hz, $C6H_2$), 3.82 (1H, dd, J = 10.4, 5.7 Hz, C5H_AH$_B$), 3.42 (1H, dd, J = 10.4, 8.7 Hz, C5H$_A$$H_B$), 2.05 (1H, dddd, J = 8.6, 7.7, 5.5, 4.6 Hz, C2H), 1.86 (1H, qdd, J = 8.7, 7.0, 5.8, C3H), 1.33 (1H, dt, J = 6.8, 5.2 Hz, C4H$_{cis}$$H_{trans}$), 1.25 (1H, dd, J = 8.3, 7.7, 4.9 Hz, C4H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.7 (C1=O), 138.0 (C7), 128.6 (2C, 2 × C9H), 127.96 (2C, 2 × C8H), 127.90 (C10H), 73.1 ($C6H_2$), 68.0 ($C5H_2$), 26.9 (C2H), 23.8 (C3H), 12.6 ($C4H_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 213.08864; $C_{12}H_{14}O_2Na$ requires 213.08860, Δ 0.18 ppm.

Note: *cis* and *trans* with respect to C2H. The analytical data are identical to those reported in literature.[33]

***rel*-1-((1*S*,2*R*)-2-((Benzyloxy)methyl)cyclopropyl)ethan-1-ol (*cis*-228, major)**



Aldehyde *cis*-**227** (1.81 g, 9.51 mmol, 1.0 equiv), MeMgBr (3.8 mL, 3.0 M in Et_2O, 11.4 mmol, 1.2 equiv) and Et_2O (45 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 75:25) afforded alcohol *cis*-**227** (major isomer, 1.41 g, 6.81 mmol, 72%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3485 (br.), 3066, 3029, 2997, 2970, 2927, 2866, 1497, 1477, 1454, 1421, 1369, 1338, 1291, 1253, 1207, 1176, 1160, 1106, 1086, 1068, 1027, 1007, 952, 922, 907, 890, 806, 737, 698, 609.

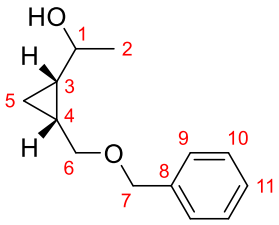
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.31 (4H, m, 2 × C9H and 2 × C10H), 7.34 – 7.26 (1H, m, C11H), 4.55 (2H, q_{AB}, J_{AB} = 11.6 Hz, Δ_{AB} = 21.2 Hz, $C7H_2$), 3.97 (1H, dd, *J* = 10.4, 5.5 Hz, C6H_AH$_B$), 3.77 (1H, s, OH), 3.35 (1H, dq, *J* = 9.8, 6.2 Hz, C1H), 3.17 (1H, dd, *J* = 11.1, 10.4 Hz, C6H$_A$$H_B$), 1.31 (3H, d, *J* = 6.2 Hz, $C2H_3$), 1.31 (1H, dtt, *J* = 11.1, 8.3, 5.3 Hz, C4H), 1.10 (1H, dtd, *J* = 9.9, 8.3, 5.6 Hz, C3H), 0.80 (1H, td, *J* = 8.3, 5.0 Hz, C5H_{cis}H$_{trans}$), 0.19 (1H, q, *J* = 5.3 Hz, C5H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 137.5 (C8), 128.7 (2C, 2 × C10H), 128.05 (2C, 2 × C9H), 128.04 (C11H), 73.3 ($C7H_2$), 71.5 ($C6H_2$), 68.8 (C1H), 24.8 (C3H), 22.0 ($C2H_3$), 15.2 (C4H), 8.9 ($C5H_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 229.11975; $C_{13}H_{18}O_2Na$ requires 229.11990, Δ –0.65 ppm.

Note: *cis* and *trans* with respect to C3H. In addition, the stereochemistry about C1H is not determined. This is the less polar diastereomer of *cis*-**228**. The combined yield is 87% (d.r. = 4.7:1). The analytical data are identical to those reported in literature.[33]

***rel*-1-((1*S*,2*R*)-2-((Benzyloxy)methyl)cyclopropyl)ethan-1-ol (*cis*-228, minor)**



In the preparation of alcohol *cis*-**228** (major isomer), alcohol *cis*-**228** (minor isomer, 299 mg, 1.45 mmol, 15%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3398 (br.), 3066, 3029, 2998, 2967, 2928, 2860, 1496, 1476, 1454, 1410, 1373, 1339, 1305, 1279, 1256, 1206, 1166, 1075, 1028, 1006, 957, 911, 895, 857, 817, 738, 698.

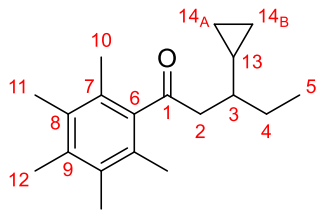
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 – 7.29 (4H, m, 2 × C9H and 2 × C10H), 7.32 – 7.25 (1H, m, C11H), 4.51 (2H, q_{AB}, J_{AB} = 11.9 Hz, Δ_{AB} = 35.6 Hz, $C7H_2$), 3.62 (1H, dd, J = 10.2, 6.5 Hz, C6H_AH$_B$), 3.45 (1H, dq, J = 9.1, 6.1 Hz, C1H), 3.36 (1H, dd, J = 10.2, 8.4 Hz, C6H$_A$$H_B$), 1.65 (1H, s, OH), 1.34 (3H, d, J = 6.2 Hz, $C2H_3$), 1.30 (1H, qdd, J = 8.5, 6.6, 5.7 Hz, C4H), 1.04 (1H, tdd, J = 9.0, 8.2, 5.8 Hz, C3H), 0.81 (1H, td, J = 8.3, 4.8 Hz, C5H_{cis}H$_{trans}$), 0.32 (1H, td, J = 5.7, 4.9 Hz, C5H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 138.2 (C8), 128.5 (2C, 2 × C10H), 127.93 (2C, 2 × C9H), 127.81 (C11H), 73.0 ($C7H_2$), 70.5 ($C6H_2$), 68.7 (C1H), 24.4 (C3H), 23.8 ($C2H_3$), 16.1 (C4H), 8.4 ($C5H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 229.11993; $C_{13}H_{18}O_2Na$ requires 229.11990, Δ 0.14 ppm.

Note: *cis* and *trans* with respect to C3H. In addition, the stereochemistry about C1H is not determined. This is the more polar diastereomer of *cis*-**228**. The combined yield is 87% (d.r. = 4.7:1). The analytical data are identical to those reported in literature.[33]

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)pentan-1-one (231)



In the preparation of ketone **232** at 105 °C, ketone **231** (12.3 mg, 45.1 μmol, 7.5%) was also isolated as a colourless solid.

m.p. = 34 – 37 °C.

IR (film) ν_{max}/cm^{-1} 3075, 2997, 2958, 2925, 2875, 1701, 1576, 1461, 1400, 1381, 1353, 1340, 1304, 1270, 1172, 1131, 1116, 1101, 1070, 1046, 1016, 962, 936, 911, 865, 820, 793, 744, 715, 690.

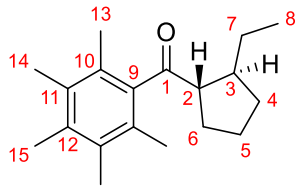
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.83 (1H, dd, J = 19.4, 4.9 Hz, C2H_AH$_B$), 2.73 (1H, dd, J = 19.4, 6.9 Hz, C2H$_A$$H_B$), 2.23 (3H, s, C12H$_3$), 2.19 (6H, s, 2 × C11H$_3$), 2.12 (6H, s, 2 × C10H$_3$), 1.66 (1H, dqd, J = 13.2, 7.6, 5.7 Hz, C4H_AH$_B$), 1.51 (1H, dquint., J = 13.5, 7.3 Hz, C4H$_A$$H_B$), 1.35 (1H, dddd, J = 12.2, 10.2, 7.0, 5.2 Hz, C3H), 1.00 (3H, t, J = 7.5 Hz, C5H$_3$), 0.63 (1H, dtt, J = 9.8, 8.1, 5.0 Hz, C13H), 0.52 (1H, dddd, J = 9.3, 8.2, 5.5, 4.1 Hz, C14$_A$$H_{cis}H_{trans}$), 0.38 (1H, dddd, J = 9.3, 8.1, 5.4, 4.0 Hz, C14$_B$$H_{cis}H_{trans}$), 0.24 (1H, dtd, J = 9.2, 5.2, 4.3 Hz, C14$_A$H$_{cis}$$H_{trans}$), 0.17 (1H, dtd, J = 9.2, 5.3, 4.1 Hz, C14$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.3 (C1=O), 141.0 (C6), 135.3 (C9), 133.2 (2C, 2 × C8), 127.4 (2C, 2 × C7), 51.0 (C2H$_2$), 39.5 (C3H), 28.0 (C4H$_2$), 17.1 (2C, 2 × C10H$_3$), 16.8 (C12H$_3$), 16.3 (C13H), 16.1 (2C, 2 × C11H$_3$), 11.6 (C5H$_3$), 5.4 (C14$_A$H$_2$), 3.4 (C14$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 273.22131; $C_{19}H_{29}O$ requires 273.22129, Δ 0.08 ppm.

Note: *cis* and *trans* with respect to C13H.

***rel*-((1*S*,2*S*)-2-Ethylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (232)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropylpropan-1-ol* (120 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **232** (80.9 mg, 0.297 mmol, 50%) as a colourless solid.

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a pale yellow oil containing a 1:8.3 mixture of ketones **231** (47.9 μmol, 8.0%) and **232** (0.399 mmol, 67%).

m.p. = 52 – 54 °C.

IR (film) ν_{max}/cm^{-1} 2956, 2928, 2872, 1738, 1688, 1573, 1457, 1381, 1341, 1303, 1260, 1169, 1120, 1093, 1069, 1021, 998, 953, 914, 891, 836, 701.

* The material was provided by Dr. James Frost.

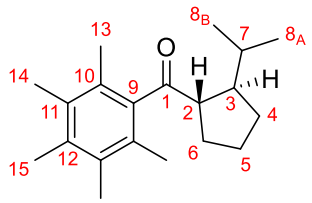
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.87 (1H, dt, J = 8.6, 7.1 Hz, C2H), 2.24 (1H, dqd, J = 9.4, 7.4, 4.6 Hz, C3H), 2.23 (3H, s, $C15H_3$), 2.18 (6H, s, 2 × $C14H_3$), 2.11 (6H, s, 2 × $C13H_3$), 1.95 (1H, dtd, J = 12.5, 7.6, 5.8 Hz, $C4H_{cis}H_{trans}$), 1.92 (1H, dq, J = 12.3, 7.2 Hz, $C6H_{cis}H_{trans}$), 1.81 (1H, dddd, J = 12.5, 8.7, 7.5, 6.4 Hz, $C6H_{cis}H_{trans}$), 1.67 (1H, dqd, J = 12.6, 7.5, 6.3 Hz, $C5H_{cis}H_{trans}$), 1.61 (1H, dtd, J = 12.6, 7.7, 6.4 Hz, $C5H_{cis}H_{trans}$), 1.52 (1H, dqd, J = 13.2, 7.5, 4.7 Hz, $C7H_AH_B$), 1.28 (1H, dq, J = 12.5, 7.6 Hz, $C4H_{cis}H_{trans}$), 1.17 (1H, ddq, J = 13.2, 9.4, 7.3 Hz, $C7H_AH_B$), 0.86 (3H, t, J = 7.4 Hz, $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.6 (C1=O), 141.1 (C9), 135.4 (C12), 133.2 (2C, 2 × C11), 128.0 (2C, 2 × C10), 60.1 (C2H), 43.9 (C3H), 32.2 ($C4H_2$), 29.9 ($C6H_2$), 28.8 ($C7H_2$), 25.2 ($C5H_2$), 18.1 (2C, br. s, 2 × $C13H_3$), 16.9 ($C15H_3$), 16.2 (2C, 2 × $C14H_3$), 12.8 ($C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 273.22128; $C_{19}H_{29}O$ requires 273.22129, Δ –0.03 ppm.

Note: *cis* and *trans* with respect to C2H. In addition, the relative stereochemistry of the product was confirmed by single crystal X-ray diffraction. The single crystal was prepared by Dr. James Frost.

***rel*-((1*S*,2*R*)-2-Isopropylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (233)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-2-methylpropan-1-ol* (137 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **233** (10.8 mg, 37.7 μmol, 6.3%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2955, 2931, 2870, 1689, 1644, 1573, 1464, 1451, 1384, 1368, 1304, 1263, 1159, 1118, 1069, 1021, 997, 946, 893, 862, 809, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.01 (1H, dt, J = 8.9, 6.0 Hz, C2H), 2.35 (1H, dddd, J = 8.5, 7.4, 6.2, 5.7 Hz, C3H), 2.23 (3H, s, $C15H_3$), 2.18 (6H, s, 2 × $C14H_3$), 2.11 (6H, s, 2 × $C13H_3$), 1.92 (1H, dq, J = 12.2, 6.1 Hz, $C6H_{cis}H_{trans}$), 1.77 (1H, tdd, J = 12.8, 8.4, 6.8 Hz, $C4H_{cis}H_{trans}$), 1.70 (1H, ddd, J = 12.6, 9.0, 7.4 Hz, $C6H_{cis}H_{trans}$), 1.66 – 1.57 (1H, m, C7H), 1.64 – 1.52 (2H, m, $C5H_2$), 1.40 (1H, dq, J = 12.5, 7.6 Hz, $C4H_{cis}H_{trans}$), 0.86 (3H, d, J = 6.8 Hz, $C8_AH_3$), 0.81 (3H, d, J = 6.7 Hz, $C8_BH_3$).

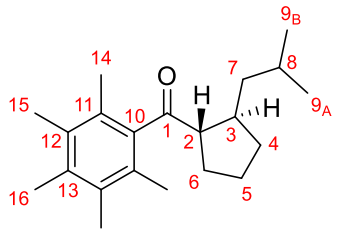
* The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.4 (C1=O), 140.9 (C9), 135.3 (C12), 133.2 (2C, 2 × C11), 128.1 (2C, v. br. s, 2 × C10), 57.3 (C2H), 47.2 (C3H), 31.0 (C7H), 30.3 ($C6H_2$), 28.2 ($C4H_2$), 26.1 ($C5H_2$), 22.1 ($C8_AH_3$), 18.31 ($C8_BH_3$), 18.20 (2C, 2 × $C13H_3$), 16.9 ($C15H_3$), 16.2 (2C, 2 × $C14H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 287.23697; $C_{20}H_{31}O$ requires 287.23694, Δ 0.09 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-((1*S*,2*R*)-2-Isobutylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (234)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-3-methylbutan-1-ol* (154 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **234** (26.3 mg, 87.5 μmol, 15%) as a colourless solid.

When the reaction was repeated at 125 °C, Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **234** (52.4 mg, 0.174 mmol, 29%) as a colourless solid.

* The material was provided by Dr. James Frost.

m.p. = 67 – 70 °C.

IR (film) ν_{max}/cm^{-1} 2952, 2869, 1689, 1574, 1466, 1450, 1383, 1365, 1344, 1306, 1258, 1226, 1169, 1120, 1068, 1019, 997, 941, 919, 850, 833, 733, 701.

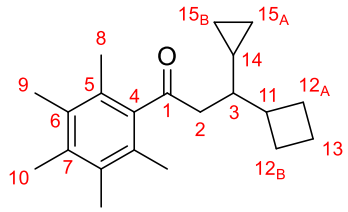
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.82 (1H, dt, J = 8.8, 7.0 Hz, C2H), 2.37 (1H, dqd, J = 10.4, 7.6, 4.6 Hz, C3H), 2.24 (3H, s, C16H_3), 2.18 (6H, s, 2 × C15H_3), 2.12 (6H, s, 2 × C14H_3), 1.98 – 1.89 (2H, m, C4$H_{cis}$$H_{trans}$ and C6$H_{cis}$$H_{trans}$), 1.87 – 1.75 (1H, m, C6$H_{cis}$$H_{trans}$), 1.70 – 1.60 (2H, m, C5H_2), 1.54 (1H, dsept.d, J = 9.3, 6.6, 4.8 Hz, C8H), 1.29 – 1.18 (1H, m, C4$H_{cis}$$H_{trans}$), 1.22 (1H, ddd, J = 13.0, 9.3, 4.7 Hz, C7$H_A$$H_B$), 1.12 (1H, ddd, J = 13.1, 10.4, 4.8 Hz, C7$H_A$$H_B$), 0.83 (3H, d, J = 6.5 Hz, C9$_A$$H_3$), 0.82 (3H, d, J = 6.6 Hz, C9$_B$$H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.4 (C1=O), 141.0 (C10), 135.4 (C13), 133.1 (2C, 2 × C12), 127.9 (2C, br. s, 2 × C11), 60.7 (C2H), 45.6 (C7H_2), 40.1 (C3H), 32.6 (C4H_2), 29.6 (C6H_2), 26.8 (C8H), 25.2 (C5H_2), 24.0 (C9$_B$$H_3$), 21.7 (C9$_A$$H_3$), 18.1 (2C, 2 × C14$H_3$), 16.8 (C16$H_3$), 16.2 (2C, 2 × C15$H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 301.25253; $C_{21}H_{33}O$ requires 301.25259, Δ –0.20 ppm.

Note: *cis* and *trans* with respect to C2H.

3-Cyclobutyl-3-cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (235)



In the preparation of ketone **236**, ketone **235** (8.2 mg, 28 μmol, 4.6%) was also isolated as a colourless solid.

m.p. = 49 – 51 °C.

IR (film) ν_{max}/cm^{-1} 3075, 2953, 2929, 2867, 1702, 1575, 1459, 1398, 1382, 1346, 1302, 1262, 1160, 1105, 1070, 1045, 1016, 996, 980, 945, 932, 916, 861, 821, 744, 721, 698, 642.

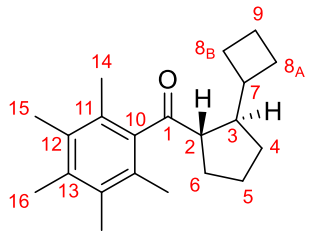
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.71 (1H, dd, J = 19.6, 6.3 Hz, C2H_AH$_B$), 2.63 (1H, dd, J = 19.6, 4.6 Hz, C2H$_A$$H_B$), 2.48 (1H, app. sext., J = 8.5 Hz, C11H), 2.23 (3H, s, C10H$_3$), 2.18 (6H, s, 2 × C9H$_3$), 2.12 (6H, s, 2 × C8H$_3$), 2.09 – 2.02 (1H, m, C12$_A$$H_AH_B$), 1.95 – 1.90 (1H, m, C12$_B$$H_AH_B$), 1.88 – 1.75 (2H, m, C12$_A$H$_A$$H_B$ and C12$_B$H$_A$$H_B$), 1.75 – 1.70 (2H, m, C13H$_2$), 1.46 (1H, tdd, J = 9.2, 6.3, 4.6 Hz, C3H), 0.62 (1H, dddd, J = 13.1, 9.5, 8.1, 5.1 Hz, C14H), 0.52 – 0.43 (1H, m, C15$_A$$H_{cis}H_{trans}$), 0.37 – 0.30 (1H, m, C15$_B$$H_{cis}H_{trans}$), 0.30 – 0.25 (1H, m, C15$_A$H$_{cis}$$H_{trans}$), 0.24 – 0.17 (1H, m, C15$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.2 (C1=O), 141.1 (C4), 135.3 (C7), 133.2 (2C, 2 × C6), 127.4 (2C, 2 × C5), 49.0 (C2H$_2$), 42.9 (C3H), 41.1 (C11H), 27.6 (C12$_A$H$_2$), 27.1 (C12$_B$H$_2$), 18.3 (C13H$_2$), 17.1 (2C, 2 × C8H$_3$), 16.8 (C10H$_3$), 16.1 (2C, 2 × C9H$_3$), 14.8 (C14H), 4.9 (C15$_A$H$_2$), 2.4 (C15$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 299.23694; $C_{21}H_{31}O$ requires 299.23694, Δ –0.01 ppm.

Note: *cis* and *trans* with respect to C14H.

***rel*-((1*S*,2*R*)-2-Cyclobutylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (236)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclobutyl(cyclopropyl)methanol* (151 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **236** (127 mg, 0.425 mmol, 71%) as a colourless solid.

m.p. = 71 – 73 °C.

IR (film) ν_{max}/cm^{-1} 2948, 2866, 1688, 1573, 1446, 1382, 1338, 1304, 1256, 1205, 1169, 1126, 1093, 1069, 1019, 997, 942, 914, 883, 854, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.83 (1H, ddd, J = 8.7, 5.7, 4.9 Hz, C2H), 2.44 (1H, tt, J = 8.5, 5.2 Hz, C3H), 2.23 (3H, s, $C16H_3$), 2.20 (1H, sext., J = 8.0 Hz, C7H), 2.18 (6H, s, 2 × $C15H_3$), 2.11 (6H, s, 2 × $C14H_3$), 1.98 – 1.83 (3H, m, $C6H_{cis}H_{trans}$, $C8_AH_{syn}H_{anti}$ and $C8_BH_{syn}H_{anti}$), 1.83 – 1.68 (2H, m, $C4H_{cis}H_{trans}$ and $C6H_{cis}H_{trans}$), 1.68 – 1.49 (4H, m, $C5H_2$, $C8_AH_{syn}H_{anti}$ and $C8_BH_{syn}H_{anti}$), 1.35 (1H, dtd, J = 12.5, 7.3, 5.6 Hz, $C4H_{cis}H_{trans}$).

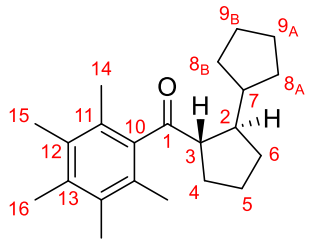
* The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.0 (C1=O), 140.6 (C10), 135.3 (C13), 133.1 (2C, 2 × C12), 128.1 (2C, br. s, 2 × C11), 58.0 (C2H), 46.5 (C3H), 40.7 (C7H), 29.50 ($C4H_2$), 29.49 ($C6H_2$), 27.1 ($C8_AH_2$), 26.5 ($C8_BH_2$), 25.3 ($C5H_2$), 18.2 (2C, 2 × $C14H_3$), 17.8 ($C9H_2$), 16.9 ($C16H_3$), 16.2 (2C, 2 × $C15H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 299.23691; $C_{21}H_{31}O$ requires 299.23694, Δ –0.11 ppm.

Note: *cis* and *trans* with respect to C2H, and *syn* and *anti* with respect to C7H.

***rel*-((1*R*,2*S*)-[1,1′-Bi(cyclopentan)]-2-yl)(2,3,4,5,6-pentamethylphenyl)methanone (237)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclopentyl(cyclopropyl)methanol* (168 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **237** (8.9 mg, 29 μmol, 4.7%) as a colourless solid.

m.p. = 72 – 74 °C.

IR (film) ν_{max}/cm^{-1} 2947, 2866, 1689, 1574, 1449, 1382, 1340, 1304, 1261, 1115, 1069, 1019, 996, 943.

* The material was provided by Dr. James Frost.

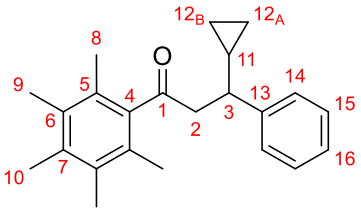
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.02 (1H, dt, J = 8.9, 5.1 Hz, C3H), 2.43 (1H, tdd, J = 8.2, 6.1, 5.1 Hz, C2H), 2.24 (3H, s, $C16H_3$), 2.18 (6H, s, 2 × $C15H_3$), 2.12 (6H, s, 2 × $C14H_3$), 1.91 (1H, dq, J = 12.1, 6.3 Hz, $C4H_{cis}H_{trans}$), 1.86 (1H, ddt, J = 12.9, 8.3, 6.9 Hz, $C6H_{cis}H_{trans}$), 1.78 (1H, dtt, J = 16.6, 9.0, 7.4 Hz, C7H), 1.73 (1H, ddd, J = 13.0, 8.9, 7.4 Hz, $C4H_{cis}H_{trans}$), 1.71 – 1.63 (1H, m, $C8_AH_{syn}H_{anti}$), 1.66 – 1.56 (3H, m, $C5H_2$ and $C8_AH_AH_B$), 1.60 – 1.40 (4H, m, $C9_AH_2$ and $C9_BH_2$), 1.42 (1H, dq, J = 13.6, 7.0 Hz, $C6H_{cis}H_{trans}$), 1.15 (1H, dq, J = 12.5, 8.3 Hz, $C8_AH_{syn}H_{anti}$), 1.08 (1H, dq, J = 12.1, 8.8 Hz, $C8_BH_{syn}H_{anti}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.1 (C1=O), 140.7 (C10), 135.3 (C13), 133.1 (2C, 2 × C12), 128.1 (2C, br. s, 2 × C11), 59.0 (C3H), 45.3 (C2H), 44.9 (C7H), 31.8 ($C8_BH_2$), 30.6 ($C6H_2$), 30.0 ($C8_BH_2$), 29.7 ($C4H_2$), 25.66 ($C5H_2$), 25.58 ($C9_AH_2$), 25.51 ($C9_BH_2$), 18.2 (2C, 2 × $C14H_3$), 16.8 ($C16H_3$), 16.2 (2C, 2 × $C15H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 313.25247; $C_{22}H_{33}O$ requires 313.25259, Δ –0.38 ppm.

Note: *cis* and *trans* with respect to C3H, and *syn* and *anti* with respect to C7H.

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylpropan-1-one (238)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 µmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 µmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclopropyl(phenyl)methanol (178 mg, 1.20 mmol, 2.0 equiv) and toluene (150 µL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a colourless oil (128 mg) containing a mixture of ketones **121** (0.127 mmol, 21%), **238** (47.2 µmol, 7.9%), **239** (0.246 mmol, 41%) and cyclopropyl phenyl ketone (0.290 mmol).

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a pale yellow oil (141 mg) containing a mixture of ketones **121** (11.4 μmol, 1.9%), **238** (34.4 μmol, 5.7%), **239** (34.4 mmol, 57%) and cyclopropyl phenyl ketone (0.116 mmol).

An analytically pure sample was prepared by preparative TLC (Pentane:Et_2O, 95:5) to give ketone **238** as a colourless solid.

m.p. = 57 – 59 °C.

IR (film) ν_{max}/cm^{-1} 3077, 3062, 3027, 2999, 2922, 2852, 1702, 1603, 1579, 1494, 1453, 1401, 1382, 1353, 1333, 1302, 1265, 1146, 1105, 1072, 1045, 1017, 996, 967, 939, 924, 868, 820, 769, 743, 699.

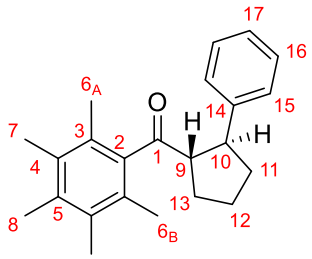
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.27 (4H, m, 2 × C14H and 2 × C15H), 7.23 – 7.18 (1H, m, C16H), 3.21 (1H, dd, J = 19.0, 5.6 Hz, C2H_AH$_B$), 3.15 (1H, dd, J = 18.9, 7.3 Hz, C2H$_A$$H_B$), 2.75 (1H, ddd, J = 9.6, 7.3, 5.6 Hz, C3H), 2.22 (3H, s, C10H$_3$), 2.15 (6H, s, 2 × C9H$_3$), 1.93 (6H, v. br. s, 2 × C8H$_3$), 1.08 (1H, dtt, J = 9.9, 8.1, 5.0 Hz, C11H), 0.61 – 0.54 (1H, m, C12$_A$$H_{cis}H_{trans}$), 0.46 – 0.40 (1H, m, C12$_B$$H_{cis}H_{trans}$), 0.40 – 0.34 (1H, m, C12$_A$H$_{cis}$$H_{trans}$), 0.25 – 0.15 (1H, m, C12$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.0 (C1=O), 145.0 (C13), 140.6 (C4), 135.4 (C7), 133.1 (2C, 2 × C6), 128.4 (2C, 2 × C15H), 128.0 (2C, 2 × C14H), 127.5 (2C, 2 × C5), 126.4 (C16H), 52.7 (C2H$_2$), 44.3 (C3H), 18.0 (C11H), 16.92 (2C, br. s, 2 × C8H$_3$), 16.81 (C10H$_3$), 16.0 (2C, 2 × C9H$_3$), 5.6 (C12$_A$H$_2$), 4.5 (C12$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 321.22122; $C_{23}H_{29}O$ requires 321.22129, Δ –0.22 ppm.

Note: *cis* and *trans* with respect to C11H.

***rel*-(2,3,4,5,6-Pentamethylphenyl)((1*S*,2*S*)-2-phenylcyclopentyl)methanone (239)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclopropyl(phenyl)methanol (178 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded a colourless oil (128 mg) containing a mixture of ketones **121** (0.127 mmol, 21%), **238** (47.2 μmol, 7.9%), **239** (0.246 mmol, 41%) and cyclopropyl phenyl ketone (0.290 mmol).

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a pale yellow oil (141 mg) containing a mixture of ketones **121** (11.4 μmol, 1.9%), **238** (34.4 μmol, 5.7%), **239** (34.4 mmol, 57%) and cyclopropyl phenyl ketone (0.116 mmol).

An analytically pure sample was prepared by preparative TLC (Pentane:Et_2O, 95:5) to give ketone **239** as a colourless solid.

m.p. = 61 – 63 °C.

IR (film) ν_{max}/cm^{-1} 3081, 3060, 3027, 2951, 2930, 2870, 1689, 1602, 1574, 1492, 1452, 1381, 1338, 1303, 1265, 1150, 1114, 1070, 1027, 1000, 955, 874, 833, 757, 700.

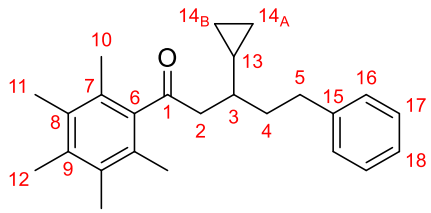
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.26 – 7.12 (5H, m, 2 × C15H, 2 × C16H and C17H), 3.61 (1H, q, J = 8.5 Hz, C9H), 3.33 (1H, q, J = 8.5 Hz, C10H), 2.29 – 2.20 (1H, m, C11H$_{cis}$*H$_{trans}$*), 2.20 (3H, s, C8H_3), 2.17 – 2.03 (1H, m, C13*H$_{cis}$*H$_{trans}$), 2.10 (6H, s, 2 × C7H_3), 2.00 (3H, v. br. s, C6$_A$H$_3$), 1.99 (1H, dtd, J = 12.7, 7.9, 6.2 Hz, C13H$_{cis}$*H$_{trans}$*), 1.90 – 1.81 (2H, m, C12H_2), 1.85 – 1.75 (1H, m, C11*H$_{cis}$*H$_{trans}$), 1.66 (3H, v. br. s, C6$_B$H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.4 (C1=O), 145.3 (C14), 140.7 (C2), 135.4 (C5), 133.1 (2C, 2 × C4), 128.4 (2C, 2 × C16H), 128.1 (2C, 2 × C3), 127.7 (2C, 2 × C15H), 126.2 (C17H), 62.6 (C9H), 47.5 (C10H), 35.9 (C11H_2), 31.3 (C13H_2), 25.9 (C12H_3), 17.6 (2C, v. br. s, 2 × C6H_3), 16.8 (C8H_3), 16.0 (2C, br. s, 2 × C7H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 321.22141; $C_{23}H_{29}O$ requires 321.22129, Δ 0.35 ppm.

Note: *cis* and *trans* with respect to C9H.

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)-5-phenylpentan-1-one (240)



In the preparation of ketone **241** at 105 °C, ketone **240** (19.6 mg, 56.2 μmol, 9.4%) was also isolated as a colourless solid.

m.p. = 73 – 76 °C.

IR (film) ν_{max}/cm^{-1} 3062, 3025, 2998, 2923, 2862, 1700, 1603, 1581, 1496, 1454, 1400, 1383, 1349, 1304, 1269, 1170, 1154, 1109, 1069, 1047, 1017, 934, 905, 877, 820, 747, 698.

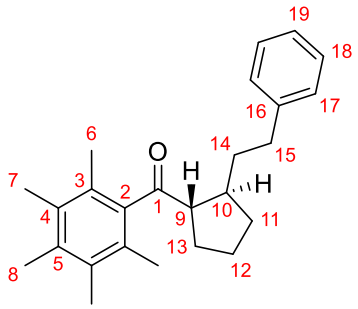
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.27 (2H, m, 2 × C17H), 7.25 – 7.19 (2H, m, 2 × C16H), 7.22 – 7.15 (1H, m, C18H), 2.91 (1H, dd, *J* = 19.3, 4.8 Hz, C2H_AH$_B$), 2.86 (1H, ddd, *J* = 13.7, 11.6, 5.6 Hz, C5H_AH$_B$), 2.79 (1H, dd, *J* = 19.4, 6.8 Hz, C2H$_A$$H_B$), 2.71 (1H, ddd, *J* = 14.0, 11.3, 5.3 Hz, C5H$_A$$H_B$), 2.24 (3H, s, C12$H_3$), 2.19 (6H, s, 2 × C11$H_3$), 2.13 (6H, s, 2 × C10$H_3$), 1.97 (1H, ddt, *J* = 13.5, 11.3, 5.5 Hz, C4H_AH$_B$), 1.81 (1H, dddd, *J* = 13.3, 11.5, 7.4, 5.4 Hz, C4H$_A$$H_B$), 1.49 (1H, dddd, *J* = 12.0, 10.1, 6.9, 5.1 Hz, C3H), 0.73 (1H, dddd, *J* = 13.1, 9.9, 8.0, 5.0 Hz, C13H), 0.58 (1H, tdd, *J* = 8.2, 5.5, 4.2 Hz, C14$_A$$H_{cis}H_{trans}$), 0.43 (1H, dddd, *J* = 9.3, 8.2, 5.4, 4.1 Hz, C14$_B$$H_{cis}H_{trans}$), 0.28 (1H, dtd, *J* = 9.4, 5.2, 4.2 Hz, C14$_A$H$_{cis}$$H_{trans}$), 0.20 (1H, dtd, *J* = 9.3, 5.3, 4.1 Hz, C14$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.0 (C1=O), 143.0 (C15), 140.9 (C6), 135.4 (C9), 133.2 (2C, 2 × C8), 128.47 (2C, 2 × C16H), 128.46 (2C, 2 × C17H), 127.4 (2C, 2 × C7), 125.8 (C18H), 51.4 (C2H_2), 38.3 (C3H), 37.4 (C4H_2), 33.8 (C5H_2), 17.2 (2C, 2 × C10H_3), 16.8 (C12H_3), 16.6 (C13H), 16.1 (2C, 2 × C11H_3), 5.7 (C14$_A$$H_2$), 3.6 (C14$_B$$H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 349.25168; $C_{25}H_{33}O$ requires 349.25259, Δ –2.62 ppm.

Note: *cis* and *trans* with respect to C13H.

***rel*-(2,3,4,5,6-Pentamethylphenyl)((1*S*,2*R*)-2-phenethylcyclopentyl)methanone (241)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-3-phenylpropan-1-ol* (212 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded the following three fractions.

Fraction	Mass / mg	Yields / mmol			
		121	**240**	**241**	1-Cyclopropyl-3-phenylpropan-1-one
1	19.6	-	0.0562	-	-
2	14.7	-	-	0.0422	-
3	127	0.153	-	0.225	0.500
Total		0.153 mmol 26%	0.562 mmol 9.4%	0.267 mmol 45%	-

Analytically pure ketone **241** was isolated from fraction 2 as a colourless solid.

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded a pale yellow oil (182 mg) containing a mixture of ketones **121** (84.8 μmol, 14%), **240** (0.121 mmol, 20%), **241** (0.305 mmol, 51%) and 1-cyclopropyl-3-phenylpropan-1-one (0.102 mmol).

* The material was provided by Dr. James Frost.

m.p. = 81 – 83 °C.

IR (film) ν_{max}/cm^{-1} 3084, 3061, 3025, 2937, 2867, 1687, 1603, 1574, 1496, 1452, 1382, 1347, 1305, 1259, 1166, 1119, 1089, 1069, 1029, 999, 943, 909, 835, 747, 699.

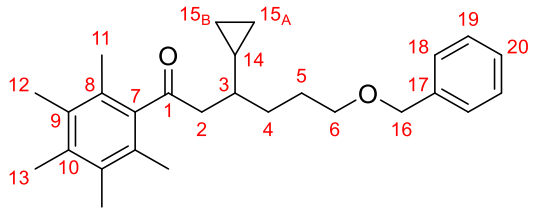
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.27 – 7.21 (2H, m, 2 × C18H), 7.20 – 7.12 (1H, m, C19H), 7.10 – 7.04 (2H, m, 2 × C17H), 2.90 (1H, dt, *J* = 8.7, 7.0 Hz, C9H), 2.61 (1H, ddd, *J* = 13.7, 10.3, 5.3 Hz, C15H_AH$_B$), 2.52 (1H, ddd, *J* = 13.7, 10.1, 6.4 Hz, C15H$_A$$H_B$), 2.31 (1H, dqd, *J* = 9.8, 7.5, 4.4 Hz, C10H), 2.24 (3H, s, C8H_3), 2.17 (6H, s, 2 × C7H_3), 2.07 (6H, br. s, 2 × C6H_3), 2.01 (1H, dq, *J* = 13.3, 7.1 Hz, C11H$_{cis}$$H_{trans}$), 1.98 (1H, dq, *J* = 14.1, 7.2 Hz, C13H$_{cis}$$H_{trans}$), 1.83 (1H, ddt, *J* = 13.6, 9.4, 7.3 Hz, C13H_{cis}H$_{trans}$), 1.77 (1H, dddd, *J* = 13.2, 10.7, 6.4, 4.6 Hz, C14H_AH$_B$), 1.74 – 1.61 (2H, m, C12H_2), 1.46 (1H, dtd, *J* = 13.2, 9.9, 5.3 Hz, C14H$_A$$H_B$), 1.36 (1H, dq, *J* = 12.5, 7.6 Hz, C11H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.1 (C1=O), 142.5 (C16), 140.9 (C2), 135.5 (C5), 133.2 (2C, 2 × C4), 128.43 (2C, 2 × C17H), 128.39 (2C, 2 × C18H), 128.0 (2C, v. br. s, 2 × C3), 125.8 (C19H), 60.3 (C9H), 41.8 (C10H), 38.0 (C14H_2), 34.8 (C15H_2), 32.6 (C11H_2), 29.5 (C13H_2), 25.2 (C12H_2), 18.1 (2C, br. s, 2 × C6H_3), 16.9 (C8H_3), 16.2 (2C, 2 × C7H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 349.25186; $C_{25}H_{33}O$ requires 349.25259, Δ –2.09 ppm.

Note: *cis* and *trans* with respect to C2H.

6-(Benzyloxy)-3-cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)hexan-1-one (242)



In the preparation of ketone **243**, an analytically pure sample of ketone **242** were obtained by preparative TLC (Pentane:Et_2O, 90:10) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3065, 3028, 2996, 2923, 2855, 2792, 1701, 1576, 1496, 1454, 1400, 1383, 1359, 1306, 1269, 1204, 1156, 1101, 1047, 1017, 935, 909, 860, 821, 735, 697.

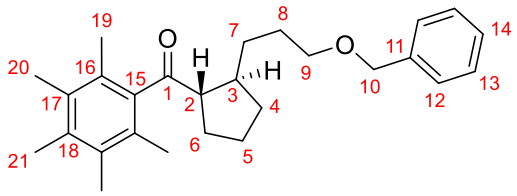
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.36 – 7.32 (4H, m, 2 × C18H and 2 × C19H), 7.31 – 7.27 (1H, m, C20H), 4.52 (2H, s, $C16H_2$), 3.55 – 3.45 (2H, m, $C6H_2$), 2.85 (1H, dd, J = 19.4, 4.8 Hz, $C2H_AH_B$), 2.72 (1H, dd, J = 19.4, 6.8 Hz, $C2H_AH_B$), 2.23 (3H, s, $C13H_3$), 2.18 (6H, s, 2 × $C12H_3$), 2.11 (6H, s, 2 × $C11H_3$), 1.92 – 1.81 (1H, m, $C5H_AH_B$), 1.77 – 1.69 (1H, m, $C2H_AH_B$), 1.69 – 1.62 (1H, m, $C4H_AH_B$), 1.60 – 1.49 (1H, m, $C4H_AH_B$), 1.42 (1H, dtt, J = 12.3, 4.9, 2.2 Hz, C3H), 0.64 (1H, dtt, J = 9.9, 8.0, 5.0 Hz, C14H), 0.53 (1H, dddd, J = 9.3, 8.1, 5.5, 4.1 Hz, $C15_AH_{cis}H_{trans}$), 0.38 (1H, dddd, J = 9.3, 8.0, 5.3, 4.0 Hz, $C15_BH_{cis}H_{trans}$), 0.24 (1H, dtd, J = 9.2, 5.1, 4.1 Hz, $C15_AH_{cis}H_{trans}$), 0.17 (1H, dtd, J = 9.3, 5.3, 4.0 Hz, $C15_BH_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.1 (C1=O), 140.9 (C7), 138.8 (C17), 135.4 (C10), 133.2 (2C, 2 × C9), 128.5 (2C, 2 × C19H), 127.8 (2C, 2 × C18H), 127.6 (C20H), 127.4 (2C, 2 × C8), 73.1 ($C16H_2$), 71.0 ($C6H_2$), 51.5 ($C2H_2$), 38.1 (C3H), 31.9 ($C4H_2$), 27.6 ($C5H_2$), 17.1 (2C, 2 × $C11H_3$), 16.8 ($C13H_3$), 16.6 (C14H), 16.1 (2C, 2 × $C12H_3$), 5.7 ($C15_AH_2$), 3.5 ($C15_BH_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 393.27875; $C_{27}H_{37}O_2$ requires 393.27881, Δ –0.15 ppm.

Note: *cis* and *trans* with respect to C14H.

***rel*-((1*S*,2*R*)-2-(3-(Benzyloxy)propyl)cyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (243)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 µmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 µmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-4-benzyloxybutan-1-ol* (264 mg, 1.20 mmol, 2.0 equiv) and toluene (150 µL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2 → 95:5) afforded ketone **243** (182 mg) as a colourless oil containing ~3 mol% of ketone **242** and < 2% of 1-cyclopropyl-4-benzyloxybutan-1-one. The corrected yield is 0.446 mmol, 74%.

IR (film) ν_{max}/cm^{-1} 3087, 3062, 3028, 2936, 2856, 2793, 1687, 1573, 1495, 1453, 1410, 1382, 1361, 1305, 1258, 1204, 1154, 1100, 1027, 999, 945, 916, 848, 734, 697.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.36 – 7.30 (4H, m, 2 × C12H and 2 × C13H), 7.30 – 7.26 (1H, m, C14H), 4.47 (2H, s, $C10H_2$), 3.46 – 3.35 (2H, m, $C9H_2$), 2.87 (1H, dt, J = 8.7, 7.0 Hz, C2H), 2.32 (1H, dqd, J = 9.7, 7.4, 4.3 Hz, C3H), 2.23 (3H, s, $C21H_3$), 2.17 (6H, s, 2 × $C20H_3$), 2.11 (6H, s, 2 × $C19H_3$), 1.96 (1H, dddd, J = 12.4, 8.0, 7.2, 5.9 Hz, $C4H_{cis}H_{trans}$), 1.91 (1H, dq, J = 12.6, 7.1 Hz, $C6H_{cis}H_{trans}$), 1.81 (1H, ddt, J = 12.8, 8.5, 6.8 Hz, $C6H_{cis}H_{trans}$), 1.71 – 1.60 (3H, m, $C5H_2$ and $C8H_AH_B$), 1.60 – 1.50 (2H, m, $C7H_AH_B$ and $C8H_AH_B$), 1.29 (1H, dq, J = 12.8, 7.8 Hz, $C4H_{cis}H_{trans}$), 1.28 – 1.18 (1H, m, $C7H_AH_B$).

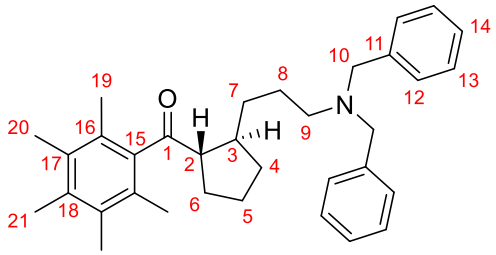
* The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.3 (C1=O), 141.0 (C15), 138.8 (C11), 135.4 (C18), 133.2 (2C, 2 × C17), 128.5 (2C, 2 × C13H), 128.0 (2C, v. br. s, 2 × C16), 127.72 (2C, 2 × C12H), 127.61 (C14H), 72.9 ($C10H_2$), 70.6 ($C9H_2$), 60.3 (C2H), 42.0 (C3H), 32.54 ($C4H_2$), 32.45 ($C7H_2$), 29.8 ($C6H_2$), 28.7 ($C8H_2$), 25.1 ($C5H_2$), 18.1 (2C, 2 × $C19H_3$), 16.9 ($C21H_3$), 16.2 (2C, 2 × $C20H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 393.27914; $C_{27}H_{37}O_2$ requires 393.27881, Δ 0.86 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-((1*S*,2*R*)-2-(3-(Dibenzylamino)propyl)cyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (244)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-4-(dibenzylamino)butan-1-ol* (371 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2 → 96:4 → 94:6) afforded ketone **244** (207 mg, 0.430 mmol, 72%) as a very viscous colourless oil.

* The material was provided by Dr. James Frost.

IR (film) ν_{max}/cm^{-1} 3084, 3061, 3026, 2939, 2866, 2794, 1688, 1601, 1574, 1494, 1452, 1381, 1366, 1345, 1304, 1257, 1207, 1155, 1123, 1070, 1027, 998, 977, 910, 844, 824, 742, 698.

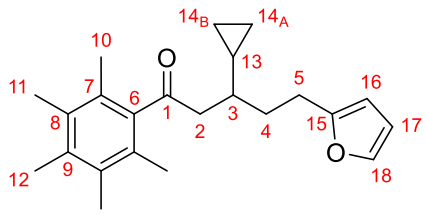
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.36 – 7.30 (4H, m, 4 × C12H), 7.34 – 7.26 (4H, m, 4 × C13H), 7.26 – 7.19 (2H, m, 2 × C14H), 3.50 (4H, s, 2 × C10H_2), 2.83 (1H, dt, *J* = 8.7, 7.0 Hz, C2H), 2.38 – 2.27 (2H, m, C9H_2), 2.29 – 2.19 (1H, m, C3H), 2.21 (3H, s, C21H_3), 2.16 (6H, s, 2 × C20H_3), 2.09 (6H, s, 2 × C19H_3), 1.98 – 1.86 (2H, m, C4H_{cis}*H_{trans}* and C6H_{cis}*H_{trans}*), 1.79 (1H, dtd, *J* = 12.9, 8.3, 6.7 Hz, C6*H_{cis}*H_{trans}), 1.71 – 1.55 (2H, m, C5H_2), 1.52 – 1.38 (2H, m, C8H_2), 1.40 (1H, dq, *J* = 10.5, 5.0 Hz, C7*H_A*H_B), 1.23 (1H, dq, *J* = 12.5, 7.6 Hz, C4*H_{cis}*H_{trans}), 1.18 – 1.07 (1H, m, C7H_A*H_B*).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.3 (C1=O), 141.0 (C15), 140.1 (2C, 2 × C11), 135.4 (C18), 133.2 (2C, 2 × C17), 128.8 (4C, 4 × C12H), 128.3 (4C, 4 × C13H), 128.0 (2C, v. br. s, 2 × C16), 126.8 (2C, 2 × C14H), 60.3 (C2H), 58.3 (2C, 2 × C10H_2), 53.6 (C9H_2), 42.1 (C3H), 33.8 (C7H_2), 32.7 (C4H_2), 29.8 (C6H_2), 25.8 (C8H_2), 25.2 (C5H_2), 18.1 (2C, br. s, 2 × C19H_3), 16.8 (C21H_3), 16.2 (2C, 2 × C20H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 482.34158; $C_{34}H_{44}NO$ requires 482.34174, Δ –0.33 ppm.

Note: *cis* and *trans* relative to C2H.

3-Cyclopropyl-5-(furan-2-yl)-1-(2,3,4,5,6-pentamethylphenyl)pentan-1-one (245)



In the preparation of ketone **246**, analytically pure ketone **245** was isolated from fraction 1 as a yellow oil.

IR (film) ν_{max}/cm^{-1} 3114, 3075, 2995, 2925, 2872, 1800, 1700, 1596, 1577, 1507, 1454, 1401, 1383, 1350, 1305, 1271, 1169, 1146, 1109, 1071, 1049, 1009, 937, 923, 904, 885, 850, 821, 796, 727, 691.

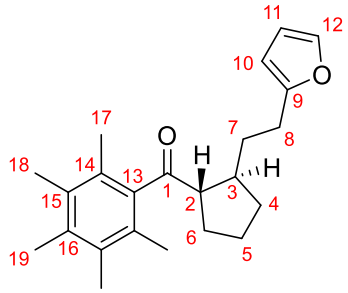
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 (1H, dd, J = 1.9, 0.8 Hz, C18H), 6.29 (1H, dd, J = 3.1, 1.9 Hz, C17H), 6.02 (1H, dq, J = 3.0, 0.9 Hz, C16H), 2.89 (1H, dd, J = 19.4, 4.8 Hz, C2H_AH$_B$), 2.87 (1H, dddd, J = 16.1, 10.5, 5.6, 0.9 Hz, C5H_AH$_B$), 2.76 (1H, dd, J = 19.4, 6.9 Hz, C2H$_A$$H_B$), 2.75 (1H, dddd, J = 15.7, 10.4, 5.9, 0.8 Hz, C5H$_A$$H_B$), 2.24 (3H, s, C12H$_3$), 2.19 (6H, s, 2 × C11H$_3$), 2.12 (6H, s, 2 × C10H$_3$), 2.01 (1H, ddt, J = 13.4, 10.4, 5.7 Hz, C4H_AH$_B$), 1.84 (1H, dddd, J = 13.3, 10.3, 7.8, 5.5 Hz, C4H$_A$$H_B$), 1.47 (1H, dtt, J = 10.0, 7.4, 5.0 Hz, C3H), 0.69 (1H, dtt, J = 9.9, 8.0, 5.0 Hz, C13H), 0.57 (1H, dddd, J = 9.4, 8.0, 5.5, 4.2 Hz, C14$_A$$H_{cis}H_{trans}$), 0.41 (1H, dddd, J = 9.3, 8.0, 5.4, 4.1 Hz, C14$_B$$H_{cis}H_{trans}$), 0.27 (1H, dtd, J = 9.3, 5.2, 4.2 Hz, C14$_A$H$_{cis}$$H_{trans}$), 0.18 (1H, dtd, J = 9.3, 5.3, 4.1 Hz, C14$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.9 (C1=O), 156.6 (C15), 140.84 (C6), 140.81 (C18H), 135.4 (C9), 133.2 (2C, 2 × C8), 127.4 (2C, 2 × C7), 110.2 (C17H), 104.7 (C16H), 51.3 (C2H$_2$), 37.9 (C3H), 33.7 (C4H$_2$), 25.9 (C5H$_2$), 17.2 (2C, 2 × C10H$_3$), 16.8 (C12H$_3$), 16.4 (C13H$_3$), 16.1 (2C, 2 × C11H$_3$), 5.7 (C14$_A$H$_2$), 3.5 (C14$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 339.23196; $C_{23}H_{31}O_2$ requires 339.23186, Δ 0.32 ppm.

Note: *cis* and *trans* with respect to C13H.

***rel*-((1*S*,2*R*)-2-(2-(Furan-2-yl)ethyl)cyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (246)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 µmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 µmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-3-(furan-2-yl)propan-1-ol [*] (199 mg, 1.20 mmol, 2.0 equiv) and toluene (150 µL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded the following four fractions.

Fraction	Mass / mg	Yields / mmol			
		121	**245**	**246**	1-Cyclopropyl-3-(2′-furyl)propan-1-one
1	12.3	-	0.0363	-	-
2	10.0	-	0.0082	0.0213	-
3	11.0	-	-	0.0325	-
4	86.0	0.0381	-	0.215	0.200
Total		38.1 µmol 6.3%	45.5 mmol 7.4 %	0.267 mmol 45%	-

[*] The material was provided by Dr. James Frost.

Analytically pure ketone **246** was isolated from fraction **3** (91.0 mg, 0.269 mmol, 45%) as a yellow solid.

m.p. = 59 – 62 °C.

IR (film) ν_{max}/cm^{-1} 2943, 2869, 1688, 1596, 1575, 1507, 1450, 1383, 1348, 1305, 1260, 1211, 1172, 1147, 1119, 1086, 1071, 1008, 923, 884, 850, 798, 727.

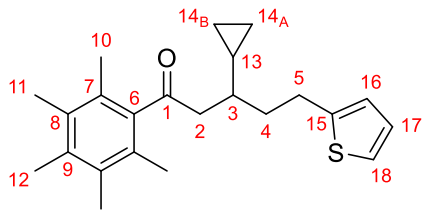
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.27 (1H, dd, J = 1.9, 0.9 Hz, C12H), 6.25 (1H, dd, J = 3.2, 1.9 Hz, C11H), 5.89 (1H, dq, J = 2.8, 0.9 Hz, C10H), 2.89 (1H, dt, J = 8.8, 7.0 Hz, C2H), 2.63 (1H, dddd, J = 15.1, 9.5, 5.5, 0.9 Hz, C8H_AH$_B$), 2.56 (1H, dddd, J = 15.3, 9.3, 6.7, 0.9 Hz, C8H$_A$$H_B$), 2.34 (1H, dqd, J = 9.5, 7.3, 4.4 Hz, C3H), 2.23 (3H, s, C19H$_3$), 2.18 (6H, s, 2 × C18H$_3$), 2.09 (6H, s, 2 × C17H$_3$), 2.03 – 1.90 (2H, m, C4H$_{cis}$$H_{trans}$ and C6H$_{cis}$$H_{trans}$), 1.88 – 1.77 (2H, m, C6H_{cis}H$_{trans}$ and C7H_AH$_B$), 1.73 – 1.60 (2H, m, C5H$_2$), 1.49 (1H, dtd, J = 13.2, 9.6, 5.5 Hz, C7H$_A$$H_B$), 1.31 (1H, dq, J = 12.5, 7.6 Hz, C4H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.1 (C1=O), 156.1 (C9), 140.87 (C13), 140.81 (C12H), 135.5 (C16), 133.2 (2C, 2 × C15), 128.0 (2C, br. s, 2 × C14), 110.2 (C11H), 104.8 (C10H), 60.3 (C2H), 41.6 (C3H), 34.3 (C7H$_2$), 32.4 (C4H$_2$), 29.6 (C6H$_2$), 27.0 (C8H$_2$), 25.1 (C5H$_2$), 18.1 (2C, br. s, 2 × C17H$_3$), 16.9 (C19H$_3$), 16.2 (2C, 2 × C18H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 339.23189; $C_{23}H_{31}O_2$ requires 339.23186, Δ 0.09 ppm.

Note: *cis* and *trans* with respect to C2H.

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)-5-(thiophen-2-yl)pentan-1-one (247)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropyl-3-(thiophen-2-yl)propan-1-ol* (219 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **247** (91.0 mg, 0.269 mmol, 45%) as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3073, 2995, 2922, 2872, 1700, 1575, 1536, 1441, 1400, 1384, 1348, 1304, 1272, 1107, 1071, 1047, 1018, 937, 904, 879, 850, 821, 745, 691.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.12 (1H, dd, J = 5.1, 1.2 Hz, C18H), 6.93 (1H, dd, J = 5.1, 3.4 Hz, C17H), 6.83 (1H, dq, J = 3.2, 1.0 Hz, C16H), 3.08 (1H, dddd, J = 14.8, 10.9, 5.5, 1.0 Hz, C5H_AH$_B$), 2.95 (1H, dddd, J = 14.7, 10.6, 5.5, 0.9 Hz, C5H$_A$$H_B$), 2.90 (1H, dd, J = 19.5, 4.7 Hz, C2H_AH$_B$), 2.78 (1H, dd, J = 19.4, 6.9 Hz, C2H$_A$$H_B$), 2.24 (3H, s, C12H$_3$), 2.19 (6H, s, 2 × C11H$_3$), 2.13 (6H, s, 2 × C10H$_3$), 2.06 (1H, ddt, J = 13.3, 11.1, 5.6 Hz, C4H_AH$_B$), 1.89 (1H, dddd, J = 13.3, 10.8, 7.7, 5.6 Hz, C4H$_A$$H_B$), 1.50 (1H, dtt, J = 10.1, 7.2, 5.1 Hz, C3H), 0.72 (1H, dddd, J = 13.0, 9.9, 8.1, 5.0 Hz, C13H), 0.59 (1H, dddd, J = 9.4, 8.0, 5.5, 4.2 Hz, C14$_A$$H_{cis}H_{trans}$), 0.43 (1H, dddd, J = 9.3, 8.1, 5.4, 4.1 Hz, C14$_B$$H_{cis}H_{trans}$), 0.29 (1H, dtd, J = 9.4, 5.2, 4.2 Hz, C14$_A$H$_{cis}$$H_{trans}$), 0.20 (1H, dtd, J = 9.4, 5.3, 4.2 Hz, C14$_B$H$_{cis}$$H_{trans}$).

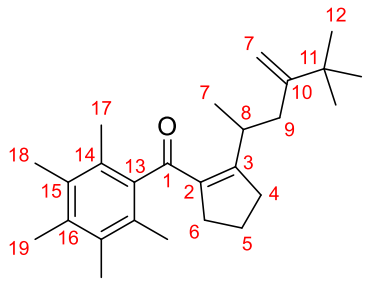
* The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.9 (C1=O), 145.9 (C15), 140.8 (C6), 135.4 (C9), 133.2 (2C, 2 × C8), 127.4 (2C, 2 × C7), 126.8 (C17H), 124.0 (C16H), 122.9 (C18H), 51.3 ($C2H_2$), 38.0 (C3H), 37.6 ($C4H_2$), 27.8 ($C5H_2$), 17.2 (2C, 2 × $C10H_3$), 16.8 ($C12H_3$), 16.4 (C13H), 16.1 (2C, 2 × $C11H_3$), 5.8 ($C14_AH_3$), 3.5 ($C14_BH_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 355.20911; $C_{23}H_{31}OS$ requires 355.20901, Δ 0.26 ppm.

Note: *cis* and *trans* with respect to C13H.

(2-(5,5-Dimethyl-4-methylenehexan-2-yl)cyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (248)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **217** (233 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded enone **248** (13.7 mg, 37.4 μmol, 6.2%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3092, 2955, 2930, 2868, 1740, 1702, 1658, 1635, 1596, 1461, 1383, 1360, 1350, 1308, 1268, 1194, 1169, 1108, 1069, 1020, 993, 893, 871, 832, 712.

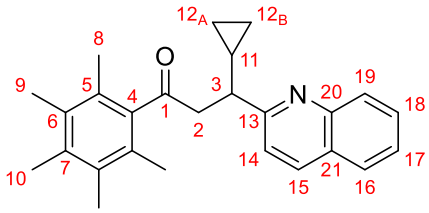
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.74 (1H, s, C7H_{syn}H$_{anti}$), 4.24 (1H, s, C7H$_{syn}$$H_{anti}$), 3.24 (1H, v. br. s, C8H), 2.60 (2H, br. t, J = 7.7 Hz, C6H_2), 2.61 – 2.48 (2H, m, C4H_2), 2.21 (3H, s, C19H_3), 2.15 (6H, s, 2 × C18H_3), 2.06 (6H, s, 2 × C17H_3), 2.01 – 1.89 (2H, m, C9H_2), 1.78 (2H, quint., J = 7.2 Hz, C5H_2), 0.97 (9H, s, 3 × C12H_3), 0.86 (3H, br. d, J = 6.6 Hz, C7H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.7 (C1=O), 165.6 (C3), 154.7 (C10), 141.2 (C13), 136.5 (br. s, C2), 135.0 (C16), 133.0 (2C, br. s, 2 × C15), 128.0 (2C, 2 × C14), 106.5 (C7H_2), 36.3 (C9H_2), 36.1 (C11), 34.15 (C4H_2), 34.02 (C6H_2), 31.5 (C8H), 29.3 (3C, 3 × C12H_3), 21.6 (C5H_2), 18.6 (2C, br. s, 2 × C17H_3), 17.4 (C7H_3), 16.8 (C19H_3), 16.1 (2C, 2 × C18H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 367.29724; $C_{26}H_{39}O$ requires 367.29954, Δ –6.27 ppm.

Note: *syn* and *anti* with respect to C11.

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)-3-(quinolin-2-yl)propan-1-one (251)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclopropyl(quinoline-2-yl)methanol* (239 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 96:4 → 94:6) afforded the following three fractions.

Fraction	Mass / mg	Yields / mmol	
		251	**253**
1	51.0	-	0.137
2	11.0	0.0296	-
3	72.0	0.129	0.0645
Total		0.159 mmol 26%	0.201 mmol 34%

Analytically pure ketone **251** was isolated from fraction 2 as a colourless solid.

m.p. = 123 – 126 °C.

IR (film) ν_{max}/cm^{-1} 3060, 3000, 2925, 1700, 1619, 1600, 1565, 1503, 1458, 1427, 1384, 1340, 1301, 1266, 1210, 1198, 1172, 1141, 1106, 1069, 1047, 1017, 995, 944, 931, 910, 875, 824, 789, 769, 754, 733.

* The material was provided by Dr. James Frost.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.09 (1H, dd, J = 8.4, 0.8 Hz, C15H), 7.99 (1H, dq, J = 8.5, 0.9 Hz, C19H), 7.79 (1H, dd, J = 8.1, 1.5 Hz, C16H), 7.66 (1H, ddd, J = 8.4, 6.9, 1.5 Hz, C18H), 7.48 (1H, ddd, J = 8.2, 6.9, 1.2 Hz, C17H), 7.45 (1H, d, J = 8.4 Hz, C14H), 3.99 (1H, dd, J = 19.4, 9.1 Hz, C2H_AH$_B$), 3.28 (1H, dd, J = 19.4, 3.6 Hz, C2H$_A$$H_B$), 2.88 (1H, td, J = 9.5, 3.6 Hz, C3H), 2.21 (3H, s, C10H_3), 2.15 (6H, s, 2 × C9H_3), 2.05 (6H, s, 2 × C8H_3), 1.17 (1H, dtt, J = 9.9, 7.9, 5.0 Hz, C11H), 0.61 (1H, dddd, J = 8.7, 7.9, 5.7, 4.2 Hz, C12$_A$$H_{cis}H_{trans}$), 0.48 (1H, dddd, J = 8.9, 8.0, 5.8, 4.4 Hz, C12$_B$$H_{cis}H_{trans}$), 0.44 (1H, ddt, J = 9.1, 5.4, 4.6 Hz, C12$_B$H$_{cis}$$H_{trans}$), 0.35 (1H, dtd, J = 9.0, 5.4, 4.3 Hz, C12$_A$H$_{cis}$$H_{trans}$).

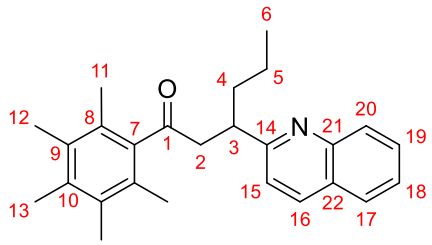
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.7 (C1=O), 164.0 (C13), 147.9 (C20), 140.5 (C4), 136.1 (C15H), 135.3 (C7), 133.0 (2C, 2 × C6), 129.15 (C18), 129.08 (C19), 127.70 (2C, v. br. s, 2 × C5), 127.68 (C16H), 127.3 (C21), 125.7 (C17H), 122.4 (C14H), 50.3 (C2H_2), 47.1 (C3H), 17.19 (C11H), 17.09 (2C, br. s, 2 × C8H_3), 16.8 (C10H_3), 16.0 (2C, 2 × C9H_3), 5.1 (C12$_A$$H_3$), 4.9 (C12$_B$$H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 301.9 (C13=N).

HRMS (ESI^+) Found $[M+H]^+$ = 372.23227; $C_{26}H_{30}NO$ requires 372.23219, Δ 0.21 ppm.

Note: *cis* and *trans* with respect to C11H.

1-(2,3,4,5,6-Pentamethylphenyl)-3-(quinolin-2-yl)hexan-1-one (253)



In the preparation of ketone **251**, analytically pure ketone **253** was isolated from fraction 1 as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3056, 2955, 2928, 2871, 1699, 1619, 1601, 1565, 1503, 1456, 1427, 1382, 1342, 1304, 1266, 1223, 1192, 1128, 1115, 1068, 1017, 999, 968, 935, 872, 830, 790, 758.

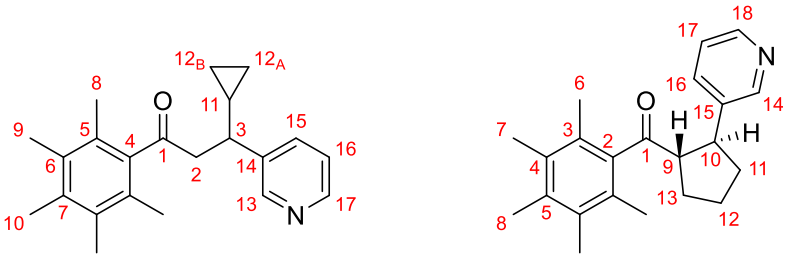
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.06 (1H, dd, J = 8.4, 0.8 Hz, C16H), 7.99 (1H, dq, J = 8.5, 1.0 Hz, C20H), 7.78 (1H, dd, J = 8.1, 1.5 Hz, C17H), 7.66 (1H, ddd, J = 8.4, 6.9, 1.5 Hz, C19H), 7.47 (1H, ddd, J = 8.1, 6.9, 1.2 Hz, C18H), 7.40 (1H, d, J = 8.4 Hz, C15H), 3.78 (1H, dd, J = 19.1, 9.1 Hz, C2H_AH$_B$), 3.66 (1H, tdd, J = 8.8, 6.1, 4.0 Hz, C3H), 3.05 (1H, dd, J = 19.1, 4.0 Hz, C2H$_A$$H_B$), 2.21 (3H, s, C13H$_3$), 2.14 (6H, s, 2 × C12H$_3$), 2.02 (6H, s, 2 × C11H$_3$), 1.81 (1H, dddd, J = 13.2, 9.7, 8.0, 5.3 Hz, C4H_AH$_B$), 1.74 (1H, ddt, J = 13.3, 10.0, 5.5 Hz, C4H$_A$$H_B$), 1.34 (1H, ddqd, J = 13.4, 10.2, 7.4, 5.8 Hz, C5H_AH$_B$), 1.23 (1H, ddqd, J = 13.4, 10.1, 7.4, 5.4 Hz, C5H$_A$$H_B$), 0.89 (3H, t, J = 7.4 Hz, C6H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.8 (C1=O), 164.8 (C14), 148.0 (C21), 140.5 (C7), 135.8 (C16H), 135.3 (C10), 133.0 (2C, 2 × C9), 129.12 (C19H), 129.05 (C18H), 127.66 (C17H), 127.53 (2C, v. br. s, 2 × C8), 127.1 (C22), 125.7 (C18H), 122.7 (C15H), 50.4 (C2H$_2$), 42.1 (C3H$_2$), 38.3 (C4H$_2$), 20.7 (C5H$_2$), 17.1 (2C, br. s, 2 × C11H$_3$), 16.8 (C13H$_3$), 16.0 (2C, 2 × C12H$_3$), 14.3 (C6H$_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 302.8 (C=N).

HRMS (ESI$^+$) Found $[M+H]^+$ = 374.24789; $C_{26}H_{32}NO$ requires 374.24784, Δ 0.14 ppm.

3-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)-3-(pyridin-3-yl)propan-1-one (255), and *rel*-(2,3,4,5,6-Pentamethylphenyl)((1*S*,2*S*)-2-(pyridin-3-yl)cyclopentyl)methanone (256)



1.8 : 1

Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclopropyl(pyridine-3-yl)methanol* (179 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O:DCM, 80:15:5 → 60:30:10 → 40:45:15) afforded a pale yellow oil (95.1 mg) containing an inseparable 1.8:1 mixture of ketones **255** (0.197 mmol, 33%) and **256** (98.6 μmol, 16%).

IR (film) ν_{max}/cm^{-1} 3078, 2997, 2927, 2873, 1698, 1574, 1478, 1450, 1425, 1402, 1383, 1338, 1304, 1267, 1238, 1188, 1147, 1106, 1069, 1046, 1024, 996, 967, 926, 870, 829, 805, 764, 745, 716.

* The material was provided by Dr. James Frost.

^{1}H NMR ($CDCl_3$, 500 MHz, cyclopropyl isomer) δ = 8.56 (1H, dd, J = 2.4, 0.9 Hz, C13H), 8.47 (1H, dd, J = 4.8, 1.7 Hz, C17H), 7.62 (1H, dt, J = 7.8, 2.0 Hz, C15H), 7.23 (1H, ddd, J = 7.8, 4.8, 0.9 Hz, C16H), 3.23 (1H, dd, J = 19.0, 5.0 Hz, C2H_AH$_B$), 3.14 (1H, dd, J = 19.0, 8.0 Hz, C2H$_A$$H_B$), 2.71 (1H, ddd, J = 9.8, 8.0, 5.0 Hz, C3H), 2.21 (3H, s, C10H_3), 2.14 (6H, s, 2 × C9H_3), 1.93 (6H, v. br. s, 2 × C8H_3), 1.09 (1H, dtt, J = 9.8, 8.0, 4.7 Hz, C11H), 0.63 (1H, dddd, J = 9.1, 8.0, 5.7, 4.4 Hz, C12$_A$$H_{cis}H_{trans}$), 0.46 (1H, dddd, J = 9.0, 8.0, 5.6, 4.6 Hz, C12$_B$$H_{cis}H_{trans}$), 0.39 (1H, ddt, J = 9.3, 5.6, 4.6 Hz, C12$_A$H$_{cis}$$H_{trans}$), 0.19 (1H, ddt, J = 9.3, 5.6, 4.8 Hz, C12$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, cyclopropyl isomer) δ = 209.5 (C1=O), 149.58 (C13H), 147.9 (C17H), 140.33 (C14), 140.17 (C4), 135.65 (C7), 135.46 (C15H), 133.23 (2C, 2 × C6), 127.4 (2C, 2 × C5), 123.38 (C16H), 52.2 (C2H_2), 42.3 (C3H), 17.5 (C11H), 17.0 (2C, br. s, 2 × C8H_3), 16.8 (C10H_3), 16.0 (2C, 2 × C9H_3), 5.8 (C12$_A$$H_2$), 4.6 (C12$_B$$H_2$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, cyclopropyl isomer) δ = 310.8 (C13=N).

^{1}H NMR ($CDCl_3$, 500 MHz, cyclopentyl isomer) δ = 8.42 (1H, dd, J = 2.4, 0.9 Hz, C14H), 8.40 (1H, dd, J = 4.8, 1.6 Hz, C18H), 7.47 (1H, dt, J = 7.8, 2.0 Hz, C16H), 7.14 (1H, ddd, J = 7.8, 4.8, 0.9 Hz, C17H), 3.57 (1H, q, J = 8.7 Hz, C10H), 3.31 (1H, q, J = 8.6 Hz, C9H), 2.26 (1H, dddd, J = 12.4, 8.6, 6.7, 5.3 Hz, C11H_{cis}H$_{trans}$), 2.19 (3H, s, C8H_3), 2.10 (6H, br. s, 2 × C7H_3), 2.14 – 2.05 (1H, m, C13H_{cis}H$_{trans}$), 2.06 – 1.97 (1H, m, C13H$_{cis}$$H_{trans}$), 1.87 (2H, m, C12$H_2$), 1.80 (6H, v. br. s, 2C, 2 × C6H_3), 1.77 (1H, dtd, J = 12.6, 8.8, 7.6 Hz, C11H$_{cis}$$H_{trans}$).

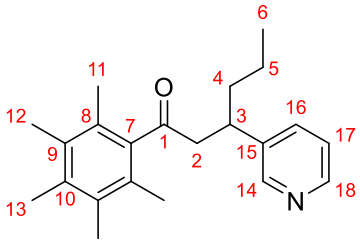
^{13}C NMR ($CDCl_3$, 126 MHz, cyclopentyl isomer) δ = 212.6 (C1=O), 149.46 (C14H), 147.7 (C18H), 140.45 (C15), 140.24 (C4), 135.70 (C7), 135.1 (C16H), 133.22 (2C, 2 × C4), 127.9 (2C, br. s, 2 × C3), 123.27 (C17H), 62.3 (C9H), 45.0 (C10H), 35.8 (C11H_2), 30.9 (C13H_2), 25.8 (C12H_2), 17.8 (2C, v. br. s, 2 × C6H_3), 16.8 (C8H_3), 16.1 (2C, br. s, 2 × C7H_3).

^{15}N NMR ($CDCl_3$, 50.7 MHz, cyclopentyl isomer) δ = 310.8 (C14=N).

HRMS (ESI$^+$) Found $[M+H]^+$ = 322.21667; $C_{22}H_{28}NO$ requires 322.21654, Δ 0.42 ppm.

Note: *cis* and *trans* with respect to C11H for cyclopropyl ketone **255**, and with respect to C9H for cyclopentyl ketone **256**.

1-(2,3,4,5,6-Pentamethylphenyl)-3-(pyridin-3-yl)hexan-1-one (257)



In the preparation of ketone **256**, ketone **257** (9.0 mg, 28 μmol, 4.6%) was also isolated as a yellow solid.

m.p. = 96 – 98 °C.

IR (film) ν_{max}/cm^{-1} 3082, 3026, 2956, 2927, 2872, 1701, 1575, 1464, 1426, 1401, 1382, 1343, 1308, 1265, 1217, 1183, 1122, 1069, 1025, 999, 934, 898, 861, 807, 775, 741, 716.

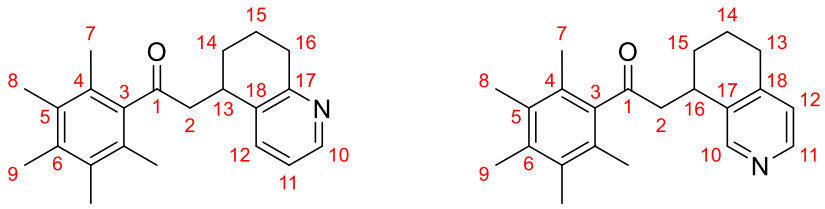
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.51 (1H, dd, J = 2.4, 0.8 Hz, C14H), 8.45 (1H, dd, J = 4.8, 1.6 Hz, C18H), 7.56 (1H, dt, J = 7.8, 2.0 Hz, C16H), 7.22 (1H, ddd, J = 7.8, 4.8, 0.8 Hz, C17H), 3.40 (1H, dtd, J = 9.8, 6.7, 5.2 Hz, C3H), 3.00 (2H, d, J = 6.7 Hz, $C2H_2$), 2.21 (3H, s, $C13H_3$), 2.14 (6H, s, 2 × $C12H_3$), 1.91 (6H, s, 2 × $C11H_3$), 1.78 (1H, dddd, J = 13.3, 10.1, 5.9, 5.0 Hz, $C4H_AH_B$), 1.61 (1H, dtd, J = 13.3, 9.8, 5.0 Hz, $C4H_AH_B$), 1.32 – 1.11 (2H, m, $C5H_2$), 0.89 (3H, t, J = 7.3 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.7 (C1=O), 149.8 (C14H), 147.9 (C18H), 140.35 (C15), 140.18 (C7), 135.7 (C10), 135.5 (C16H), 133.2 (2C, 2 × C9), 127.4 (2C 2 × C8), 123.4 (C17H), 52.5 ($C2H_2$), 38.3 ($C4H_2$), 37.4 (C3H), 20.6 ($C5H_2$), 17.0 (2C, br. s, 2 × $C11H_3$), 16.8 ($C13H_3$), 16.0 (2C, 2 × $C12H_3$), 14.0 ($C6H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 324.23233; $C_{22}H_{30}NO$ requires 324.23219, Δ 0.43 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)-2-(5,6,7,8-tetrahydroquinolin-5-yl)ethan-1-one (258, major), and

1-(2,3,4,5,6-Pentamethylphenyl)-2-(5,6,7,8-tetrahydroisoquinolin-8-yl)ethan-1-one (259, minor)



2 : 1

In the preparation of ketone **256**, a yellow oil (25.0 mg) was also isolated containing an inseparable 2:1 mixture of ketones **258** (51.8 μmol, 8.6%) and **259** (25.9 μmol, 4.3%).

IR (film) ν_{max}/cm^{-1} 3046, 2982, 2931, 2868, 1699, 1586, 1572, 1443, 1426, 1413, 1399, 1384, 1348, 1304, 1279, 1178, 1160, 1146, 1114, 1086, 1069, 998, 927, 901, 859, 827, 793, 749, 732, 700, 685.

^{1}H NMR ($CDCl_3$, 500 MHz, quinoline isomer) δ = 8.36 (1H, dd, J = 4.7, 1.7 Hz, C10H), 7.53 (1H, ddd, J = 7.8, 1.7, 0.8 Hz, C12H), 7.05 (1H, ddt, J = 7.8, 4.7, 0.8 Hz, C11H), 3.73 – 3.64 (1H, m, C13H), 3.09 – 2.85 (2H, m, $C2H_2$), 2.78 (1H, dt, J = 18.0, 5.9 Hz, $C16H_AH_B$), 2.72 (1H, ddd, J = 17.7, 8.1, 6.0 Hz, $C16H_AH_B$), 2.22 (6H, s, $C9H_3$), 2.17 (6H, s, 2C, 2 × $C8H_3$), 2.09 (6H, s, 2 × $C7H_3$), 2.12 – 2.03 (1H, m, $C14H_AH_B$), 1.97 – 1.85 (1H, m, $C14H_AH_B$), 1.89 – 1.78 (2H, m, $C15H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz, quinoline isomer) δ = 210.1 (C1=O), 157.4 (C17), 147.2 (C10H), 140.17 (C3), 136.4 (C12H), 135.72 (C6), 135.56 (C18), 133.30 (2C, 2 × C5), 127.33 (2C, 2 × C4), 121.3 (C11H), 53.1 ($C2H_2$), 32.6 ($C14H_2$), 31.9 (C13H), 28.4 ($C16H_2$), 19.7 ($C15H_2$), 17.14 (2C, 2 × $C7H_3$), 16.82 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, quinoline isomer) δ = 310.0 (C=N).

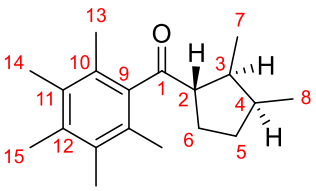
^{1}H NMR ($CDCl_3$, 500 MHz, isoquinoline isomer) δ = 8.42 (1H, s, C10H), 8.26 (1H, d, J = 5.1 Hz, C11H), 6.96 (1H, d, J = 5.0 Hz, C12H), 3.73 – 3.64 (1H, m, C16H), 3.09 – 2.85 (4H, m, $C2H_2$ and $C15H_2$), 2.22 (3H, s, $C9H_3$), 2.17 (6H, s, 2 × $C8H_3$), 2.12 (6H, s, 2 × $C7H_3$), 2.12 – 2.03 (1H, m, $C13H_AH_B$), 1.97 – 1.85 (2H, m, $C14H_2$), 1.89 – 1.78 (1H, m, $C13H_AH_B$).

^{13}C NMR ($CDCl_3$, 126 MHz, isoquinoline isomer) δ = 209.9 (C1=O), 150.2 (C10H), 146.7 (C11H), 146.3 (C18), 140.13 (C3), 136.2 (br. s, C17), 135.70 (C6), 133.29 (2C, 2 × C5), 127.36 (2C, 2 × C4), 124.0 (br. s, C12H), 52.9 ($C2H_2$), 29.8 (C16H), 28.9 ($C13H_2$), 28.1 ($C15H_2$), 19.0 ($C14H_2$), 17.16 (2C, br. s, 2 × $C7H_3$), 16.81 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, isoquinoline isomer) δ = 303.1 (C=N).

HRMS (ESI^+) Found $[M+H]^+$ = 322.21662; $C_{22}H_{28}NO$ requires 322.21654, Δ 0.26 ppm.

***rel*-((1*S*,2*S*,3*S*)-2,3-Dimethylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (261)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **260**[*] (120 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O:DCM, 98.5:1:0.5) afforded a colourless oil (118 mg) containing a mixture of ketone **121** (0.211 mmol, 35%), ketone **261** (0.154 mmol, 26%, d.r. = 6.9:1) and enone **262** (0.132 mmol, 22%) as a colourless oil.

[*] The material was provided by Dr. James Frost.

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **261** (57.3 mg, 0.209 mmol, 35%, d.r. = 6.6:1) as a colourless solid.

m.p. = 56 – 58 °C.

IR (film) ν_{max}/cm^{-1} 2955, 2930, 2871, 1688, 1573, 1451, 1380, 1343, 1304, 1260, 1189, 1119, 1089, 1069, 1023, 1002, 943, 889, 869, 833, 703.

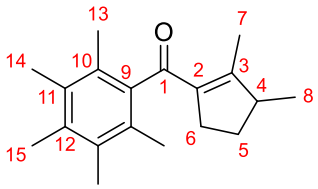
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.90 (1H, td, J = 8.0, 6.7 Hz, C2H), 2.37 (1H, sext., J = 7.1 Hz, C3H), 2.24 (3H, s, C15H_3), 2.19 (6H, s, 2 × C14H_3), 2.18 – 2.13 (1H, m, C4H), 2.12 (6H, s, 2 × C13H_3), 1.95 – 1.88 (2H, m, C6H_2), 1.88 – 1.81 (1H, m, C5$H_{cis}$$H_{trans}$), 1.33 (1H, dq, J = 12.2, 7.5 Hz, C5$H_{cis}$$H_{trans}$), 0.89 (3H, d, J = 5.0 Hz, C7H_3), 0.88 (3H, d, J = 5.0 Hz, C8H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.9 (C1=O), 141.2 (C9), 135.4 (C12), 133.2 (2C, 2 × C11), 127.9 (2C, 2 × C10), 60.7 (C2H), 39.8 (C3H), 37.7 (C4H), 33.1 (C5H_2), 27.9 (C6H_2), 18.0 (2C, br. s, 2 × C13H_3), 16.9 (C15H_3), 16.2 (2C, 2 × C14H_3), 15.9 (C7H_3), 15.3 (C8H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 273.22128; $C_{19}H_{29}O$ requires 273.22129, Δ –0.03 ppm.

Note: *cis* and *trans* with respect to C2H. In addition, the minor diastereomer could not be fully characterised. Comparison of diastereomeric ratio was performed using signals at δ = 0.88 (3H, d, C8H_3, major) and δ = 0.98 (3H, d, minor).

(2,3-Dimethylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (262)



In the preparation of ketone **261** at 105 °C, enone **262** (35.7 mg, 0.132 mmol, 22%) was also isolated as a colourless solid.

m.p. = 93 – 96 °C.

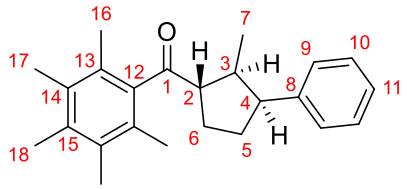
IR (film) ν_{max}/cm^{-1} 2954, 2925, 2862, 1664, 1628, 1607, 1455, 1417, 1379, 1345, 1319, 1270, 1237, 1188, 1107, 1070, 1025, 992, 908, 888, 836, 760, 733, 713.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.72 (1H, sext.sext., J = 7.2, 1.5 Hz, C4H), 2.64 (1H, dddt, J = 16.0, 8.9, 5.3, 1.8 Hz, C6H_AH$_B$), 2.54 (1H, dddt, J = 15.7, 8.5, 6.5, 1.8 Hz, C6H$_A$$H_B$), 2.23 (3H, s, C15H$_3$), 2.18 (6H, s, 2 × C14H$_3$), 2.05 (1H, dddd, J = 12.7, 8.9, 8.3, 5.4 Hz, C5H_AH$_B$), 2.05 (6H, s, 2 × C13H$_3$), 1.56 (3H, q, J = 1.8 Hz, C7H$_3$), 1.40 (1H, ddt, J = 12.7, 9.0, 6.2 Hz, C5H$_A$$H_B$), 1.07 (3H, d, J = 7.0 Hz, C8H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.2 (C1=O), 160.2 (C3), 140.9 (C9), 137.0 (C2), 135.0 (C12), 133.0 (2C, 2 × C11), 128.0 (2C, 2 × C10), 47.3 (C4H), 31.5 (C6H$_2$), 30.3 (C5H$_2$), 18.5 (C8H$_3$), 17.1 (2C, 2 × C13H$_3$), 16.8 (C15H$_3$), 16.1 (2C, 2 × C14H$_3$), 14.1 (C7H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 271.20057; $C_{19}H_{27}O$ requires 271.20564, Δ –0.28 ppm.

***rel*-((1*S*,2*S*,3*S*)-2-methyl-3-phenylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (264)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **263**[*] (195 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1 → 97.5:2.5) afforded ketone **264** (5.1 mg, 15 μmol, 2.5%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3084, 3059, 3026, 2953, 2926, 2872, 1737, 1689, 1644, 1602, 1574, 1495, 1450, 1380, 1349, 1306, 1263, 1179, 1158, 1128, 1115, 1068, 1027, 1001, 944, 908, 841, 806, 762, 746, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.39 – 7.31 (1H, m, C11H), 7.31 – 7.27 (2H, m, 2 × C10H), 7.19 – 7.15 (2H, m, 2 × C9H), 3.39 (1H, dt, J = 9.6, 6.7 Hz, C4H), 3.06 (1H, td, J = 7.9, 5.0 Hz, C2H), 2.72 (1H, quint.d, J = 7.4, 4.7 Hz, C3H), 2.24 (3H, s, $C18H_3$), 2.20 (6H, s, 2 × $C17H_3$), 2.15 (6H, s, 2 × $C16H_3$), 2.14 – 2.04 (3H, m, $C5H_{cis}H_{trans}$ and $C6H_2$), 2.07 – 1.97 (1H, m, $C5H_{cis}H_{trans}$), 0.62 (3H, d, J = 7.2 Hz, $C7H_3$).

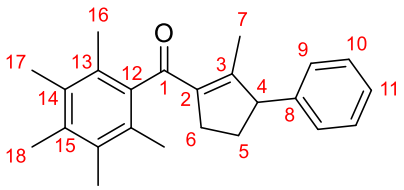
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.4 (C1=O), 142.3 (C8), 141.0 (C12), 135.6 (C15), 133.3 (2C, 2 × C14), 128.5 (2C, 2 × C9H), 128.2 (2C, 2 × C10H), 128.0 (2C, br. s, 2 × C13), 126.1 (C11H), 61.3 (C2H), 48.9 (C4H), 40.4 (C3H), 29.1 ($C5H_2$), 28.2 ($C6H_2$), 18.1 (2C, br. s, 2 × $C16H_3$), 17.3 ($C7H_3$), 16.9 ($C18H_3$), 16.2 (2C, 2 × $C17H_3$).

[*] The material was provided by Dr. James Frost.

HRMS (ESI$^+$) Found $[M+H]^+$ = 335.23688; $C_{24}H_{31}O$ requires 335.23694, Δ –0.19 ppm.

Note: *cis* and *trans* with respect to C2H.

(2-Methyl-3-phenylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (265)



In the preparation of ketone **264**, enone **265** (15.3 mg, 46.0 μmol, 7.7%) was also isolated as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3060, 3025, 2925, 2857, 1737, 1665, 1619, 1493, 1452, 1417, 1379, 1346, 1306, 1274, 1264, 1234, 1197, 1172, 1145, 1073, 1027, 908, 878, 852, 839, 803, 761, 732, 701.

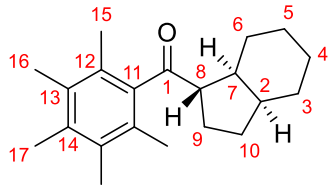
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.26 (2H, m, 2 × C10H), 7.28 – 7.17 (1H, m, C11H), 7.14 – 7.08 (2H, m, 2 × C9H), 3.86 (1H, ddq, J = 9.3, 6.3, 1.6 Hz, C4H), 2.86 (1H, dtquint., J = 16.1, 7.3, 1.9 Hz, C6H_{cis}H$_{trans}$), 2.73 (1H, dddquint., J = 15.6, 9.1, 6.3, 1.9 Hz, C6H$_{cis}$$H_{trans}$), 2.38 (1H, dtd, J = 13.2, 9.2, 5.4 Hz, C5H$_{cis}$$H_{trans}$), 2.22 (3H, s, C18H$_3$), 2.18 (6H, s, 2 × C17H$_3$), 2.11 (6H, s, 2 × C16H$_3$), 1.83 (1H, ddt, J = 13.3, 9.2, 6.2 Hz, C5H_{cis}H$_{trans}$), 1.37 (3H, s, C7H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.2 (C1=O), 157.6 (C3), 144.3 (C8), 140.7 (C12), 139.0 (C3), 135.2 (C15), 133.1 (2C, 2 × C14), 128.8 (2C, 2 × C10H), 128.03 (2C, 2 × C13), 127.89 (2C, 2 × C9H), 126.8 (C11H), 59.7 (C4H), 32.6 (C6H$_2$), 31.6 (C5H$_2$), 17.2 (2C, 2 × C16H$_3$), 16.8 (C18H$_3$), 16.1 (2C, 2 × C17H$_3$), 14.9 (C7H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 333.22117; $C_{24}H_{29}O$ requires 333.22129, Δ –0.36 ppm.

Note: *cis* and *trans* with respect to C4H.

***rel*-((1*S*,6*S*,7*S*)-Bicyclo[4.3.0]nonan-7-yl)(2,3,4,5,6-pentamethylphenyl)methanone (266) or *rel*-((1*S*,3a*S*,7a*S*)-Octahydro-1*H*-inden-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (266)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), spirocyclic alcohol **223** (151 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **266** (88.0 mg, 0.295 mmol, 49%) as a colourless solid.

m.p. = 86 – 88 °C.

IR (film) ν_{max}/cm^{-1} 2922, 2853, 1688, 1574, 1448, 1382, 1341, 1308, 1258, 1182, 1153, 1118, 1102, 1068, 1041, 1002, 944, 909, 894, 879, 853, 827, 804, 702.

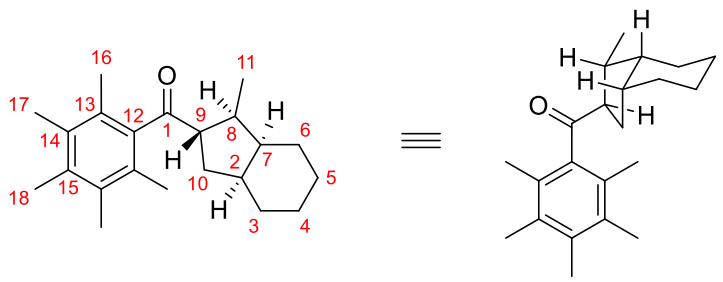
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.11 (1H, dt, J = 9.7, 6.1 Hz, C8H), 2.29 (1H, quint., J = 6.1 Hz, C7H), 2.23 (3H, s, $C17H_3$), 2.18 (6H, s, 2 × $C16H_3$), 2.11 (6H, s, 2 × $C15H_3$), 2.11 (1H, qd, J = 6.3, 4.4 Hz, C2H), 2.04 (1H, ddt, J = 13.5, 9.5, 6.1 Hz, C9H_{cis}H$_{trans}$), 1.96 (1H, dtd, J = 13.3, 9.3, 5.7 Hz, C9H$_{cis}H_{trans}$), 1.73 (1H, ddt, J = 12.6, 9.5, 6.4 Hz, C10H$_{cis}H_{trans}$), 1.54 (1H, ddt, J = 12.9, 9.0, 6.7 Hz, C10H_{cis}H$_{trans}$), 1.55 – 1.46 (2H, m, C6H_{cis}H$_{trans}$ and C3H$_{cis}H_{trans}$), 1.51 – 1.45 (1H, m, C4H_{cis}H$_{trans}$), 1.45 – 1.36 (1H, m, C5H$_{cis}H_{trans}$), 1.41 – 1.31 (2H, m, C3H_{cis}H$_{trans}$ and C6H$_{cis}H_{trans}$), 1.35 – 1.25 (2H, m, C4H$_{cis}H_{trans}$ and C5H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.9 (C1=O), 141.2 (C11), 135.4 (C14), 133.2 (2C, 2 × C13), 128.0 (2C, br. s, 2 × C12), 57.0 (C8H), 42.2 (C7H), 39.6 (C2H), 29.6 ($C10H_2$), 27.9 ($C6H_2$), 27.6 ($C3H_2$), 26.7 ($C9H_2$), 23.6 ($C5H_2$), 23.3 ($C4H_2$), 18.0 (2C, br. s, 2 × $C15H_3$), 16.8 ($C17H_3$), 16.2 (2C, 2 × $C16H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 299.23691; $C_{21}H_{31}O$ requires 299.23694, Δ –0.11 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-((1*S*,6*S*,7*S*,8*S*)-7-Methylbicyclo[4.3.0]nonan-8-yl)(2,3,4,5,6-pentamethylphenyl)methanone (267) or *rel*-((1*S*,2*S*,3a*S*,7a*S*)-1-Methyloctahydro-1*H*-inden-2-yl)(2,3,4,5,6-pentamethylphenyl)methanone (267)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 µmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 µmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **221** (168 mg, 1.20 mmol, 2.0 equiv) and toluene (150 µL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **267** (36.0 mg) as a colourless solid. Two other fractions containing ketone **267** and undetermined enones were also collected.

Fraction	Mass / mg	Yields / mmol	
		267	Unknown enones
1	36.0	0.115	-
2	31.3	0.0638	0.037
3	12.5	0.0078	0.032
Total		0.187 mmol 31%	0.069 mmol 12%

When the reaction was repeated at 125 °C, purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **267** (120 mg, 0.385 mmol, 64%) as a colourless solid.

m.p. = 118 – 120 °C.

IR (film) ν_{max}/cm^{-1} 2921, 2872, 2853, 1687, 1573, 1448, 1379, 1361, 1340, 1309, 1258, 1221, 1174, 1140, 1130, 1122, 1104, 1070, 1020, 998, 958, 926, 912, 870, 853, 814, 706.

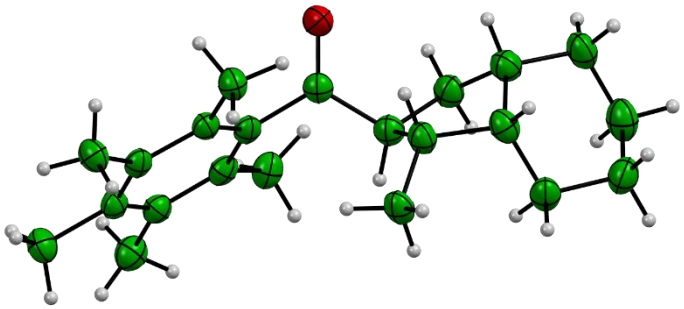
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.99 (1H, ddd, J = 10.8, 9.7, 5.0 Hz, C9H), 2.41 (1H, dquint., J = 9.7, 6.8 Hz, C8H), 2.30 – 2.19 (1H, m, C2H), 2.23 (3H, s, C18H_3), 2.18 (6H, s, 2 × C17H_3), 2.12 (6H, s, 2 × C16H_3), 1.98 – 1.89 (2H, m, C10H_2), 1.81 (1H, dq, J = 11.1, 5.6 Hz, C7H), 1.69 (1H, dquint.d, J = 12.9, 3.4, 1.3 Hz, C5H$_{cis}$*H$_{trans}$*), 1.63 – 1.51 (2H, m, C3H_2), 1.48 (1H, dq, J = 13.1, 4.3 Hz, C6*H$_{cis}$*H$_{trans}$), 1.46 (1H, dquint., J = 13.4, 3.9 Hz, C4*H$_{cis}$*H$_{trans}$), 1.30 (1H, qdd, J = 13.0, 5.2, 3.2 Hz, C4H$_{cis}$*H$_{trans}$*), 1.11 (1H, qt, J = 13.0, 3.2 Hz, C5*H$_{cis}$*H$_{trans}$), 0.91 (1H, qd, J = 12.9, 3.4 Hz, C6H$_{cis}$*H$_{trans}$*), 0.88 (3H, d, J = 6.9 Hz, C11H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 215.4 (C1=O), 141.4 (C12), 135.4 (C15), 133.2 (2C, 2 × C14), 127.8 (2C, v. br. s, 2 × C13), 58.5 (C9H), 45.0 (C7H), 42.3 (C8H), 38.8 (C2H), 30.4 (C10H_2), 26.7 (C3H_2), 25.5 (C5H_2), 23.1 (C6H_2), 20.9 (C4H_2), 18.1 (2C, br. s, 2 × C16H_3), 16.9 (C18H_3), 16.2 (2C, 2 × C17H_3), 15.3 (C11H_3).

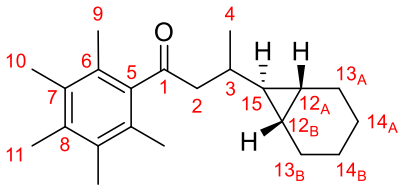
HRMS (ESI$^+$) Found [M+H]$^+$ = 313.25250; $C_{22}H_{33}O$ requires 313.25259, Δ –0.29 ppm.

Note: *cis* and *trans* with respect to C2H.

The relative stereochemistry of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



***rel*-3-((1*R*,6*S*,7*r*)-Bicyclo[4.1.0]heptan-7-yl)-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (269)**



In the preparation of ketone **270**, analytically pure ketone **269** was isolated from fraction 1 as a colourless solid.

m.p. = 72 – 75 °C.

IR (film) ν_{max}/cm^{-1} 2923, 2852, 1701, 1575, 1448, 1399, 1381, 1351, 1307, 1261, 1208, 1145, 1121, 1091, 1071, 1022, 1000, 981, 930, 893, 844, 793, 767, 744, 699.

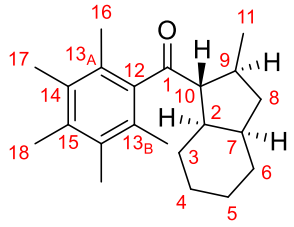
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.84 (1H, dd, J = 19.1, 4.1 Hz, C2H_AH$_B$), 2.62 (1H, dd, J = 19.1, 8.4 Hz, C2H$_A$$H_B$), 2.23 (3H, s, C11H$_3$), 2.19 (6H, s, 2 × C10H$_3$), 2.12 (6H, s, 2 × C9H$_3$), 1.90 – 1.84 (1H, m, C13$_A$$H_{cis}H_{trans}$), 1.84 – 1.79 (1H, m, C13$_B$$H_{cis}H_{trans}$), 1.61 (1H, dddd, J = 13.5, 7.3, 5.1, 1.5 Hz, C13$_A$H$_{cis}$$H_{trans}$), 1.51 (1H, dddd, J = 13.6, 8.0, 5.4, 1.9 Hz, C13$_B$H$_{cis}$$H_{trans}$), 1.52 – 1.41 (1H, m, C3H), 1.24 – 1.15 (2H, m, C14$_A$$H_{cis}H_{trans}$ and C14$_B$$H_{cis}H_{trans}$), 1.18 – 1.05 (2H, m, C14$_A$H$_{cis}$$H_{trans}$ and C14$_B$H$_{cis}$$H_{trans}$), 1.10 (3H, d, J = 6.7 Hz, C4H$_3$), 0.77 – 0.66 (2H, m, C12$_A$H and C12$_B$H), 0.30 (1H, dt, J = 9.4, 4.7 Hz, C15H).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.4 (C1=O), 141.0 (C5), 135.4 (C8), 133.2 (2C, 2 × C7), 127.4 (2C, 2 × C6), 52.9 ($C2H_2$), 33.6 (C3H), 31.2 (C15H), 24.04 ($C13_BH_2$), 24.03 ($C13_AH_2$), 21.78 ($C14_BH_2$), 21.73 ($C14_AH_2$), 19.9 ($C4H_3$), 17.2 (2C, 2 × $C9H_3$), 16.81 ($C11H_3$), 16.79 ($C12_AH$), 16.69 ($C12_BH$), 16.1 (2C, 2 × $C10H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 313.25253; $C_{22}H_{33}O$ requires 313.25259, Δ –0.19 ppm.

Note: *cis* and *trans* with respect to $C12_{A/B}H$. The d.r. is 7.9:1, but the minor diastereomer could not be fully characterised. Comparison of diastereomeric ratio was performed using signals at δ = 2.84 (1H, dd, $C2H_AH_B$, major) and δ = 2.49 (1H, dd, minor). The relative geometry of the diastereomers could not be determined.

***rel*-((1*R*,6*R*,8*S*,9*R*)-8-Methylbicyclo[4.3.0]nonan-9-yl)(2,3,4,5,6-pentamethylphenyl)methanone, or *rel*-((1*R*,2*S*,3a*R*,7a*R*)-2-Methyloctahydro-1*H*-inden-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **268**[*] (168 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded the following three fractions.

[*] The material was provided by Dr. James Frost.

Fraction	Mass / mg	Yields / mmol	
		269	**270**
1	59.3	0.190	-
2	87.0	0.0363	0.242
3	12.5	-	0.0400
Total		0.226 mmol 38%	0.282 mmol 47%

Analytically pure ketone **270** was isolated from fraction 3 as a colourless solid.

m.p. = 81 – 84 °C.

IR (film) ν_{max}/cm^{-1} 2922, 2853, 1737, 1686, 1573, 1448, 1418, 1380, 1337, 1304, 1261, 1175, 1134, 1107, 1070, 999, 950, 914, 887, 825, 800, 780, 702.

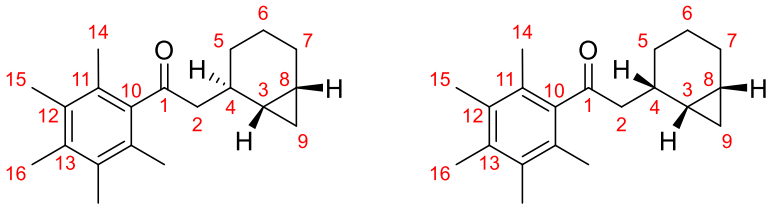
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.59 (1H, dd, J = 7.1, 4.0 Hz, C10H), 2.43 (1H, ddquint., J = 9.3, 7.8, 6.8 Hz, C9H), 2.27 (1H, dtd, J = 10.0, 6.1, 4.7 Hz, C2H), 2.23 (3H, s, C18H_3), 2.18 (6H, s, 2 × C17H_3), 2.19 – 2.10 (1H, m, C7H), 2.11 (6H, s, 2 × C16H_3), 1.81 (1H, ddd, J = 12.1, 8.1, 6.3 Hz, C8H_{cis}H$_{trans}$), 1.58 – 1.51 (2H, m, C6H_2), 1.56 – 1.49 (1H, m, C4H_{cis}H$_{trans}$), 1.53 – 1.46 (1H, m, C3H_{cis}H$_{trans}$), 1.43 – 1.34 (3H, m, C8H$_{cis}$$H_{trans}$ and C5H_2), 1.33 – 1.22 (1H, m, C3H$_{cis}$$H_{trans}$), 1.25 – 1.16 (1H, m, C4H$_{cis}$$H_{trans}$), 1.01 (3H, d, J = 6.8 Hz, C11H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.3 (C1=O), 141.2 (C12), 135.3 (C15), 133.1 (2C, 2 × C14), 128.0 (v. br. s, C13$_A$), 127.7 (v. br. s, C13$_B$), 67.3 (C10H), 42.4 (C2H), 39.1 (C7H), 38.2 (C8H_2), 36.3 (C9H), 29.7 (C3H_2), 27.6 (C6H_2), 25.3 (C4H_2), 22.7 (C11H_3), 22.2 (C5H_2), 18.1 (2C, br. s, 2 × C16H_3), 16.8 (C18H_3), 16.2 (2C, 2 × C17H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 313.25259; $C_{22}H_{33}O$ requires 313.25259, Δ 0.00 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-2-((1*S*,2*R*,6*R*)-Bicyclo[4.1.0]heptan-2-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (*syn*-272, major), and *rel*-2-((1*S*,2*S*,6*R*)-Bicyclo[4.1.0]heptan-2-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (*anti*-272, minor)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **271**[*] (135 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1 → 98:2) afforded ketone **272** (26.8 mg) as a colourless solid. A second fraction (25.6 mg) was also isolated containing an approximately 1.5:1 mixture of ketones **272** and **274**. The total approximate yield is 0.148 mmol, 25%, and the calculated *anti*:*syn* ratio is 1:1.5.

m.p. = 92 – 95 °C.

IR (film) ν_{max}/cm^{-1} 3062, 2995, 2921, 2854, 1695, 1574, 1452, 1400, 1379, 1354, 1303, 1280, 1264, 1203, 1166, 1140, 1115, 1105, 1069, 1017, 994, 933, 909, 886, 827, 795, 764, 734, 696, 647.

[*] The material was provided by Dr. James Frost.

^{1}H NMR ($CDCl_3$, 500 MHz, *anti* isomer) δ = 2.82 (2H, d, J = 6.8 Hz, C2H_2), 2.24 (3H, s, C16H_3), 2.25 – 2.18 (1H, m, C4H), 2.19 (6H, s, 2 × C15H_3), 2.14 (6H, s, 2 × C14H_3), 1.79 (1H, dt, J = 13.4, 4.7 Hz, C7$H_{cis}$$H_{trans}$), 1.73 (1H, ddt, J = 13.5, 11.2, 5.6 Hz, C7$H_{cis}$$H_{trans}$), 1.67 – 1.57 (1H, m, C5$H_{cis}$$H_{trans}$), 1.48 – 1.39 (1H, m, C6$H_{cis}$$H_{trans}$), 1.06 (1H, dtdd, J = 13.6, 11.3, 5.2, 2.3 Hz, C6$H_{cis}$$H_{trans}$), 0.95 – 0.91 (1H, m, C8H), 0.91 – 0.83 (1H, m, C5$H_{cis}$$H_{trans}$), 0.66 – 0.60 (2H, m, C3H and C9$H_{cis}$$H_{trans}$), 0.18 – 0.09 (1H, m, C9$H_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, *anti* isomer) δ = 211.3 (C1=O), 140.82 (C10), 135.44 (C13), 133.20 (2C, 2 × C12), 127.6 (2C, 2 × C11), 54.2 (C2H_2), 30.8 (C4H), 29.6 (C5H_2), 23.4 (C7H_2), 19.2 (C6H_2), 17.3 (2C, 2 × C14H_3), 16.83 (C16H_3), 16.10 (2C, 2 × C15H_3), 15.3 (C3H), 10.68 (C8H), 10.44 (C9H_2).

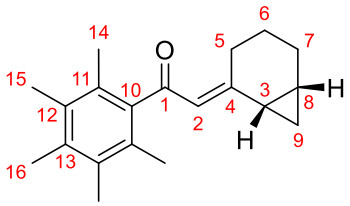
^{1}H NMR ($CDCl_3$, 500 MHz, *syn* isomer) δ = 2.78 (1H, dd, J = 18.1, 7.2 Hz, C2$H_A$$H_B$), 2.63 (1H, ddd, J = 11.1, 7.2, 5.4 Hz, C4H), 2.58 (1H, dd, J = 18.0, 5.2 Hz, C2$H_A$$H_B$), 2.23 (3H, s, C16$H_3$), 2.19 (6H, s, 2 × C15$H_3$), 2.13 (6H, s, 2 × C14$H_3$), 2.05 – 1.95 (1H, m, C7$H_{cis}$$H_{trans}$), 1.60 – 1.49 (1H, m, C5$H_{cis}$$H_{trans}$), 1.39 – 1.35 (1H, m, C6$H_{cis}$$H_{trans}$), 1.35 – 1.29 (1H, m, C7$H_{cis}$$H_{trans}$), 1.29 – 1.19 (1H, m, C6$H_{cis}$$H_{trans}$), 1.18 (1H, tt, J = 8.8, 5.5 Hz, C3H), 1.00 (1H, tdd, J = 8.6, 3.7, 2.2 Hz, C8H), 0.72 – 0.66 (1H, m, C5$H_{cis}$$H_{trans}$), 0.45 (1H, td, J = 8.8, 4.4 Hz, C9$H_{cis}$$H_{trans}$), –0.08 (1H, q, J = 5.1 Hz, C9$H_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, *syn* isomer) δ = 211.6 (C1=O), 140.98 (C10), 135.34 (C13), 133.16 (2C, 2 × C12), 127.4 (2C, 2 × C11), 53.2 (C2H_2), 28.3 (C4H), 26.8 (C5H_2), 23.9 (C7H_2), 22.7 (C6H_2), 17.1 (2C, 2 × C14H_3), 16.81 (C16H_3), 16.08 (2C, 2 × C15H_3), 15.5 (C3H), 10.41 (C8H), 8.25 (C9H_2).

HRMS (ESI^+) Found $[M+H]^+$ = 285.22128; $C_{20}H_{29}O$ requires 285.22129, Δ –0.03 ppm.

Note: *cis* and *trans* with respect to C3H.

***rel*-(*E*)-2-((1*S*,6*R*)-Bicyclo[4.1.0]heptan-2-ylidene)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one ((*E*)-273)**



In the preparation of ketone **272**, the column was flushed with Et_2O after ketones **272** and **274** had fully eluted. The eluent was concentrated *in vacuo* and purified by preparative TLC (Pentane:Et_2O:DCM, 95:4:1) to give enone (*E*)-**273** (8.4 mg, 30 μmol, 5.0%) as a colourless solid.

m.p. = 108 – 111 °C.

IR (film) ν_{max}/cm^{-1} 3071, 3006, 2924, 2860, 1701, 1659, 1578, 1449, 1384, 1339, 1302, 1265, 1222, 1177, 1131, 1094, 1069, 1020, 919, 895, 846, 732, 701.

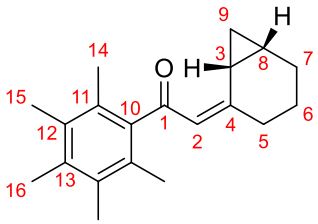
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.35 (1H, t, J = 1.9 Hz, C2H), 2.84 – 2.70 (2H, m, $C5H_2$), 2.23 (3H, s, $C16H_3$), 2.19 (6H, s, 2 × $C15H_3$), 2.14 (6H, s, 2 × $C14H_3$), 1.89 – 1.78 (2H, m, $C6H_2$), 1.59 (1H, ddd, J = 9.3, 7.6, 4.5 Hz, C3H), 1.54 – 1.46 (2H, m, C7$H_{cis}$$H_{trans}$ and C8H), 1.40 (1H, dtt, J = 13.9, 9.0, 6.0 Hz, C7$H_{cis}$$H_{trans}$), 0.96 (1H, ddd, J = 9.4, 8.2, 4.8 Hz, C9$H_{cis}$$H_{trans}$), 0.87 (1H, dt, J = 5.8, 4.7 Hz, C9$H_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 199.9 (C1=O), 164.1 (C4), 142.2 (C10), 134.9 (C13), 133.0 (2C, 2 × C12), 128.0 (2C, 2 × C11), 124.8 (C2H), 27.0 ($C5H_2$), 22.0 ($C6H_2$), 21.5 (C3H), 18.9 ($C7H_2$), 17.3 (2C, 2 × $C14H_3$), 16.8 ($C16H_3$), 16.13 (2C, 2 × $C15H_3$), 16.09 (C8H), 13.1 ($C9H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 283.20563; $C_{20}H_{27}O$ requires 283.20564, Δ –0.05 ppm.

Note: *cis* and *trans* with respect to C3H.

***rel*-(*Z*)-2-((1*R*,6*S*)-Bicyclo[4.1.0]heptan-2-ylidene)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one ((*Z*)-273)**



In the preparative TLC of the column flush eluent from the preparation of ketone **272**, enone (*Z*)-**273** (8.2 mg, 29 μmol, 4.8%) was also isolated as a colourless solid.

m.p. = 118 – 120 °C.

IR (film) ν_{max}/cm^{-1} 3072, 3007, 2926, 2859, 1733, 1703, 1662, 1631, 1584, 1449, 1414, 1384, 1338, 1315, 1300, 1265, 1218, 1188, 1163, 1130, 1070, 1018, 1002, 927, 883, 846, 811, 746, 708.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.21 (1H, q, J = 1.2 Hz, C2H), 2.70 (1H, ddd, J = 9.9, 7.5, 4.8 Hz, C3H), 2.22 (3H, s, C16H_3), 2.18 (6H, s, 2 × C15H_3), 2.15 (6H, s, 2 × C14H_3), 2.14 – 2.10 (2H, m, C5H_2), 1.93 (1H, ddt, J = 14.0, 8.3, 5.9 Hz, C7H_{cis}H$_{trans}$), 1.78 (1H, dddd, J = 13.8, 7.0, 5.1, 2.1 Hz, C7H$_{cis}$$H_{trans}$), 1.54 – 1.41 (2H, m, C6H_2), 1.37 (1H, ttd, J = 8.0, 6.0, 2.1 Hz, C8H), 1.03 (1H, ddd, J = 9.8, 8.2, 4.4 Hz, C9H_{cis}H$_{trans}$), 0.63 (1H, dt, J = 5.8, 4.7 Hz, C9H$_{cis}$$H_{trans}$).

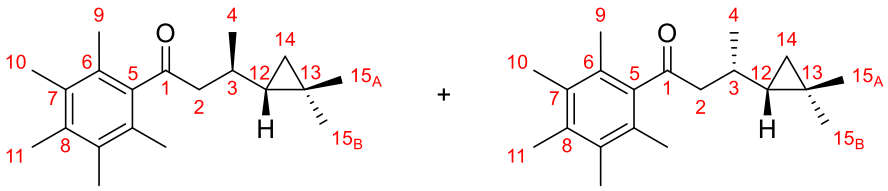
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.4 (C1=O), 162.9 (C4), 142.1 (C10), 134.9 (C13), 133.0 (2C, 2 × C12), 128.1 (2C, 2 × C11), 125.7 (C2H), 33.1 (C5H_2), 23.2 (C7H_2), 21.0 (C6H_2), 17.3 (2C, 2 × C14H_3), 16.84 (C16H_3), 16.72 (C3H), 16.1 (2C, 2 × C15H_3), 15.7 (C8H), 14.4 (C9H_2).

HRMS (ESI$^+$) Found $[M+H]^+$ = 283.20569; $C_{20}H_{27}O$ requires 283.20564, Δ 0.16 ppm.

Note: *cis* and *trans* with respect to C3H.

***rel*-(*R*)-3-((*S*)-2,2-Dimethylcyclopropyl)-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (277), and**

***rel*-(*S*)-3-((*S*)-2,2-Dimethylcyclopropyl)-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (277)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **276**[*] (137 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **277** (51.2 mg, 0.179 mmol, 30%, d.r. = 2.2:1) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3053, 2952, 2927, 2870, 1701, 1575, 1455, 1400, 1378, 1349, 1308, 1274, 1205, 1126, 1099, 1068, 1020, 999, 970, 933, 898, 880, 857, 822, 705, 689.

^{1}H NMR ($CDCl_3$, 500 MHz, isomer A) δ = 2.81 (1H, dd, J = 19.4, 2.5 Hz, C2H_AH_B), 2.67 (1H, dd, J = 19.4, 9.9 Hz, C2H_AH_B), 2.24 (3H, s, C11H_3), 2.20 (6H, s, 2 × C10H_3), 2.13 (6H, s, 2 × C9H_3), 1.80 – 1.70 (1H, m, C3H), 1.20 (3H, d, J = 6.5 Hz, C4H_3), 1.10 (3H, s, C15$_A$$H_3$), 1.00 (3H, s, C15$_B$$H_3$), 0.47 – 0.37 (2H, m, C12H and C14$H_{cis}H_{trans}$), 0.02 (1H, dd, J = 4.0, 3.3 Hz, C14$H_{cis}$$H_{trans}$).

[*] The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 126 MHz, isomer A) δ = 211.1 (C1=O), 140.8 (C5), 135.35 (C8), 133.15 (2C, 2 × C7), 127.30 (2C, 2 × C6), 53.6 ($C2H_2$), 32.0 (C12H), 29.80 (C3H), 27.8 ($C15_BH_3$), 20.5 ($C4H_3$), 20.09 ($C15_AH_3$), 19.30 ($C14H_2$), 17.07 (2C, 2 × $C9H_3$), 16.77 ($C11H_3$), 16.18 (C13), 16.04 (2C, 2 × $C10H_3$).

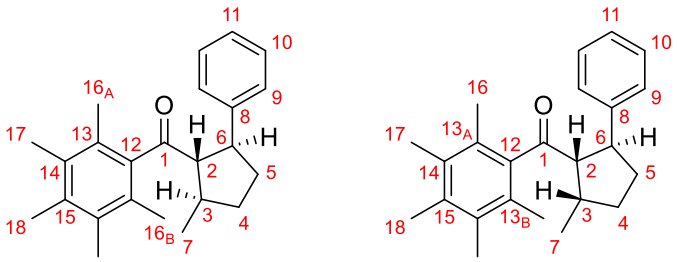
^{1}H NMR ($CDCl_3$, 500 MHz, isomer B) δ = 2.87 (1H, dd, J = 19.1, 3.9 Hz, $C2H_AH_B$), 2.64 (1H, dd, J = 19.1, 8.5 Hz, $C2H_AH_B$), 2.24 (3H, s, $C11H_3$), 2.20 (6H, s, 2 × $C10H_3$), 2.13 (6H, s, 2 × $C9H_3$), 1.83 (1H, ddqd, J = 10.3, 8.3, 6.6, 3.8 Hz, C3H), 1.17 (3H, s, $C15_AH_3$), 1.15 (3H, d, J = 6.6 Hz, $C4H_3$), 1.06 (3H, s, $C15_BH_3$), 0.42 – 0.32 (2H, m, C12H and $C14H_{cis}H_{trans}$), 0.05 (1H, dd, J = 4.5, 3.1 Hz, $C14H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer B) δ = 211.4 (C1=O), 141.0 (C5), 135.30 (C8), 133.12 (2C, 2 × C7), 127.38 (2C, 2 × C6), 53.3 ($C2H_2$), 32.2 (C12H), 29.81 (C3H), 28.0 ($C15_BH_3$), 21.3 ($C4H_3$), 20.00 ($C15_AH_3$), 19.38 ($C14H_2$), 17.08 (2C, 2 × $C9H_3$), 16.78 ($C11H_3$), 16.5 (C13), 16.05 (2C, 2 × $C10H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 287.23712; $C_{20}H_{31}O$ requires 287.23694, Δ 0.62 ppm.

Note: *cis* and *trans* with respect to C12H. In addition, the d.r. is 2.2:1, but it is not possible to distinguish between either diastereomers.

***rel*-((1*S*,2*R*,5*S*)-2-Methyl-5-phenylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (280, major), and *rel*-((1*S*,2*S*,5*S*)-2-Methyl-5-phenylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (281, minor)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **279** (103 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded the following three fractions.

Fraction	Mass / mg	Yields / mmol				
		121	**280**	**281**	Unknown isomer A[a]	Unknown isomer B[a]
1	23.2	-	0.0482	0.0109	0.105	
2	79.2	-	0.173	0.0577	-	0.0058
3	14.3	0.0080	0.0193	0.0073	-	0.0129
Total		8.0 μmol 1.3%	0.240 mmol 40%	75.9 μmol 13%		

[a]*The molecular mass of the unknown isomers was assumed to be the same as ketones **280** or **281**.*

Characterisation of the inseparable mixture of ketones **280** and **281** was carried out with fraction 2.

IR (film) ν_{max}/cm^{-1} 3082, 3061, 3027, 2950, 2869, 1686, 1602, 1573, 1493, 1453, 1381, 1338, 1303, 1269, 1167, 1126, 1092, 1070, 1029, 999, 950, 910, 823, 756, 700.

^{1}H NMR ($CDCl_3$, 500 MHz, major isomer) δ = 7.21 – 7.14 (2H, m, 2 × C10H), 7.14 – 7.09 (3H, m, 2 × C9H and C11H), 3.58 (1H, q, J = 8.8 Hz, C6H), 2.93 (1H, dd, J = 9.1, 7.6 Hz, C2H), 2.43 (1H, ddq, J = 14.7, 8.0, 6.8 Hz, C3H), 2.17 (3H, s, C18H), 2.12 (1H, dddd, J = 12.5, 8.4, 6.9, 5.3 Hz, $C5H_{cis}\mathit{H_{trans}}$), 2.08 (6H, br. s, 2 × $C17H_3$), 2.00 (1H, dtd, J = 12.4, 8.0, 7.0 Hz, $C4H_{cis}\mathit{H_{trans}}$), 1.99 (3H, v. br. s, $C16_AH_3$), 1.85 (1H, ddt, J = 12.5, 8.8, 7.8 Hz, $C5\mathit{H_{cis}}H_{trans}$), 1.68 (3H, v. br. s, $C16_BH_3$), 1.54 (1H, ddt, J = 12.0, 7.9, 5.7 Hz, $C4\mathit{H_{cis}}H_{trans}$), 1.03 (3H, d, J = 6.7 Hz, $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, major isomer) δ = 213.0 (C1=O), 145.2 (C8), 140.7 (C12), 135.38 (C15), 132.96 (2C, br. s, 2 × C14), 128.21 (2C, 2 × C10H), 128.01 (2C, v. br. s, 2 × C13), 127.6 (2C, 2 × C9H), 126.03 (C11H), 69.7 (C2H), 48.6 (C6H), 38.4 (C3H), 34.89 ($C4H_2$), 34.5 ($C5H_2$), 21.7 ($C7H_3$), 17.81 (br. s, $C16_AH_3$), 17.80 (br. s, $C16_BH_3$), 16.80 ($C18H_3$), 16.09 (2C, br. s, 2 × $C17H_3$).

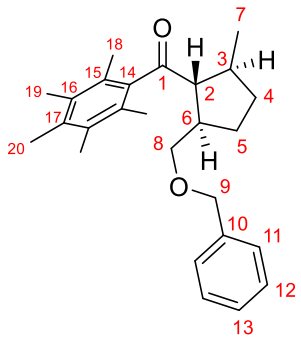
^{1}H NMR ($CDCl_3$, 500 MHz, minor isomer) δ = 7.21 – 7.14 (2H, m, 2 × C10H), 7.14 – 7.09 (1H, m, C11H), 7.08 – 7.04 (2H, m, 2 × C9H), 3.60 (1H, td, J = 10.4, 6.5 Hz, C6H), 3.33 (1H, dd, J = 9.8, 6.0 Hz, C2H), 2.64 (1H, dddq, J = 12.8, 9.8, 7.6, 6.6 Hz, C3H), 2.38 (1H, ddt, J = 13.6, 10.3, 8.4 Hz, $C5H_{cis}\mathit{H_{trans}}$), 2.18 (3H, s, $C18H_3$), 2.06 (6H, s, 2 × $C17H_3$), 2.08 – 1.99 (1H, m, $C4\mathit{H_{cis}}H_{trans}$), 1.79 (1H, dddd, J = 13.3, 9.6, 6.3, 3.7 Hz, $C5\mathit{H_{cis}}H_{trans}$), 1.77 (6H, s, v. br. s, 2 × $C16H_3$), 1.67 (1H, ddt, J = 11.9, 8.3, 3.4 Hz, $C4H_{cis}\mathit{H_{trans}}$), 1.15 (3H, d, J = 6.9 Hz, $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, minor isomer) δ = 212.6 (C1=O), 146.1 (C8), 141.0 (C12), 135.37 (C15), 133.01 (2C, 2 × C14), 128.43 ($C13_A$), 128.41 ($C13_B$), 128.22 (2C, 2 × C10H), 127.85 (2C, 2 × C9H), 126.04 (C11H), 67.0 (C2H), 45.3 (C6H), 38.0 (C3H), 34.8 ($C4H_2$), 32.8 ($C5H_2$), 17.4 (2C, br. s, 2 × $C16H_3$), 16.83 ($C18H_3$), 16.19 ($C7H_3$), 16.07 (C2C, 2 × $C17H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 335.23694; $C_{40}H_{31}O$ requires 335.23694, Δ –0.01 ppm.

Note: *cis* and *trans* with respect to C2H for both isomers.

***rel*-((1*R*,2*R*,5*S*)-2-((Benzyloxy)methyl)-5-methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (282)**



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 µmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 µmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), *cis*-**228** (248 mg, 1.20 mmol, 2.0 equiv) and toluene (150 µL, 4 M) were subjected to **General Procedure F** at 125 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 97:3 → 95:5) afforded three fractions.

Fraction	Mass / mg	Yields / mmol		
		282	**283**	**284**
1	23.5	-	0.0396	0.0225
2	33.7	0.0686	0.0131	0.0686
3	69.2	0.153	-	-
Total		0.251 mmol 42%	52.7 μmol 8.7%	29.8 μmol 5.0%

Analytically pure ketone **282** was isolated from fraction 3 as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3087, 3063, 3029, 2948, 2926, 2866, 2789, 1685, 1573, 1496, 1454, 1407, 1379, 1362, 1305, 1266, 1206, 1173, 1098, 1028, 1002, 952, 929, 906, 863, 830, 735, 697.

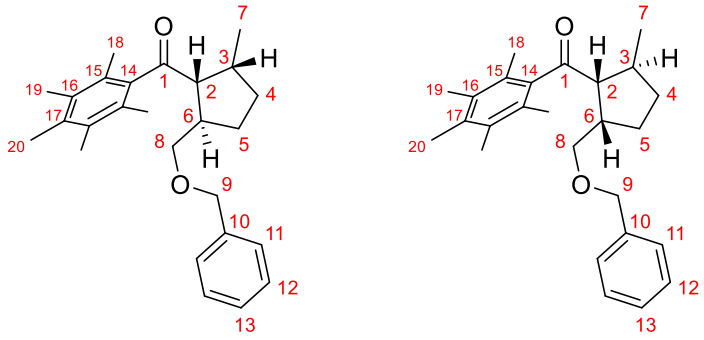
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.28 (2H, m, 2 × C12H), 7.30 – 7.22 (1H, m, C13H), 7.27 – 7.21 (2H, m, C11H), 4.39 (2H, q_{AB}, J_{AB} = 12.2 Hz, Δ_{AB} = 14.0 Hz, $C9H_2$), 3.33 (1H, dd, J = 9.3, 5.3 Hz, $C8H_AH_B$), 3.27 (1H, dd, J = 9.3, 7.0 Hz, $C8H_AH_B$), 2.72 (1H, tq, J = 7.9, 5.7 Hz, C6H), 2.62 (1H, t, J = 7.2 Hz, C2H), 2.34 (1H, sept., J = 7.1 Hz, C3H), 2.22 (3H, s, $C20H_3$), 2.16 (6H, s, 2 × $C19H_3$), 2.08 (6H, s, 2 × $C18H_3$), 1.89 – 1.80 (1H, m, $C4H_{cis}H_{trans}$), 1.86 – 1.75 (1H, m, $C5H_{cis}H_{trans}$), 1.71 – 1.61 (1H, m, $C5H_{cis}H_{trans}$), 1.31 (1H, tt, J = 11.9, 7.9 Hz, $C4H_{cis}H_{trans}$), 0.93 (3H, d, J = 6.7 Hz, $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.3 (C1=O), 140.7 (C14), 138.8 (C10), 135.4 (C17), 133.1 (2C, 2 × C16), 128.4 (2C, 2 × C12H), 128.0 (2C, 2 × C15), 127.55 (2C, 2 × C11H), 127.51 (C13H), 73.7 ($C8H_2$), 72.9 ($C9H_2$), 63.7 (C2H), 42.0 (C6H), 37.6 (C3H), 34.5 ($C4H_2$), 28.9 ($C5H_2$), 21.0 ($C7H_3$), 18.1 (2C, 2 × $C18H_3$), 16.9 ($C20H_3$), 16.2 (2C, 2 × $C19H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 401.24500; $C_{26}H_{34}O_2Na$ requires 401.24510, Δ –0.27 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-((1*R*,2*R*,5*R*)-2-((Benzyloxy)methyl)-5-methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (283, major), and *rel*-((1*R*,2*S*,5*S*)-2-((Benzyloxy)methyl)-5-methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (284, minor)**



1.7 : 1

In the preparation of ketone **282**, analytically pure ketones **283** and **284** were isolated (as an inseparable 1.76:1 mixture) from fraction 1 as a colourless oil. The final calculated yield for ketone **283** is 52.7 μmol, 8.7%, and for ketone **284** it is 29.8 μmol, 5.0%.

IR (film) ν_{max}/cm^{-1} 3085, 3063, 3029, 2927, 2868, 2795, 1739, 1684, 1604, 1572, 1496, 1454, 1408, 1380, 1362, 1305, 1257, 1205, 1175, 1097, 1028, 999, 942, 907, 845, 827, 735, 698.

^{1}H NMR ($CDCl_3$, 500 MHz, major) δ = 7.34 – 7.26 (2H, m, 2 × C12H), 7.29 – 7.22 (1H, m, C13H), 7.21 – 7.15 (2H, m, 2 × C11H), 4.32 (2H, s, $C9H_2$), 3.35 (1H, dd, J = 9.4, 5.6 Hz, $C8H_AH_B$), 3.24 (1H, dd, J = 9.4, 6.4 Hz, $C8H_AH_B$), 3.18 (1H, t, J = 6.6 Hz, C2H), 2.66 (1H, dquint., J = 9.3, 6.0 Hz, C6H), 2.37 (1H, sept., J = 6.6 Hz, C3H), 2.23 (3H, s, $C20H_3$), 2.17 (6H, s, 2 × $C19H_3$), 2.15 (6H, s, 2 × $C18H_3$), 2.02 (1H, dddd, J = 13.0, 9.7, 8.4, 6.8 Hz, $C5H_{cis}H_{trans}$), 1.76 (1H, dtd, J = 12.6, 8.8, 7.3 Hz, $C4H_{cis}H_{trans}$), 1.61 (1H, dddd, J = 12.1, 8.3, 5.8, 5.3 Hz, $C4H_{cis}H_{trans}$), 1.54 (1H, ddt, J = 13.0, 9.0, 5.2 Hz, $C5H_{cis}H_{trans}$), 1.13 (3H, d, J = 7.0 Hz, $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, major) δ = 212.78 (C1=O), 140.83 (C14), 138.69 (C10), 135.6 (C17), 133.19 (2C, 2 × C16), 128.6 (2C, 2 × C15), 128.36 (2C, 2 × C12H), 127.48 (C13H), 127.46 (2C, 2 × C11H), 73.5 ($C8H_2$), 72.6 ($C10H_2$), 59.4 (C2H), 40.2 (C6H), 37.5 (C3H), 33.6 ($C4H_2$), 27.1 ($C5H_2$), 18.1 (2C, 2 × $C18H_3$), 16.92 ($C20H_3$), 16.23 (2C, 2 × $C19H_3$), 15.8 ($C7H_3$).

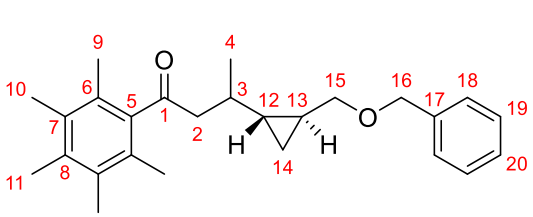
^{1}H NMR ($CDCl_3$, 500 MHz, minor) δ = 7.37 – 7.29 (4H, m, 2 × C11H and 2 × C12H), 7.34 – 7.26 (1H, m, C13H), 4.51 (2H, q_{AB}, J_{AB} = 11.8 Hz, Δ_{AB} = 30.4 Hz, $C9H_2$), 3.97 (1H, dd, J = 9.1, 7.0 Hz, C8H_AH$_B$), 3.71 (1H, dd, J = 9.1, 7.4 Hz, C8H$_A$$H_B$), 3.05 (1H, dd, J = 7.4, 5.9 Hz, C2H), 2.61 (1H, dquint., J = 8.9, 7.4 Hz, C6H), 2.30 (1H, sept., J = 6.7 Hz, C3H), 2.24 (3H, s, $C20H_3$), 2.18 (6H, s, 2 × $C19H_3$), 2.17 (6H, s, 2 × $C18H_3$), 2.00 (1H, dddd, J = 12.6, 8.8, 7.5, 4.6 Hz, C4H$_{cis}$$H_{trans}$), 1.92 (1H, dtd, J = 12.6, 7.9, 4.6 Hz, C5H_{cis}H$_{trans}$), 1.78 (1H, ddd, J = 12.4, 8.9, 6.5 Hz, C5H$_{cis}$$H_{trans}$), 1.27 (1H, dddd, J = 12.7, 8.1, 7.5, 6.2 Hz, C4H_{cis}H$_{trans}$), 0.91 (3H, d, J = 6.8 Hz, $C7H_3$).

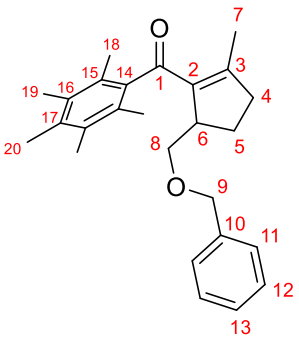
^{13}C NMR ($CDCl_3$, 126 MHz, minor) δ = 212.76 (C1=O), 140.82 (C14), 138.78 (C10), 135.8 (C17), 133.25 (2C, 2 × C16), 129.1 (2C, 2 × C15), 128.40 (2C, 2 × C12H), 127.9 (2C, 2 × C13H), 127.55 (C14H), 73.3 ($C10H_2$), 71.3 ($C8H_2$), 62.3 (C2H), 43.1 (C6H), 38.1 (C3H), 33.0 ($C4H_2$), 29.3 ($C5H_2$), 21.9 ($C7H_3$), 18.1 (2C, 2 × $C18H_3$), 16.95 ($C20H_3$), 16.26 (2C, 2 × $C19H_3$).

HRMS (ESI^{+1}) Found $[M+Na]^+$ = 401.24481; $C_{26}H_{34}O_2Na$ requires 401.24510, Δ –0.72 ppm.

Note: *cis* and *trans* with respect to C2H for both cases.

***rel*-3-((1*R*,2*S*)-2-((Benzyloxy)methyl)cyclopropyl)-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (286, isomer A), and (5-((Benzyloxy)methyl)-2-methylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (285)**





In the preparation of ketone **282**, three other fractions were also obtained.

Fraction	Mass / mg	Yields / mmol			
		285	**286A**	**286B**	**287**
4	27.4	-	-	0.0217	0.0507
5	14.9	0.0106	0.0166	0.0041	0.0081
6	8.7	0.0063	0.0166	-	-
Total		16.9 µmol 2.8%	33.2 µmol 5.5%	25.8 µmol 4.3%	58.8 µmol 9.8%

An analytically pure 1:2.6 inseparable mixture of enone **285** and ketone **286A** was isolated from fraction 6 as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3087, 3062, 3028, 2924, 2854, 1736, 1700, 1634, 1619, 1496, 1454, 1399, 1362, 1309, 1271, 1203, 1172, 1096, 1074, 1027, 1002, 941, 899, 849, 804, 735, 697.

^{1}H NMR ($CDCl_3$, 500 MHz, isomer A) δ = 7.36 – 7.31 (4H, m, 2 × C18H and 2 × C19H), 7.32 – 7.23 (1H, m, C20H), 4.54 (2H, q_{AB}, J_{AB} = 12.0 Hz, Δ_{AB} = 4.5 Hz, C16H_2), 3.39 (1H, dd, J = 10.3, 6.6 Hz, C15H_AH$_B$), 3.28 (1H, dd, J = 10.3, 7.1 Hz, C15H$_A$$H_B$), 2.84 (1H, dd, J = 19.1, 4.2 Hz, C2H_AH$_B$), 2.64 (1H, dd, J = 19.1, 8.2 Hz, C2H$_A$$H_B$), 2.23 (3H, s, C11$H_3$), 2.18 (6H, s, 2 × C10$H_3$), 2.11 (6H, s, 2 × C9$H_3$), 1.61 (1H, ddqd, J = 9.4, 8.2, 6.7, 4.2 Hz, C3H), 1.16 (3H, d, J = 6.7 Hz, C4H_3), 1.00 (1H, dtt, J = 8.5, 6.9, 4.6 Hz, C13H), 0.58 (1H, dddd, J = 9.4, 8.4, 4.9, 4.3 Hz, C12H), 0.51 (1H, dt, J = 8.3, 4.9 Hz, C14H$_{cis}$$H_{trans}$), 0.39 (1H, dt, J = 8.3, 4.8 Hz, C14H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer A) δ = 211.1 (C1=O), 140.84 (C5), 138.8 (C17), 135.4 (C8), 133.19 (2C, 2 × C7), 128.49 (2C, 2 × C19H), 127.72 (2C, 2 × C18H), 127.61 (C20H), 127.39 (2C, 2 × C6), 74.3 (C15H_2), 72.5 (C16H_2), 52.7 (C2H_2), 32.6 (C3H), 24.3 (C12H), 20.1 (C4H_3), 18.0 (C13H), 17.13 (2C, 2 × C9H_3), 16.82 (C11H_3), 16.08 (2C, 2 × C10H_3), 10.3 (C14H_2).

^{1}H NMR ($CDCl_3$, 500 MHz, enone isomer) δ = 7.36 – 7.31 (4H, m, 2 × C11H and 2 × C12H), 7.32 – 7.23 (1H, m, C13H), 4.51 (2H, q_{AB}, J_{AB} = 12.1 Hz, Δ_{AB} = 22.3 Hz, C9H_2), 3.74 (2H, br. dd, J = 8.2, 2.7 Hz, C8H_AH$_B$), 3.57 – 3.49 (2H, br. m, C6H and C8H$_A$$H_B$), 2.68 (1H, dt, J = 18.5, 8.7 Hz, C5H_AH$_B$), 2.40 (1H, ddd, J = 19.0, 8.7, 4.5 Hz, C5H$_A$$H_B$), 2.23 (3H, s, C20$H_3$), 2.17 (6H, s, 2 × C19$H_3$), 2.03 (6H, s, 2 × C18$H_3$), 1.97 (1H, td, J = 8.7, 7.5 Hz, C4H_AH$_B$), 1.96 (1H, dt, J = 8.5, 4.5 Hz, C4H$_A$$H_B$), 1.40 (1H, br. s, C7$H_3$).

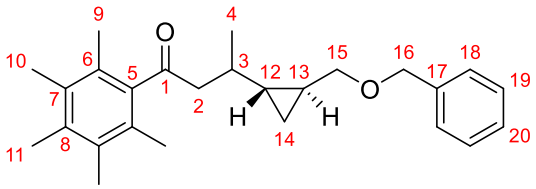
^{13}C NMR ($CDCl_3$, 126 MHz, enone isomer) δ = 199.7 (C1=O), 159.7 (C3), 140.73 (C14), 139.1 (C10), 137.9 (C2), 135.1 (C17), 133.07 (2C, 2 × C7), 128.40 (2C, 2 × C12H), 128.2 (2C, br. s, 2 × C15), 127.58 (2C, 2 × C11H), 127.42 (C13H), 73.0 ($C8H_2$), 72.2 ($C9H_2$), 46.7 (C6H), 41.1 ($C5H_2$), 25.6 ($C4H_2$), 17.00 (2C, br. s, 2 × $C18H_3$), 16.87 ($C20H_3$), 16.19 ($C7H_3$), 16.10 (2C, 2 × $C19H_3$).

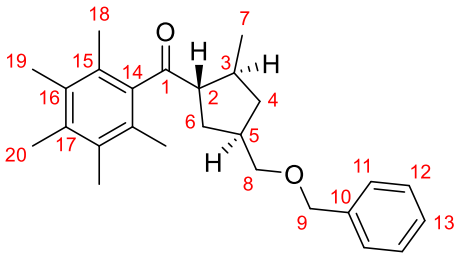
HRMS (Isomer A, ESI^+) Found $[M+Na]^+$ = 399.22937; $C_{26}H_{32}O_2Na$ requires 399.22945, Δ –0.20 ppm.

HRMS (Enone isomer, ESI^+) Found $[M+Na]^+$ = 401.24481; $C_{26}H_{34}O_2Na$ requires 401.24510, Δ –0.72 ppm.

Note: *cis* and *trans* with respect to C12H for isomer A.

rel-3-((1_R_,2_S_)-2-((Benzyloxy)methyl)cyclopropyl)-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (286, isomer B), and _rel_-((1_S_,2_S_,4_R_)-4-((Benzyloxy)methyl)-2-methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (287)





In the preparation of ketone **282**, an analytically pure 1:2.34 inseparable mixture of ketones **286B** and **287** was obtained from fraction 4. The final calculated yield for ketone **286B** is 25.8 μmol, 4.3%, and for ketone **287** it is 58.8 μmol, 9.8%.

IR (film) ν_{max}/cm^{-1} 3086, 3063, 3029, 2951, 2926, 2856, 1697, 1574, 1496, 1454, 1381, 1363, 1308, 1270, 1257, 1204, 1170, 1097, 1075, 1027, 1000, 926, 902, 843, 736, 698.

^{1}H NMR ($CDCl_3$, 500 MHz, cyclopropane isomer B) δ = 7.37 – 7.28 (4H, m, 2 × C18H and 2 × C19H), 7.31 – 7.23 (1H, m, C20H), 4.55 – 4.46 (2H, q_{AB}, J_{AB} = 12.0 Hz, Δ_{AB} = 9.1 Hz, $C16H_2$), 3.33 (1H, dd, J = 10.3, 6.7 Hz, $C15H_AH_B$), 3.26 (1H, dd, J = 10.2, 7.0 Hz, $C15H_AH_B$), 2.91 (1H, dd, J = 19.1, 3.7 Hz, $C2H_AH_B$), 2.68 (1H, dd, J = 19.1, 8.6 Hz, $C2H_AH_B$), 2.24 (3H, s, $C11H_3$), 2.18 (6H, s, 2 × $C10H_3$), 2.10 (6H, s, 2 × $C9H_3$), 1.61 (1H, ddqd, J = 9.2, 8.7, 6.7, 3.7 Hz, C3H), 1.12 (3H, d, J = 6.7 Hz, $C4H_3$), 0.61 (1H, tt, J = 9.2, 4.8 Hz, C12H), 0.49 (1H, dt, J = 8.4, 5.0 Hz, $C14H_{cis}H_{trans}$), 0.45 (1H, dt, J = 8.4, 4.8 Hz, $C14H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, cyclopropane isomer B) δ = 211.1 (C1=O), 140.81 (C5), 138.76 (C17), 135.37 (C8), 133.15 (2C, 2 × C7), 128.42 (2C, 2 × C19H), 127.67 (2C, 2 × C18H), 127.56 (C20H), 127.4 (2C, 2 × C6), 74.1 ($C15H_2$), 72.5 ($C16H_2$), 52.9 ($C2H_2$), 32.6 (C3H), 24.3 (C12H), 19.8 ($C4H_3$), 18.10 (C13H), 17.1 (2C, 2 × $C9H_3$), 16.79 ($C11H_3$), 16.06 (2C, 2 × $C10H_3$), 9.9 ($C14H_2$).

^{1}H NMR ($CDCl_3$, 500 MHz, cyclopentane isomer) δ = 7.37 – 7.28 (4H, m, 2 × C11H and 2 × C12H), 7.31 – 7.23 (1H, m, C13H), 4.50 (2H, s, $C9H_2$), 3.35 (2H, q_{AB}, J = 9.4 Hz, Δ_{AB} = 13.0 Hz, $C8H_2$), 2.85 (1H, td, J = 9.1, 7.3 Hz, C2H), 2.45 – 2.31 (2H, m, C3H and C5H), 2.24 (3H, s, $C20H_3$), 2.19 (6H, s, 2 × $C19H_3$), 2.18 – 2.13 (1H, m, $C6H_{cis}H_{trans}$), 2.12 (6H, s, 2 × $C18H_3$), 2.13 – 2.07 (1H, m, $C4H_{cis}H_{trans}$), 1.70 (1H, ddd, J = 13.2, 9.4, 7.2 Hz, $C6H_{cis}H_{trans}$), 1.07 – 0.97 (1H, m, $C4H_{cis}H_{trans}$), 1.02 (3H, d, J = 6.6 Hz, $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, cyclopentane isomer) δ = 214.1 (C1=O), 140.92 (C14), 138.75 (C10), 135.50 (C17), 133.18 (2C, 2 × C16), 128.45 (2C, 2 × C12H), 128.0 (2C, v. br. s, 2 × C15), 127.64 (2C, 2 × C11H), 127.59 (C13H), 74.6 ($C8H_2$), 73.0 ($C9H_2$), 60.6 (C2H), 39.6 ($C4H_2$), 38.6 (C5H), 37.7 (C3H), 33.0 ($C6H_2$), 20.2 ($C7H_3$), 18.03 (2C, 2 × $C18H_3$), 16.85 ($C20H_3$), 16.17 (2C, 2 × $C19H_3$).

^{1}H NMR (C_6D_6, 500 MHz, cyclopropane isomer B) δ = 7.32 – 7.28 (2H, m, 2 × C18H), 7.20 – 7.17 (2H, m, 2 × C19H), 7.12 – 7.10 (1H, m, C20H), 4.34 (2H, q_{AB}, J_{AB} = 12.2 Hz, Δ_{AB} = 15.5 Hz, $C16H_2$), 3.30 (1H, dd, J = 10.0, 6.0 Hz, $C15H_AH_B$), 3.04 (1H, dd, J = 10.0, 7.4 Hz, $C15H_AH_B$), 2.95 (1H, dd, J = 19.0, 3.7 Hz, $C2H_AH_B$), 2.59 (1H, dd, J = 19.0, 8.5 Hz, $C2H_AH_B$), 2.06 (6H, s, 2 × $C9H_3$), 2.04 (3H, s, $C11H_3$), 1.96 (6H, s, 2 × $C10H_3$), 1.67 (1H, dqd, J = 8.5, 6.6, 3.7 Hz, C3H), 1.20 (3H, d, J = 6.7 Hz, $C4H_3$), 1.04 – 0.99 (1H, m, C13H), 0.59 – 0.50 (1H, m, C12H), 0.37 – 0.30 (2H, m, 2 × $C14H_2$).

^{13}C NMR (C_6D_6, 126 MHz, cyclopropane isomer B) δ = 209.6 (C1=O), 141.74 (C5), 139.55 (C17), 134.7 (C8), 132.89 (2C, 2 × C7), 128.51 (2C, 2 × C19H), 127.65 (2C, 2 × C18H), 127.57 (2C, 2 × C6), 127.53 (C20H), 74.1 ($C15H_2$), 72.5 ($C16H_2$), 53.1 ($C2H_2$), 33.21 (C3H), 24.8 (C12H), 20.1 ($C4H_3$), 18.6 (C13H), 17.2 (2C, 2 × $C9H_3$), 16.60 ($C11H_3$), 15.93 (2C, 2 × $C10H_3$), 9.8 ($C14H_2$).

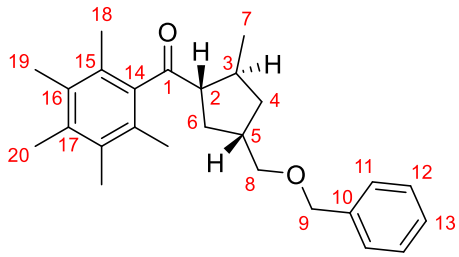
^{1}H NMR (C_6D_6, 500 MHz, cyclopentane isomer) δ = 7.28 – 7.25 (2H, m, 2 × C11H), 7.17 – 7.14 (2H, m, 2 × C12H), 7.10 – 7.07 (1H, m, C13H), 4.30 (2H, s, $C9H_2$), 3.17 (1H, d, J = 6.1 Hz, $C8H_2$), 2.86 (1H, td, J = 9.4, 6.8 Hz, C2H), 2.49 (1H, ddquint., J = 10.8, 8.9, 6.6 Hz, C3H), 2.43 – 2.35 (1H, m, C5H), 2.33 (1H, td, J = 8.5, 6.9 Hz, $C6H_{cis}H_{trans}$), 2.09 (6H, s, 2 × $C18H_3$), 2.05 – 1.95 (1H, m, $C4H_{cis}H_{trans}$), 2.01 (3H, s, $C20H_3$), 1.95 (6H, s, 2 × $C19H_3$), 1.70 (1H, ddd, J = 12.1, 9.1, 6.5 Hz, $C6H_{cis}H_{trans}$), 1.02 (3H, d, J = 6.6 Hz, $C7H_3$), 0.98 (1H, dt, J = 12.4, 10.7, 9.4 Hz, $C4H_{cis}H_{trans}$).

^{13}C NMR (C_6D_6, 126 MHz, cyclopentane isomer) δ = 212.2 (C1=O), 141.79 (C14), 139.47 (C10), 135.1 (C20), 133.04 (2C, 2 × C16), 128.55 (2C, 2 × C12H), 128.2 (2C, 2 × C15), 127.69 (2C, 2 × C11H), 127.60 (C13H), 74.6 ($C8H_2$), 73.1 ($C9H_2$), 61.0 (C1H), 39.8 ($C4H_2$), 39.1 (C5H), 38.0 (C3H), 33.16 ($C6H_2$), 20.3 ($C7H_3$), 18.1 (2C, br. s, 2 × $C18H_3$), 16.64 ($C20H_3$), 16.02 (2C, 2 × $C19H_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 401.24496; $C_{26}H_{34}O_2Na$ requires 401.24510, Δ –0.34 ppm.

Note: *cis* and *trans* with respect to C12H for cyclopropane isomer B, and with respect to C2H for cyclopropentane isomer.

***rel*-((1*S*,2*S*,4*S*)-4-((Benzyloxy)methyl)-2-methylcyclopentyl)(2,3,4,5,6-pentamethylphenyl)methanone (288)**



In the preparation of ketone **282**, ketone **288** (3.4 mg, 9.0 μmol, 1.5%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3088, 3063, 3029, 2925, 2854, 2793, 1737, 1689, 1574, 1496, 1454, 1379, 1364, 1305, 1268, 1204, 1098, 1028, 1000, 948, 904, 831, 735, 698.

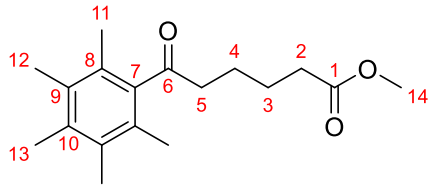
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 – 7.32 (4H, m, 2 × C11H and 2 × C12H), 7.32 – 7.23 (1H, m, C13H), 4.51 (2H, s, C9H_2), 3.41 (1H, dd, J = 9.0, 7.1 Hz, C8H_AH$_B$), 3.38 (1H, dd, J = 9.0, 6.9 Hz, C8H$_A$$H_B$), 2.83 (1H, dt, J = 10.1, 7.8 Hz, C2H), 2.42 (1H, tt, J = 8.2, 7.0 Hz, C3H), 2.34 (1H, ttt, J = 8.8, 7.4, 6.4 Hz, C8H), 2.23 (3H, s, C20H_3), 2.18 (6H, s, 2 × C19H_3), 2.10 (6H, s, 2 × C18H_3), 2.08 (1H, ddd, J = 12.6, 7.5, 7.0 Hz, C6H_{cis}H$_{trans}$), 1.73 (1H, ddd, J = 13.0, 8.6, 7.1 Hz, C4H$_{cis}$$H_{trans}$), 1.62 (1H, ddd, J = 12.6, 10.1, 9.0 Hz, C6H$_{cis}$$H_{trans}$), 1.47 (1H, ddd, J = 13.0, 8.4, 7.0 Hz, C4H_{cis}H$_{trans}$), 1.01 (3H, d, J = 6.7 Hz, C7H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.0 (C1=O), 141.1 (C14), 138.7 (C10), 135.5 (C17), 133.2 (2C, 2 × C16), 128.5 (2C, 2 × C12H), 127.76 (2C, 2 × C15), 127.75 (2C, 2 × C11H), 127.65 (C13H), 74.7 ($C8H_2$), 73.2 ($C6H_2$), 62.0 (C2H), 38.3 (C5H), 37.9 ($C4H_2$), 35.9 (C3H), 34.4 ($C6H_2$), 20.9 ($C7H_3$), 18.0 (2C, br. s, 2 × $C18H_3$), 16.9 ($C20H_3$), 16.2 (2C, 2 × $C19H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 379.26321; $C_{26}H_{35}O_2$ requires 379.26316, Δ 0.14 ppm.

Note: *cis* and *trans* with respect to C2H.

Methyl 6-oxo-6-(2,3,4,5,6-pentamethylphenyl)hexanoate (289)



Pentamethylbenzene (2.08 g, 14.0 mmol, 1.0 equiv), adipoyl chloride (2.50 g, 14.0 mmol, 1.0 equiv), $AlCl_3$ (2.05 g, 15.4 mmol, 1.1 equiv) and DCM (70 mL, 0.2 M) were subjected to **General Procedure B**. Purification by flash column chromatography (Pentane:Et_2O, 98:2 → 95:5 → 80:20) afforded ester **289** (949 mg, 3.27 mmol, 23%) as a colourless solid.

m.p. = 64 – 66 °C.

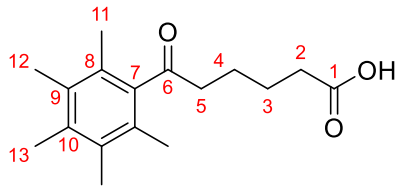
IR (film) ν_{max}/cm^{-1} 2949, 2923, 2873, 2854, 1738, 1700, 1576, 1457, 1437, 1406, 1381, 1362, 1304, 1263, 1235, 1196, 1172, 1117, 1069, 1015, 998, 922.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.68 (3H, s, $C14H_3$), 2.69 (2H, t, J = 6.8 Hz, $C5H_2$), 2.37 (2H, t, J = 6.9 Hz, $C2H_2$), 2.23 (3H, s, $C13H_3$), 2.18 (6H, s, 2 × $C12H_3$), 2.09 (6H, s, 2 × $C11H_3$), 1.81 – 1.67 (4H, m, $C3H_2$ and $C4H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.6 (C6=O), 174.0 (C1=O), 140.7 (C7), 135.6 (C10), 133.2 (2C, 2 × C9), 127.4 (2C, 2 × C8), 51.7 ($C14H_3$), 45.3 ($C5H_2$), 34.1 ($C2H_2$), 24.6 ($C3H_2$), 22.9 ($C4H_2$), 17.3 (2C, 2 × $C11H_3$), 16.8 ($C13H_3$), 16.1 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 291.19562; $C_{18}H_{27}O_3$ requires 291.19547, Δ 0.50 ppm.

6-Oxo-6-(2,3,4,5,6-pentamethylphenyl)hexanoic acid (290)



To a solution of ester **289** (949 mg, 3.27 mmol, 1.0 equiv) in MeOH:H_2O (1:1, 16 mL, 0.2 M) was added LiOH (93.0 mg, 3.88 mmol, 1.2 equiv), and the reaction stirred at RT for 24 h. The reaction mixture was diluted with brine (80 mL) and DCM (20 mL), and the layers separated. The organic layer was extracted with H_2O (20 mL), and the organic layer discarded. The combined aqueous layers were acidified with 1 M aq. HCl (30 mL), extracted with DCM (3 × 30 mL). and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. The crude material was triturated with cold pentane:Et_2O (90:10, 3 × 5 mL), then dried *in vacuo* to give carboxylic acid **290** (826 mg, 2.99 mmol, 92%) as a colourless solid.

m.p. = 137 – 139 °C.

IR (film) ν_{max}/cm^{-1} 2987, 2946, 2877, 2651, 1695, 1687, 1574, 1465, 1449, 1429, 1410, 1382, 1367, 1305, 1270, 1250, 1226, 1202, 1178, 1118, 1066, 1015, 1002, 942, 831, 804, 766, 740, 674, 641.

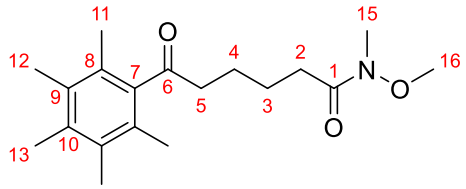
^{1}H NMR (DMSO-d_6, 500 MHz) δ = 12.02 (1H, s, OH), 2.64 (2H, t, J = 6.8 Hz, $C5H_2$), 2.24 (2H, t, J = 6.9 Hz, $C2H_2$), 2.16 (3H, s, $C13H_3$), 2.12 (6H, s, 2 × $C12H_3$), 1.99 (6H, s, 2 × $C11H_3$), 1.66 – 1.50 (4H, m, $C3H_2$ and $C4H_2$).

^{13}C NMR (DMSO-d_6, 126 MHz) δ = 210.9 (C6=O), 174.4 (C1=O), 140.5 (C7), 134.6 (C10), 132.4 (2C, 2 × C9), 126.7 (2C, 2 × C8), 44.5 ($C5H_2$), 33.6 ($C3H_2$), 24.0 ($C3H_2$), 22.4 ($C4H_2$), 16.8 (2C, 2 × $C11H_3$), 16.4 ($C13H_3$), 15.7 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 277.18002; $C_{17}H_{25}O_3$ requires 277.17982, Δ 0.73 ppm.

The analytical data are identical to those reported in literature.[6]

_N_-Methoxy-_N_-methyl-6-oxo-6-(2,3,4,5,6-pentamethylphenyl)hexanamide (291)[6]



Carboxylic acid **290** (780 mg, 2.82 mmol, 1.0 equiv), CDI (618 mg, 3.81 mmol, 1.35 equiv), *N*,*O*-dimethylhydroxylamine·HCl (385 mg, 3.95 mmol, 1.4 equiv), Et_3N (550 μL, 400 mg, 3.95 mmol, 1.4 equiv) and DCM (7.0 mL, 0.4 M) were subjected to **General Procedure I**. The crude product was passed through a silica plug, eluting with Et_2O, and the eluent concentrated *in vacuo* to afford Weinreb amide **291** (889 mg, 2.78 mmol, 99%) as a colourless solid.

m.p. = 65 – 67 °C.

IR (film) ν_{max}/cm^{-1} 2937, 2937, 1698, 1663, 1575, 1460, 1445, 1412, 1384, 1306, 1276, 1262, 1177, 1154, 1119, 1069, 997, 933, 920, 729, 698.

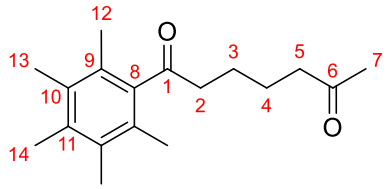
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.69 (3H, s, $C16H_3$), 3.18 (3H, s, $C15H_3$), 2.71 (2H, t, J = 6.9 Hz, $C5H_2$), 2.48 (2H, br. t, J = 7.0 Hz, $C2H_2$), 2.23 (3H, s, $C13H_3$), 2.18 (6H, s, 2 × $C12H_3$), 2.09 (6H, s, 2 × $C11H_3$), 1.82 – 1.67 (4H, m, $C3H_2$ and $C4H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.8 (C6=O), 174.4 (C1=O), 140.8 (C7), 135.5 (C10), 133.2 (2C, 2 × C9), 127.4 (2C, 2 × C8), 61.4 ($C16H_3$), 45.6 ($C5H_2$), 32.3 (v. br. s, $C15H_3$), 31.9 (br. s, $C2H_2$), 24.4 ($C3H_2$), 23.2 ($C4H_2$), 17.3 (2C, 2 × $C11H_3$), 16.8 ($C13H_3$), 16.1 (2C, 2 × $C12H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 188.2 (N–O).

HRMS (ESI^+) Found $[M+H]^+$ = 320.22183; $C_{19}H_{30}NO_3$ requires 320.22202, Δ –0.59 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)heptane-1,6-dione (292)[6]



Weinreb amide **291** (296 mg, 0.928 mmol, 1.0 equiv), MeMgBr (340 µL, 3.0 M in THF, 1.02 mmol, 1.1 equiv) and THF (5.0 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded dione **292** (210 mg, 0.765 mmol, 83%) as a colourless solid.

m.p. = 70 – 72 °C.

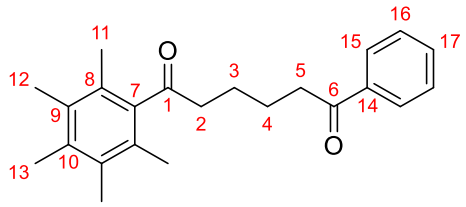
IR (film) ν_{max}/cm^{-1} 2982, 2937, 2872, 1698, 1575, 1462, 1406, 1367, 1324, 1298, 1263, 1235, 1168, 1120, 1069, 1020, 993, 968, 931, 797, 719, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.69 (2H, t, J = 6.9 Hz, $C2H_2$), 2.49 (2H, t, J = 7.0 Hz, $C5H_2$), 2.23 (3H, s, $C14H_3$), 2.18 (6H, s, 2 × $C13H_3$), 2.15 (3H, s, $C7H_3$), 2.09 (6H, s, 2 × $C12H_3$), 1.77 – 1.61 (4H, m, $C3H_2$ and $C4H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.8 (C1=O), 208.8 (C6=O), 140.7 (C8), 135.5 (C11), 133.2 (2C, 2 × C10), 127.4 (2C, 2 × C9), 45.5 ($C2H_2$), 43.7 ($C5H_2$), 30.1 ($C7H_3$), 23.4 ($C4H_2$), 22.9 ($C3H_2$), 17.3 (2C, 2 × $C12H_3$), 16.8 ($C14H_3$), 16.1 (2C, 2 × $C13H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 275.20078; $C_{18}H_{27}O_2$ requires 275.20056, Δ 0.79 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)-6-phenylhexane-1,6-dione (292)



Weinreb amide **291** (296 mg, 0.928 mmol, 1.0 equiv), PhMgBr (500 µL, 2.0 M in THF, 1.00 mmol, 1.1 equiv) and THF (5.0 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O:DCM, 85:10:5) afforded dione **292** (209 mg, 0.622 mmol, 67%) as a colourless solid.

m.p. = 121 – 123 °C.

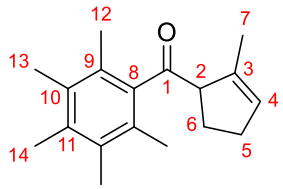
IR (film) ν_{max}/cm^{-1} 3060, 2981, 2934, 2869, 1694, 1680, 1597, 1580, 1459, 1449, 1405, 1378, 1366, 1318, 1298, 1266, 1243, 1202, 1184, 1118, 1074, 1018, 1001, 977, 932, 900, 803, 756, 725, 692.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.01 – 7.94 (2H, m, 2 × C15H), 7.61 – 7.53 (1H, m, C17H), 7.50 – 7.43 (2H, m, 2 × C16H), 3.04 (2H, t, J = 6.9 Hz, C5H_2), 2.74 (2H, t, J = 6.8 Hz, C2H_2), 2.23 (3H, s, C13H_3), 2.18 (6H, s, 2 × C12H_3), 2.10 (6H, s, 2 × C11H_3), 1.90 – 1.76 (4H, m, C3H_2 and C4H_2).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.8 (C1=O), 200.1 (C6=O), 140.8 (C7), 137.1 (C14), 135.5 (C10), 133.23 (2C, 2 × C9), 133.14 (C17H), 128.7 (2C, 2 × C16H), 128.2 (2C, 2 × C15H), 127.4 (2C, 2 × C8), 45.6 (C2H_2), 38.6 (C5H_2), 24.0 (C4H_2), 23.1 (C3H_2), 17.3 (2C, 2 × C11H_3), 16.8 (C13H_3), 16.1 (2C, 2 × C12H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 337.21634; $C_{23}H_{29}O_2$ requires 337.21621, Δ 0.39 ppm.

(2-Methylcyclopent-2-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (293)[37]



To a round bottom flask equipped with a water condenser was added dione **292** (210 mg, 0.765 mmol, 1.0 equiv), KO*t*-Bu (429 mg, 3.83 mmol, 5.0 equiv) and THF (15 mL, 0.05 M), and the reaction mixture was heated to reflux for 16 h. The reaction mixture was cooled to RT, then quenched with sat. aq. NH_4Cl (20 mL), and diluted with Et_2O (15 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 10 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 98.5:1.5 → 97:3) afforded skipped enone **293** (64.1 mg, 0.250 mmol, 33%) as a colourless solid.

m.p. = 57 – 59 °C.

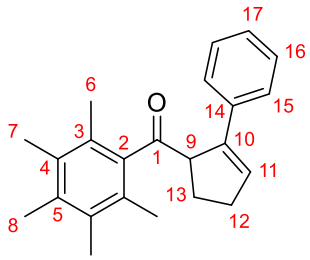
IR (film) ν_{max}/cm^{-1} 3038, 2924, 2853, 1690, 1647, 1573, 1447, 1381, 1315, 1266, 1231, 1175, 1114, 1069, 1017, 992, 945, 930, 883, 847, 806, 760, 713.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 5.59 (1H, sept., J = 1.6 Hz, C4H), 3.74 (1H, m, C2H), 2.36 (1H, app. dddh, J = 15.9, 8.5, 7.7, 2.3 Hz, C6H_AH$_B$), 2.29 – 2.22 (1H, m, C6H$_A$$H_B$), 2.24 (3H, s, C14H$_3$), 2.21 (1H, tq, J = 8.6, 4.1 Hz, C5H_AH$_B$), 2.19 (6H, s, 2 × C13H$_3$), 2.12 (6H, s, 2 × C12H$_3$), 2.08 (1H, dtd, J = 13.0, 9.1, 6.9 Hz, C5H$_A$$H_B$), 1.75 (3H, dddd, J = 2.4, 2.0, 1.5, 0.9 Hz, C7H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.7 (C1=O), 140.5 (C8), 138.3 (C3), 135.6 (C11), 133.2 (2C, 2 × C10), 129.3 (C4H), 128.2 (2C, 2 × C9), 63.0 (C2H), 31.4 (C6H$_2$), 28.3 (C5H$_2$), 18.0 (2C, 2 × C12H$_3$), 16.9 (C14H$_3$), 16.17 (2C, 2 × C13H$_3$), 16.14 (C7H$_3$).

HRMS (ESI$^+$) Found [M+Na]$^+$ = 279.17200; $C_{18}H_{24}ONa$ requires 279.17194, Δ 0.22 ppm.

(2,3,4,5,6-Pentamethylphenyl)(2-phenylcyclopent-2-en-1-yl)methanone (296)[37]



To a round bottom flask equipped with a water condenser was added dione **294** (209 mg, 0.622 mmol, 1.0 equiv), KO*t*-Bu (349 mg, 3.11 mmol, 5.0 equiv) and THF (13 mL, 0.05 M), and the reaction mixture was heated to reflux for 16 h. The reaction mixture was cooled to RT, then quenched with sat. aq. NH_4Cl (20 mL) and diluted with Et_2O (15 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 10 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 98:2 → 93:7) afforded skipped enone **296** (149 mg, 0.468 mmol, 75%) as a colourless solid.

m.p. = 93 – 95 °C.

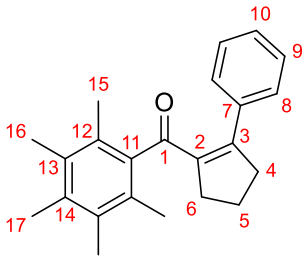
IR (film) ν_{max}/cm^{-1} 3079, 3053, 3022, 2928, 2848, 1691, 1598, 1574, 1494, 1446, 1382, 1314, 1263, 1153, 1113, 1073, 1030, 999, 910, 854, 812, 751, 722, 694.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.19 – 7.11 (2H, m, 2 × C15H), 7.12 – 7.03 (3H, m, 2 × C16H and C17H), 6.24 (1H, ddd, J = 3.0, 2.2, 1.5 Hz, C11H), 4.43 (1H, ddddd, J = 9.4, 2.8, 2.1, 1.5, 0.8 Hz, C9H), 2.71 (1H, dtt, J = 16.4, 8.3, 2.4 Hz, C12H_AH$_B$), 2.64 (1H, ddt, J = 12.8, 7.9, 1.8 Hz, C13H_AH$_B$), 2.52 (1H, ddddd, J = 16.8, 9.5, 3.1, 1.7, 0.7 Hz, C12H$_A$$H_B$), 2.23 (1H, dtd, J = 12.8, 9.4, 8.6 Hz, C13H$_A$$H_B$), 2.15 (3H, s, C8H$_3$), 2.05 (6H, s, 2 × C7H$_3$), 1.90 (6H, s, 2 × C6H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.2 (C1=O), 142.0 (C10), 140.6 (C2), 135.9 (C14), 135.4 (C5), 132.9 (2C, 2 × C4), 130.8 (C11H), 128.2 (2C, v. br. s, 2 × C3), 127.7 (2C, 2 × C16H), 126.9 (C17H), 126.3 (2C, 2 × C15H), 60.0 (C9H), 32.4 ($C12H_2$), 28.4 ($C14H_2$), 17.9 (2C, br. s, 2 × $C6H_3$), 16.7 ($C8H_3$), 16.0 (2C, 2 × $C7H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 341.18762; $C_{23}H_{26}ONa$ requires 341.18759, Δ 0.10 ppm.

(2,3,4,5,6-Pentamethylphenyl)(2-phenylcyclopent-1-en-1-yl)methanone (295)



In the preparation of skipped enone **296**, enone **295** (17.6 mg, 55.3 μmol, 8.9%) was also isolated as a colourless solid.

m.p. = 84 – 87 °C.

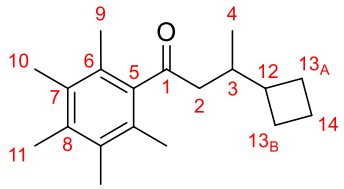
IR (film) ν_{max}/cm^{-1} 3077, 3052, 2923, 2854, 1738, 1637, 1591, 1490, 1442, 1380, 1347, 1307, 1270, 1214, 1186, 1122, 1071, 1024, 1001, 979, 937, 908, 856, 839, 756, 737, 714, 697.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.98 – 6.93 (1H, m, C10H), 6.93 – 6.88 (2H, m, 2 × C9H), 6.79 – 6.75 (2H, m, 2 × C8H), 2.94 (2H, tt, J = 7.9, 2.2 Hz, $C6H_2$), 2.86 (2H, tt, J = 7.9, 2.2 Hz, $C4H_2$), 2.00 (3H, s, $C17H_3$), 1.99 (2H, quint., J = 7.7 Hz, $C5H_2$), 1.94 (6H, s, 2 × $C16H_3$), 1.93 (6H, s, 2 × $C15H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.2 (C1=O), 156.9 (C3), 139.63 (C11), 139.55 (C2), 137.1 (C7), 134.6 (C14), 132.1 (2C, 2 × C13), 128.3 (2C, 2 × C12), 126.5 (2C, 2 × C9H), 126.4 (C10H), 126.0 (2C, 2 × C8H), 43.1 ($C4H_2$), 34.0 ($C6H_2$), 21.4 ($C5H_2$), 17.5 (2C, 2 × $C15H_3$), 16.3 ($C17H_3$), 15.6 (2C, 2 × $C16H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 319.20563; $C_{23}H_{27}O$ requires 319.20564, Δ –0.05 ppm.

3-Cyclobutyl-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (298)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), alcohol **297**[*] (120 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **298** (124 mg, 0.457 mmol, 76%) as a colourless solid.

m.p. = 60 – 63 °C.

IR (film) ν_{max}/cm^{-1} 2952, 2927, 2868, 1700, 1575, 1456, 1400, 1380, 1351, 1316, 1273, 1256, 1240, 1217, 1170, 1129, 1097, 1069, 1018, 998, 987, 932, 894, 814, 699.

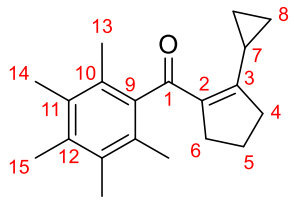
[*] The material was provided by Dr. James Frost.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.66 (1H, dd, J = 18.9, 2.2 Hz, C2H_AH$_B$), 2.34 (1H, dd, J = 19.0, 9.3 Hz, C2H$_A$$H_B$), 2.23 (3H, s, C11H$_3$), 2.18 (6H, s, 2 × C10H$_3$), 2.10 (6H, s, 2 × C9H$_3$), 2.14 – 2.04 (2H, m, C3H and C12H), 2.05 – 1.99 (1H, m, C13$_A$$H_AH_B$), 1.99 – 1.91 (1H, m, C13$_B$$H_AH_B$), 1.88 – 1.72 (2H, m, C14H$_2$), 1.72 – 1.62 (2H, m, C13$_A$H$_A$$H_B$ and C13$_B$H$_A$$H_B$), 0.97 (3H, d, J = 6.1 Hz, C4H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.7 (C1=O), 141.0 (C5), 135.4 (C8), 133.2 (2C, 2 × C7), 127.3 (2C, 2 × C6), 49.9 (C2H$_2$), 41.8 (C3H), 34.7 (C12H), 26.83 (C13$_B$H$_2$), 26.71 (C13$_A$H$_2$), 17.4 (C14H$_2$), 17.19 (C4H$_3$), 17.14 (2C, 2 × C9H$_3$), 16.8 (C11H$_3$), 16.1 (2C, 2 × C10H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 273.22131; $C_{19}H_{29}O$ requires 273.22129, Δ 0.06 ppm.

(2-Cyclopropylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (300)



In the preparation of ketone **166** but with cataCXium® A (8.06 mg, 24.0 μmol, 4 mol%) under a balloon of Ar, enone **300** (18.0 mg, 63.7 μmol, 11%) was also isolated as a colourless solid.

m.p. = 132 – 134 °C.

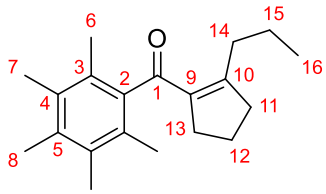
IR (film) ν_{max}/cm^{-1} 3088, 3007, 2927, 2868, 1736, 1654, 1626, 1593, 1456, 1432, 1368, 1350, 1307, 1268, 1211, 1173, 1097, 1068, 1050, 1035, 1006, 994, 970, 911, 884, 855, 826, 812, 764, 731, 713, 647, 635.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.63 (2H, br. tt, J = 7.5, 2.0 Hz, C6H$_2$), 2.21 (3H, s, C15H$_3$), 2.20 (2H, ttd, J = 7.8, 1.9, 0.7 Hz, C4H$_2$), 2.17 (6H, s, 2 × C14H$_3$), 2.10 (6H, s, 2 × C13H$_3$), 1.97 (1H, v. br. m, C7H), 1.75 (2H, quint., J = 7.7 Hz, C5H$_2$), 0.69 – 0.59 (4H, m, 2 × C8H$_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.6 (C1=O), 162.3 (C3), 141.2 (C9), 137.7 (br. s, C2), 134.8 (C12), 132.9 (2C, 2 × C11), 128.2 (2C, 2 × C10), 34.22 ($C6H_2$), 34.08 ($C4H_2$), 21.2 ($C5H_2$), 17.2 (2C, 2 × $C13H_3$), 16.8 ($C15H_3$), 16.1 (2C, 2 × $C14H_3$), 12.1 (C7H), 7.6 (2C, 2 × $C8H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 283.20566; $C_{20}H_{27}O$ requires 283.20564, Δ 0.06 ppm.

(2,3,4,5,6-Pentamethylphenyl)(2-propylcyclopent-1-en-1-yl)methanone (302)



In the preparation of ketone **165** but with cataCXium® A (8.06 mg, 24.0 μmol, 4 mol%) under a balloon of Ar, enone **302** (10.1 mg, 35.5 μmol, 5.9%) was also isolated as a colourless oil.

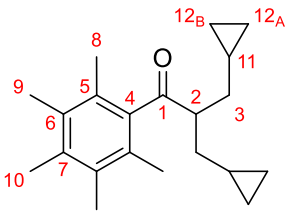
IR (film) ν_{max}/cm^{-1} 2956, 2928, 2870, 1736, 1661, 1635, 1606, 1455, 1431, 1380, 1353, 1309, 1270, 1232, 1189, 1171, 1110, 1070, 1016, 864, 839, 742, 714, 633.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.64 (2H, br. t, J = 7.3 Hz, $C13H_2$), 2.55 (2H, ttt, J = 8.0, 2.0, 0.9 Hz, $C11H_2$), 2.23 (3H, s, $C8H_3$), 2.17 (6H, s, 2 × $C7H_3$), 2.05 (6H, s, 2 × $C6H_3$), 1.99 (2H, br. t, J = 7.9 Hz, $C14H_2$), 1.80 (2H, quint., J = 7.7 Hz, $C12H_2$), 1.34 – 1.21 (2H, m, $C15H_2$), 0.67 (3H, t, J = 7.3 Hz, $C16H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.7 (C1=O), 161.0 (C10), 140.9 (C2), 137.5 (C9), 135.0 (C5), 132.9 (2C, 2 × C4), 128.1 (2C, 2 × C3), 39.2 ($C11H_2$), 33.8 ($C13H_2$), 31.9 ($C12H_2$), 21.4 ($C15H_2$), 21.4 ($C14H_2$), 17.3 (2C, 2 × $C6H_3$), 16.8 ($C8H_3$), 16.1 (2C, 2 × $C7H_3$), 14.2 ($C16H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 285.22122; $C_{20}H_{29}O$ requires 285.22129, Δ –0.25 ppm.

3-Cyclopropyl-2-(cyclopropylmethyl)-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (304)



In the preparation of enone **305**, ketone **304** (7.0 mg) was also isolated as a colourless solid c.a. 10 mol% of the monoalkylated product. The corrected yield is 21 μmol, 3.5%.

m.p. = 76 – 78 °C.

IR (film) ν_{max}/cm^{-1} 3076, 2999, 2923, 2855, 1737, 1690, 1573, 1460, 1445, 1428, 1382, 1351, 1302, 1261, 1238, 1153, 1110, 1070, 1045, 1015, 959, 918, 896, 864, 823.

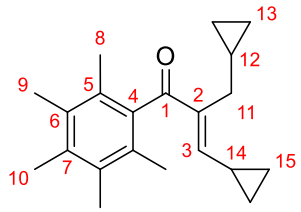
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.03 (1H, quint., J = 6.5 Hz, C2H), 2.23 (3H, s, C10H$_3$), 2.18 (6H, s, 2 × C9H$_3$), 2.13 (6H, s, 2 × C8H$_3$), 1.70 (2H, dt, J = 13.5, 6.5 Hz, 2 × C3H_AH$_B$), 1.40 (2H, dt, J = 13.9, 6.9 Hz, 2 × C3H$_A$$H_B$), 0.79 (2H, ttt, J = 8.1, 7.0, 4.9 Hz, 2 × C11H), 0.49 – 0.38 (4H, m, 2 × C12$_A$$H_{cis}H_{trans}$ and 2 × C12$_B$$H_{cis}H_{trans}$), 0.08 – 0.00 (4H, m, 2 × C12$_A$H$_{cis}$$H_{trans}$ and 2 × C12$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.9 (C1=O), 139.9 (C4), 135.5 (7), 133.1 (2C, 2 × C6), 128.7 (2C, 2 × C5), 55.5 (C2H), 34.9 (2C, 2 × C3H$_2$), 18.0 (2C, 2 × C8H$_3$), 16.9 (C10H$_3$), 16.2 (2C, 2 × C9H$_3$), 9.8 (2C, 2 × C11H), 5.6 (2C, 2 × C12$_A$H$_2$), 5.2 (2C, 2 × C12$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 299.23688; $C_{21}H_{31}O$ requires 299.23694, Δ –0.22 ppm.

Note: *cis* and *trans* with respect to C11H.

(*E*)-3-Cyclopropyl-2-(cyclopropylmethyl)-1-(2,3,4,5,6-pentamethylphenyl)prop-2-en-1-one (305)



Ketone **121** (114 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (8.06 mg, 24.0 μmol, 4 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), cyclopropylmethanol (103 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to a modification of **General Procedure F** at 105 °C under a balloon of Ar. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1 → 98:2) afforded enone **305** (108 mg, 0.366 mmol, 61%) as a colourless solid.

m.p. = 84 – 86 °C.

IR (film) ν_{max}/cm^{-1} 3078, 3004, 2922, 2868, 1646, 1625, 1458, 1442, 1428, 1384, 1336, 1306, 1273, 1222, 1191, 1155, 1128, 1067, 1049, 1015, 986, 956, 931, 910, 896, 879, 863, 833, 823, 807, 781, 730, 671, 646.

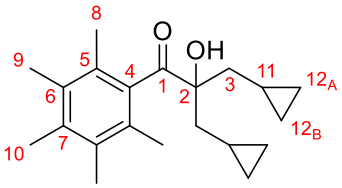
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 5.62 (1H, d, J = 10.6 Hz, C3H), 2.53 (2H, d, J = 6.9 Hz, $C11H_2$), 2.23 (3H, s, $C10H_3$), 2.17 (6H, s, 2 × $C9H_3$), 2.03 (6H, s, 2 × $C8H_3$), 1.76 (1H, dtt, J = 10.6, 8.0, 4.6 Hz, C14H), 1.03 (1H, ttt, J = 8.0, 7.0, 4.9 Hz, C12H), 0.95 (2H, dq_{AB}, J = 8.0 Hz, J_{AB} = 4.4 Hz, Δ_{AB} = 5.1 Hz, 2 × C15H_{cis}H$_{trans}$), 0.47 (2H, dq_{AB}, J = 4.7 Hz, J_{AB} = 4.3 Hz, Δ_{AB} = 4.9 Hz, 2 × C15H$_{cis}$$H_{trans}$), 0.45 (2H, dq_{AB}, J = 8.1 Hz, J_{AB} = 4.4 Hz, Δ_{AB} = 4.1 Hz, 2 × C13H$_{cis}$$H_{trans}$), 0.28 (2H, dq_{AB}, J = 4.9 Hz, J_{AB} = 4.2 Hz, Δ_{AB} = 3.6 Hz, 2 × C13H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.9 (C1=O), 154.0 (C3H), 141.1 (C2), 138.3 (C4), 134.8 (C7), 132.6 (2C, 2 × C6), 129.3 (2C, 2 × C5), 29.3 ($C11H_2$), 17.4 (2C, 2 × $C8H_3$), 16.8 ($C10H_3$), 16.1 (2C, 2 × $C9H_3$), 12.6 (C14H), 11.1 (C12H), 9.1 (2C, 2 × $C15H_2$), 4.9 (2C, 2 × $C13H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 297.22122; $C_{21}H_{29}O$ requires 297.22129, Δ –0.24 ppm.

Note: *cis* and *trans* with respect to C12H or C14H.

3-Cyclopropyl-2-(cyclopropylmethyl)-2-hydroxy-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (306)



In the preparation of enone **305**, α-hydroxyketone **306** (3.0 mg, 9.5 μmol, 1.6%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3513, 3078, 3001, 2924, 2855, 1733, 1692, 1573, 1460, 1383, 1299, 1259, 1154, 1109, 1081, 1049, 1017, 975, 916, 884, 852, 825, 804.

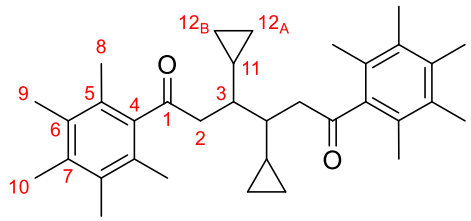
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.55 (1H, s, OH), 2.23 (3H, s, $C10H_3$), 2.18 (6H, s, 2 × $C9H_3$), 2.16 (6H, s, 2 × $C8H_3$), 1.80 (4H, d, J = 6.6 Hz, 2 × $C3H_2$), 0.85 (2H, dddt, J = 14.6, 8.0, 6.6, 5.0 Hz, 2 × C11H), 0.56 – 0.48 (4H, m, 2 × $C12_AH_{cis}H_{trans}$ and 2 × $C12_BH_{cis}H_{trans}$), 0.19 – 0.12 (4H, m, 2 × $C12_AH_{cis}H_{trans}$ and 2 × $C12_BH_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 215.7 (C1=O), 137.2 (C4), 135.8 (C7), 133.2 (2C, 2 × C6), 129.4 (2C, 2 × C5), 84.4 (C2), 41.9 (2C, 2 × $C3H_2$), 19.0 (2C, 2 × $C8H_3$), 16.9 ($C10H_3$), 16.2 (2C, 2 × $C9H_3$), 5.8 (2C, 2 × C11H), 5.1 (2C, 2 × $C12_AH_2$), 4.9 (2C, 2 × $C12_BH_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 315.23201; $C_{21}H_{31}O_2$ requires 315.23186, Δ 0.50 ppm.

Note: *cis* and *trans* with respect to C11H.

3,4-Dicyclopropyl-1,6-bis(2,3,4,5,6-pentamethylphenyl)hexane-1,6-dione (307)



In the preparation of enone **305**, dione **307** (10.4 mg, 21.4 μmol, 7.1%) was also isolated as a colourless solid.

m.p. = 194 – 197 °C.

IR (film) ν_{max}/cm^{-1} 3078, 2997, 2921, 1702, 1575, 1459, 1429, 1395, 1384, 1352, 1308, 1267, 1198, 1108, 1069, 1049, 1019, 997, 966, 935, 910, 824, 794, 731.

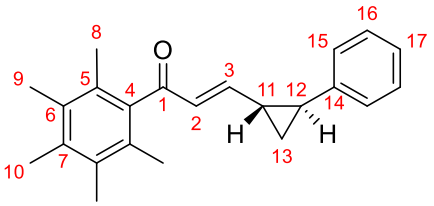
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.91 (2H, dd, J = 19.6, 7.0 Hz, 2 × C2H_AH$_B$), 2.85 (2H, dd, J = 19.7, 3.9 Hz, 2 × C2H$_A$$H_B$), 2.23 (6H, s, 2 × C10H$_3$), 2.18 (12H, s, 4 × C9H$_3$), 2.13 (12H, s, 4 × C8H$_3$), 1.83 (2H, ddt, J = 10.9, 7.3, 3.6 Hz, 2 × C3H), 0.69 (2H, dtt, J = 10.1, 8.0, 5.3 Hz, 2 × C11H), 0.54 – 0.43 (6H, m, 2 × C12$_A$$H_AH_B$ and 2 × C12$_B$H$_2$), 0.33 – 0.24 (2H, m, 2 × C12$_A$H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.4 (2C, 2 × C1=O), 141.0 (2C, 2 × C4), 135.4 (2C, 2 × C7), 133.2 (4C, 4 × C6), 127.4 (4C, 4 × C5), 49.6 (2C, 2 × C2H$_2$), 41.6 (2C, 2 × C3H), 17.2 (4C, 4 × C8H$_3$), 16.8 (2C, 2 × C10H$_3$), 16.1 (4C, 4 × C9H$_3$), 15.1 (2C, 2 × C11H), 5.1 (2C, 2 × C12$_A$H$_2$), 4.8 (2C, 2 × C12$_B$H$_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 487.35689; $C_{34}H_{47}O_2$ requires 487.35706, Δ –0.34 ppm.

Note: The compound was isolated as a single diastereomer, but the relative stereochemistry about both C3H was not determined.

***rel*-(*E*)-1-(2,3,4,5,6-Pentamethylphenyl)-3-((1*S*,2*R*)-2-phenylcyclopropyl)prop-2-en-1-one (308)**



Ketone **121** (556 mg, 2.92 mmol, 1.0 equiv), aldehyde **S37** (475 mg, 3.25 mmol, 1.1 equiv), NaOH (143 mg, 3.65 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 19 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded enone **308** (875 mg, 2.75 mmol, 94%) as a colourless solid.

m.p. = 119 – 121 °C.

IR (film) ν_{max}/cm^{-1} 3026, 3002, 2925, 1674, 1643, 1602, 1498, 1459, 1408, 1383, 1313, 1273, 1237, 1194, 1150, 1118, 1094, 1065, 1030, 1018, 977, 922, 880, 833, 812, 747, 733, 697.

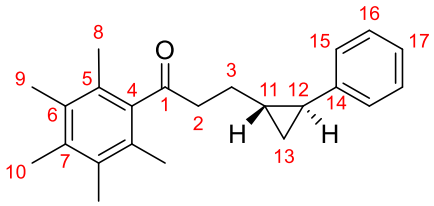
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.33 – 7.24 (2H, m, 2 × C16H), 7.23 – 7.16 (1H, m, C17H), 7.10 – 7.04 (2H, m, 2 × C15H), 6.42 (1H, d, J = 15.6 Hz, C12H), 6.16 (1H, dd, J = 15.6, 9.7 Hz, C13H), 2.26 (3H, s, C10H_3), 2.20 (6H, s, 2 × C9H_3), 2.12 (1H, ddd, J = 8.9, 6.1, 4.0 Hz, C12H), 2.09 (6H, s, 2 × C8H_3), 1.88 (1H, tdd, J = 9.3, 5.3, 4.2 Hz, C11H), 1.46 (1H, ddd, J = 8.4, 6.0, 5.1 Hz, C13H_{cis}H$_{trans}$), 1.26 (1H, dt, J = 8.9, 5.2 Hz, C13H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.1 (C1=O), 154.7 (C3H), 140.7 (C14), 138.2 (C4), 135.4 (C7), 132.9 (2C, 2 × C6), 130.7 (C2H), 129.0 (2C, 2 × C5), 128.7 (2C, 2 × C16H), 126.5 (C17H), 126.0 (2C, 2 × C15H), 27.6 (C12H), 27.4 (C11H), 18.6 (C13H_2), 17.6 (2C, 2 × C8H_3), 16.9 (C10H_3), 16.1 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 319.20560; $C_{23}H_{27}O$ requires 319.20564, Δ –0.14 ppm.

Note: *cis* and *trans* with respect to C11H.

***rel*-1-(2,3,4,5,6-Pentamethylphenyl)-3-((1*S*,2*S*)-2-phenylcyclopropyl)propan-1-one (309)**



Enone **306** (47.8 mg, 0.150 mmol, 1.0 equiv), $NaBH_4$ (11.4 mg, 0.300 mmol, 2.0 equiv) and MeOH:THF (1:1, 750 μL, 0.2 M) were subjected to **General Procedure K**. The crude material was passed through a silica plug, eluting with Et_2O, and the eluent concentrated *in vacuo* to afford ketone **309** (47.8 mg, 0.149 mmol, 99%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3062, 3026, 2995, 2922, 1699, 1604, 1579, 1496, 1461, 1446, 1400, 1382, 1358, 1304, 1264, 1242, 1219, 1183, 1126, 1108, 1090, 1067, 1029, 996, 930, 915, 879, 857, 785, 742, 697.

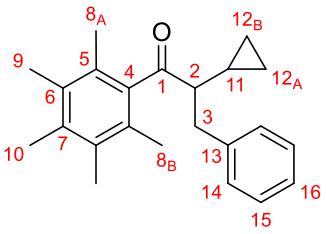
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.23 (2H, m, 2 × C16H), 7.19 – 7.12 (1H, m, C17H), 7.09 – 7.03 (2H, m, 2 × C15H), 2.87 (2H, t, J = 7.2 Hz, C2H_2), 2.26 (3H, s, C10H_3), 2.20 (6H, s, 2 × C9H_3), 2.09 (6H, s, 2 × C8H_3), 1.89 (1H, dq, J = 14.2, 7.1 Hz, C3H_AH$_B$), 1.81 (1H, dq, J = 14.4, 7.3 Hz, C3H$_A$$H_B$), 1.73 (1H, dt, J = 9.1, 4.8 Hz, C12H), 1.18 (1H, dtdd, J = 8.4, 7.0, 5.7, 4.5 Hz, C11H), 0.96 (1H, dt, J = 8.4, 5.0 Hz, C13H_{cis}H$_{trans}$), 0.87 (1H, ddd, J = 8.7, 5.8, 4.8 Hz, C13H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.8 (C1=O), 143.5 (C14), 140.8 (C4), 135.4 (C7), 133.2 (2C, 2 × C6), 128.3 (2C, 2 × C16H), 127.4 (2C, 2 × C5), 125.7 (2C, 2 × C15H), 125.4 (C17H), 45.4 (C2H_2), 28.1 (C3H_2), 23.6 (C12H), 23.2 (C11H), 17.2 (2C, 2 × C8H_3), 16.8 (C13H_2), 16.3 (C10H_3), 16.0 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 321.22125; $C_{23}H_{29}O$ requires 321.22129, Δ –0.12 ppm.

Note: *cis* and *trans* with respect to C11H.

2-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylpropan-1-one (311)



Ketone **310**[*] (138 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), BnOH (130 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 97:3) afforded ketone **311** (108 mg, 0.338 mmol, 56%) as a pale yellow solid.

m.p. = 76 – 79 °C.

IR (film) ν_{max}/cm^{-1} 3081, 3063, 3025, 3002, 2922, 2873, 1692, 1604, 1574, 1494, 1454, 1382, 1306, 1259, 1197, 1181, 1118, 1074, 1048, 1022, 1002, 915, 897, 880, 856, 826, 803, 744, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.20 (4H, m, 2 × C14H and 2 × C15H), 7.23 – 7.15 (1H, m, C16H), 3.34 (1H, dd, J = 13.5, 6.6 Hz, C3H_AH$_B$), 2.93 (1H, dd, J = 13.5, 7.1 Hz, C3H$_A$$H_B$), 2.21 (3H, s, C10H$_3$), 2.21 – 2.10 (1H, m, C2H), 2.15 (9H, v. br. s, C8$_A$H$_3$ and 2 × C9H$_3$), 1.81 (3H, v. br. s, C8$_B$H$_3$), 0.78 (1H, dddd, J = 12.9, 9.9, 8.2, 5.1 Hz, C11H), 0.40 (1H, dddd, J = 9.2, 8.1, 5.7, 4.5 Hz, C12$_A$$H_{cis}H_{trans}$), 0.30 (1H, dddd, J = 9.0, 7.9, 5.7, 4.7 Hz, C12$_B$$H_{cis}H_{trans}$), –0.17 (1H, dq, J = 10.2, 5.1 Hz, C12$_B$H$_{cis}$$H_{trans}$), –0.25 (1H, dq, J = 9.7, 5.0 Hz, C12$_A$H$_{cis}$$H_{trans}$).

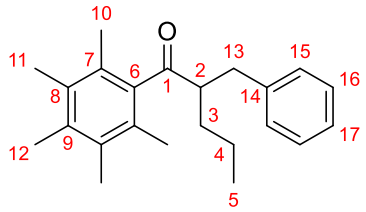
[*] The material was provided by Dr. James Frost.

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.7 (C1=O), 140.64 (C13), 140.63 (C4), 135.5 (C7), 133.0 (2C, br. s, 2 × C6), 129.9 (2C, 2 × C14H), 129.1 (2C, v. br. s, 2 × C5), 128.2 (2C, 2 × C15H), 126.1 (C16H), 61.2 (C2H), 37.1 ($C3H_2$), 17.8 (2C, br. s, $C8_AH_3$ and $C8_BH_3$), 16.9 ($C10H_3$), 16.1 (2C, v. br. s, 2 × $C9H_3$), 13.6 (C11H), 5.5 ($C12_AH_2$), 4.5 ($C12_BH_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 321.22134; $C_{23}H_{29}O$ requires 321.22129, Δ 0.16 ppm.

Note: *cis* and *trans* with respect to C11H.

2-Benzyl-1-(2,3,4,5,6-pentamethylphenyl)pentan-1-one (312)



In the preparation of ketone **311**, ketone **312** (26.2 mg, 81.9 μmol, 14%) was also isolated as a colourless solid.

m.p. = 83 – 85 °C.

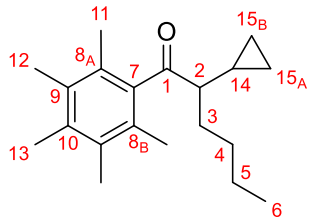
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 3002, 2957, 2930, 2872, 1691, 1604, 1573, 1496, 1454, 1381, 1300, 1259, 1230, 1185, 1132, 1098, 1071, 1029, 1000, 937, 915, 886, 737, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.22 (2H, m, 2 × C16H), 7.21 – 7.15 (3H, m, 2 × C15H and C17H), 3.17 (1H, dd, J = 13.5, 6.3 Hz, $C13H_AH_B$), 3.07 (1H, dt, J = 11.8, 5.9 Hz, C2H), 2.68 (1H, dd, J = 13.5, 7.5 Hz, $C13H_AH_B$), 2.23 (3H, s, $C12H_3$), 2.16 (6H, br. s, 2 × $C11H_3$), 2.00 (6H, v. br. s, 2 × $C10H_3$), 1.71 – 1.64 (1H, m, $C3H_AH_B$), 1.42 – 1.31 (3H, m, $C3H_AH_B$ and $C4H_2$), 0.83 (3H, t, J = 7.1 Hz, $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.1 (C1=O), 140.6 (C14), 139.7 (C6), 135.7 (C9), 133.2 (2C, 2 × C8), 129.5 (2C, 2 × C15H), 128.8 (2C, 2 × C7), 128.4 (2C, 2 × C16H), 126.1 (C17H), 56.0 (C2H), 35.6 ($C13H_2$), 31.9 ($C3H_2$), 20.6 ($C4H_2$), 17.8 (2C, 2 × $C10H_3$), 16.9 ($C12H_3$), 16.2 (2C, br. s, 2 × $C11H_3$), 14.3 ($C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 323.23689; $C_{23}H_{31}O$ requires 323.23694, Δ –0.17 ppm.

2-Cyclopropyl-1-(2,3,4,5,6-pentamethylphenyl)hexan-1-one (313)



Ketone **310**[*] (138 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 μmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 μmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), *n*-butanol (89.0 mg, 1.20 mmol, 2.0 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O:DCM, 100:0:0 → 98.5:1:0.5) afforded ketone **313** (88.0 mg, 0.307 mmol, 51%) as a pale yellow solid.

m.p. = 64 – 67 °C.

IR (film) ν_{max}/cm^{-1} 3078, 3002, 2955, 2930, 2871, 2861, 1692, 1655, 1574, 1458, 1381, 1304, 1264, 1211, 1197, 1169, 1154, 1130, 1089, 1069, 1048, 1021, 998, 966, 907, 828, 730, 705.

[*] The material was provided by Dr. James Frost.

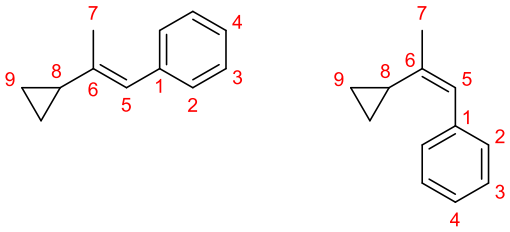
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.24 (3H, s, C13H_3), 2.18 (6H, s, 2 × C12H_3), 2.11 (6H, br. s, 2 × C11H_3), 1.95 (1H, ddd, *J* = 9.6, 6.9, 6.1 Hz, C2H), 1.88 (1H, ddd, *J* = 13.5, 11.1, 5.7 Hz, C3H_AH$_B$), 1.67 (1H, dddd, *J* = 13.6, 10.9, 6.8, 4.8 Hz, C3H$_A$$H_B$), 1.50 (1H, dtd, *J* = 10.4, 7.3, 4.6 Hz, C4H_AH$_B$), 1.43 (1H, dtd, *J* = 12.8, 5.5, 2.3 Hz, C4H$_A$$H_B$), 1.41 – 1.31 (2H, m, C5H_2), 0.93 (3H, t, *J* = 7.3 Hz, C6H_3), 0.77 (1H, dtt, *J* = 9.8, 8.0, 5.0 Hz, C14H), 0.57 (1H, dddd, *J* = 9.1, 8.1, 5.9, 4.5 Hz, C15$_A$$H_{cis}H_{trans}$), 0.37 (1H, dddd, *J* = 9.2, 8.0, 5.9, 4.9 Hz, C15$_B$$H_{cis}H_{trans}$), 0.13 (1H, ddt, *J* = 9.4, 5.8, 4.7 Hz, C15$_A$H$_{cis}$$H_{trans}$), –0.07 (1H, ddt, *J* = 9.5, 5.8, 4.9 Hz, C15$_B$H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.8 (C1=O), 141.0 (C7), 135.3 (C10), 133.0 (2C, br. s, 2 × C9), 128.8 (v. br. s, C8$_A$), 128.0 (v. br. s, C8$_B$), 58.3 (C2H), 30.9 (C3H_2), 29.8 (C4H_2), 23.3 (C5H_2), 18.0 (2C, 2 × C11H_3), 16.8 (C13H_3), 16.1 (2C, br. s, 2 × C12H_3), 14.2 (C6H_3), 13.1 (C14H), 5.1 (C15$_A$$H_2$), 4.2 (C15$_B$$H_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 309.21096; $C_{20}H_{30}ONa$ requires 309.21889, Δ 0.54 ppm.

Note: *cis* and *trans* with respect to C14H.

(*E*)-(2-Cyclopropylprop-1-en-1-yl)benzene ((*E*)-315, major), and (*Z*)-(2-Cyclopropylprop-1-en-1-yl)benzene ((*Z*)-315, minor)



1.9 : 1

To a round bottom flask equipped with a water condenser containing a solution of benzyltriphenylphosphonium bromide (4.33 g, 10.0 mmol, 1.0 equiv) in EtOH (50 mL, 0.2 M) was added and NaOEt (3.1 mL, 21% in EtOH, 9.56 mmol, 0.95 equiv), and the reaction heated to reflux for 10 min. The reaction mixture was cooled to RT, then cyclopropyl methyl ketone (841 mg, 10.0 mmol, 1.0 equiv) was added and the reaction heated to reflux for 3.5 h. The reaction mixture was cooled to RT, diluted with pentane (40 mL) and filtered, eluting with Pentane:EtOH (1:1). The filtrate was concentrated *in vacuo*, then redissolved in Et_2O (10 mL), pentane (30 mL) and H_2O (30 mL). The layers were separated, the aqueous layer extracted with pentane (3 × 20 mL), and the combined organics dried (Na_2SO_4) and concentrated by blowing with a stream of N_2 until the volume had reduced by two-thirds. The concentrate was then passed through a silica plug pre-equilibrated with pentane, eluting with pentane, and the eluent concentrated *in vacuo* to give styrene **315** (473 mg, 2.99 mmol, 30%, *E*:*Z* = 1.9:1) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3081, 3058, 3019, 3009, 2983, 2936, 2915, 2858, 1639, 1599, 1574, 1493, 1441, 1389, 1378, 1366, 1227, 1203, 1174, 1160, 1072, 1046, 1030, 1018, 923, 914, 881, 817, 764, 752, 733, 697.

^{1}H NMR ($CDCl_3$, 500 MHz, major) δ = 7.35 – 7.28 (2H, m, 2 × C2H), 7.26 – 7.20 (2H, m, 2 × C3H), 7.22 – 7.14 (1H, m, C4H), 6.34 (1H, s, C5H), 1.74 (3H, d, J = 1.4 Hz, C7H$_3$), 1.57 (1H, tt, J = 8.4, 5.4 Hz, C8H), 0.72 – 0.62 (2H, m, 2 × C9H_{cis}H$_{trans}$), 0.64 – 0.58 (2H, m, 2 × C9H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz, major) δ = 139.7 (C6), 138.69 (C1), 128.96 (2C, 2 × C2H), 128.15 (2C, 2 × C3H), 125.85 (C4H), 123.6 (C5H), 20.0 (C8), 15.3 (C7H$_3$), 5.1 (2C, 2 × C9H$_2$).

^{1}H NMR ($CDCl_3$, 500 MHz, minor) δ = 7.40 – 7.35 (2H, m, 2 × C3H), 7.35 – 7.28 (2H, m, 2 × C2H), 7.22 – 7.14 (1H, m, C4H), 6.36 (1H, s, C5H), 1.96 (1H, tt, J = 8.0, 5.8 Hz, C8H), 1.62 (3H, d, J = 1.5 Hz, C7H$_3$), 0.72 – 0.62 (4H, m, 2 × C9H$_2$).

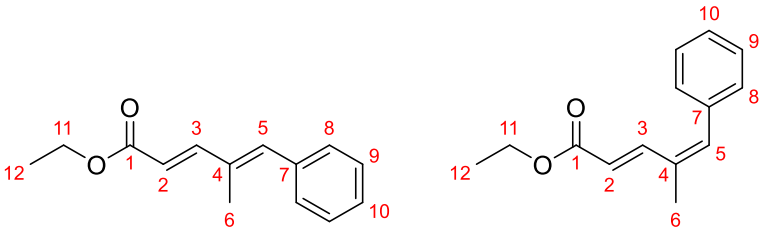
^{13}C NMR ($CDCl_3$, 126 MHz, minor) δ = 138.9 (C6), 138.63 (C1), 129.14 (2C, 2 × C2H), 128.10 (2C, 2 × C3H), 125.90 (C4H), 125.88 (C5H), 19.8 (C8), 13.9 (C7H$_3$), 5.5 (2C, 2 × C9H$_2$).

HRMS (EI) Found $[M]^+$ = 158.1087; $C_{12}H_{14}$ requires 158.1090, Δ –1.91 ppm.

Note: *cis* and *trans* with respect to C8H. The analytical data are identical to those reported in literature.[38]

Ethyl (2*E*,4*E*)-4-methyl-5-phenylpenta-2,4-dienoate ((*E*)-319, major), and

Ethyl (2*E*,4*Z*)-4-methyl-5-phenylpenta-2,4-dienoate ((*Z*)-319, minor)[39]



A suspension of NaH (840 mg, 60% dispersion in mineral oil, 21.0 mmol, 1.05 equiv) in THF (25 mL, 0.8 M) was cooled to 0 °C, followed by the addition of triethyl phosphonoacetate (3.97 mL, 4.48 g, 20.0 mmol, 1.0 equiv) over 5 min. The reaction was vigorously stirred for 30 min at 0 °C, followed by the addition of (*E*)-2-methylcinnamaldehyde **318** (2.79 mL, 2.92 g, 20.0 mmol, 1.0 equiv) in a single portion. The reaction was allowed to gradually warm up to RT over 12 h, then quenched with sat. aq. NH_4Cl (15 mL) and diluted with H_2O (10 mL), brine (10 mL) and Et_2O (30 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1 → 98:2) afforded ester **319** (4.25 g, 19.6 mmol, 98%, *E*:*Z* = 95:5) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3061, 3023, 2981, 2905, 2872, 1707, 1619, 1574, 1491, 1445, 1393, 1366, 1297, 1260, 1210, 1164, 1096, 1077, 1034, 1023, 980, 922, 889, 847, 754, 720, 697.

^{1}H NMR ($CDCl_3$, 500 MHz, major) δ = 7.51 (1H, dd, J = 15.7, 0.8 Hz, C3H), 7.42 – 7.35 (2H, m, 2 × C9H), 7.38 – 7.32 (2H, m, 2 × C8H), 7.32 – 7.25 (1H, m, C10H), 6.86 (1H, s, C5H), 5.98 (1H, dd, J = 15.7, 0.8 Hz, C2H), 4.25 (2H, q, J = 7.1 Hz, $C11H_2$), 2.05 (3H, d, J = 1.3 Hz, $C6H_3$), 1.33 (3H, t, J = 7.1 Hz, $C12H_3$).

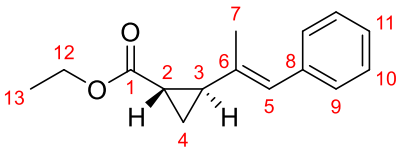
^{13}C NMR ($CDCl_3$, 126 MHz, major) δ = 167.48 (C1=O), 149.9 (C3H), 139.0 (C5H), 136.8 (C7), 134.3 (C4), 129.59 (2C, 2 × C8H), 128.4 (2C, 2 × C9H), 127.83 (C10H), 117.7 (C2H), 60.45 ($C11H_2$), 14.47 ($C12H_3$), 13.8 ($C6H_3$).

^{1}H NMR ($CDCl_3$, 500 MHz, minor) δ = 7.82 (1H, dd, J = 15.7, 0.9 Hz, C3H), 7.42 – 7.35 (2H, m, 2 × C9H), 7.38 – 7.32 (2H, m, 2 × C8H), 7.32 – 7.25 (1H, m, C10H), 6.81 (1H, s, C5H), 6.03 (1H, dd, J = 15.7, 0.8 Hz, C2H), 4.21 (2H, q, J = 6.8 Hz, $C11H_2$), 2.05 (3H, d, J = 1.3 Hz, $C6H_3$), 1.29 (3H, t, J = 7.1 Hz, $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, minor) δ = 167.47 (C1=O), 142.7 (C3H), 137.1 (C5H), 136.6 (C7), 132.8 (C4), 129.61 (2C, 2 × C8H), 128.5 (2C, 2 × C9H), 127.69 (C10H), 120.1 (C2H), 60.44 ($C11H_2$), 20.8 ($C6H_2$), 14.42 ($C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 217.12249; $C_{14}H_{17}O_2$ requires 217.12231, Δ 0.86 ppm.

Ethyl *rel*-(1*S*,2*S*)-2-((*E*)-1-phenylprop-1-en-2-yl)cyclopropane-1-carboxylate (320)[39]



Ester **320** (4.22 g, 19.5 mmol, 1.0 equiv), NaH (820 mg, 60% dispersion in mineral oil, 20.5 mmol, 1.05 equiv), trimethylsulfoxonium iodide (4.94 g, 22.4 mmol, 1.2 equiv) and anhydrous DMSO (38 mL, 0.5 M) were subjected to **General Procedure L**. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded ester **320** (1.94 g, 8.41 mmol, 43%, *E*:*Z* = 95:5) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3082, 3057, 3022, 2982, 2939, 2909, 2872, 1721, 1647, 1620, 1599, 1575, 1492, 1445, 1406, 1386, 1366, 1318, 1265, 1224, 1203, 1176, 1113, 1095, 1079, 1056, 1032, 985, 952, 918, 860, 828, 796, 750, 727, 698.

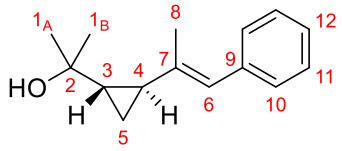
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.28 (2H, m, 2 × C10H), 7.25 – 7.17 (3H, m, 2 × C9H and C11H), 6.40 (1H, s, C5H), 4.17 (2H, qq_{AB}, J = 7.1 Hz, J_{AB} = 10.9 Hz, Δ_{AB} = 7.5 Hz, $C12H_2$), 2.20 (1H, dddd, J = 9.0, 6.6, 4.3, 1.0 Hz, C3H), 1.81 (1H, ddd, J = 8.5, 5.2, 4.3 Hz, C2H), 1.76 (3H, d, J = 1.4 Hz, C7H), 1.37 (1H, ddd, J = 9.1, 5.2, 4.5 Hz, $C4H_{cis}H_{trans}$), 1.30 (3H, t, J = 7.1 Hz, $C13H_3$), 1.23 (1H, ddd, J = 8.4, 6.7, 4.5 Hz, $C4H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 174.0 (C1=O), 137.9 (C8), 136.0 (C6), 128.9 (2C, 2 × C9H), 128.2 (2C, 2 × C10H), 126.4 (C11H), 126.0 (C5H), 60.8 ($C12H_2$), 30.9 (C3H), 20.5 (C2H), 15.6 ($C7H_3$), 14.4 ($C13H_3$), 14.1 ($C4H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 231.13815; $C_{15}H_{19}O_2$ requires 231.13796, Δ 0.85 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-2-((1*S*,2*S*)-2-((*E*)-1-Phenylprop-1-en-2-yl)cyclopropyl)propan-2-ol (321)**



Ester **320** (651 mg, 2.83 mmol, 1.0 equiv), MeMgBr (2.0 mL, 3 M in Et_2O, 6.00 mmol, 2.1 equiv) and Et_2O (14 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 85:15 → 80:20) afforded alcohol **321** (544 mg, 2.51 mmol, 89%, *E*:*Z* = 96:4) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3403 (br.), 3080, 3056, 3023, 2971, 2916, 2879, 2860, 1676, 1641, 1599, 1575, 1493, 1445, 1376, 1324, 1227, 1202, 1179, 1155, 1107, 1074, 1046, 1029, 982, 964, 939, 917, 890, 852, 745, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.28 (2H, m, 2 × C11H), 7.25 – 7.20 (2H, m, 2 × C10H), 7.21 – 7.14 (1H, m, C12H), 6.31 (1H, s, C6H), 1.81 (3H, d, *J* = 1.3 Hz, C8H), 1.59 (1H, dtd, *J* = 8.9, 5.3, 1.0 Hz, C4H), 1.29 (3H, s, C1$_A$H$_3$), 1.28 (3H, s, C1$_B$H$_3$), 1.22 (1H, br. s, OH), 1.14 (1H, ddd, *J* = 8.9, 6.0, 5.2 Hz, C3H), 0.79 (1H, dt, *J* = 8.8, 5.2 Hz, C5*H*$_{cis}$H$_{trans}$), 0.76 (1H, ddd, *J* = 8.7, 6.1, 4.8 Hz, C5H$_{cis}$*H*$_{trans}$).

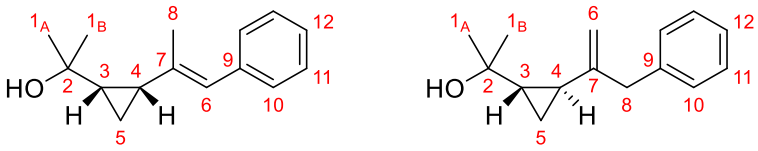
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 139.0 (C7), 138.5 (C9), 128.9 (2C, 2 × C10H), 128.1 (2C, 2 × C11H), 125.9 (C12H), 123.6 (C6H), 69.6 (C2), 30.6 (C3H), 29.2 (C1$_B$H$_3$), 29.0 (C1$_A$H$_3$), 23.8 (C4H), 16.5 (C8H$_3$), 8.2 (C5H$_2$).

HRMS (EI) Found [M]$^+$ = 216.1511; $C_{15}H_{20}O$ requires 216.1509, Δ 1.08 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-2-((1*S*,2*R*)-2-((*E*)-1-Phenylprop-1-en-2-yl)cyclopropyl)propan-2-ol (*cis*-321, major), and**

***rel*-2-((1*S*,2*S*)-2-(3-Phenylprop-1-en-2-yl)cyclopropyl)propan-2-ol (322, minor)**



2.2 : 1

Alcohol *trans*-**321** (130 mg, 0.600 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (4.03 mg, 6.00 µmol, 1 mol%), cataCXium® A (17.2 mg, 24.0 µmol, 8 mol%), KO*t*-Bu (67.3 mg, 0.600 mmol, 1.0 equiv), 1-cyclopropylethan-1-ol (103 mg, 1.20 mmol, 2.0 equiv) and toluene (150 µL, 4 M) were subjected to **General Procedure F** at 105 °C. Purification by flash column chromatography (Pentane:Et_2O, 85:15 → 80:20) afforded a colourless oil (3.2 mg) containing an inseparable mixture of alcohols *cis*-**321** (10.2 mmol, 1.7%) and **322** (4.6 µmol, 0.8%).

IR (film) ν_{max}/cm^{-1} 3391 (br.), 3078, 3060, 3021, 3006, 2970, 2928, 1640, 1599, 1493, 1463, 1453, 1441, 1374, 1231, 1204, 1177, 1152, 1108, 1075, 1029, 1005, 970, 942, 913, 886, 850, 828, 762, 735, 698.

^{1}H NMR ($CDCl_3$, 500 MHz, major isomer) δ = 7.38 – 7.32 (2H, m, 2 × C10H), 7.35 – 7.28 (2H, m, 2 × C11H), 7.22 – 7.14 (1H, m, C12H), 6.35 (1H, s, C6H), 1.98 (1H, dtd, J = 9.0, 5.5, 0.9 Hz, C3H), 1.66 (3H, d, J = 1.4 Hz, $C8H_3$), 1.56 (1H, br. s, OH), 1.26 (1H, ddd, J = 8.8, 6.1, 5.5 Hz, C4H), 1.20 (3H, s, $C1_AH_3$), 1.20 (3H, s, $C1_BH_3$), 0.75 – 0.68 (2H, m, $C5H_2$).

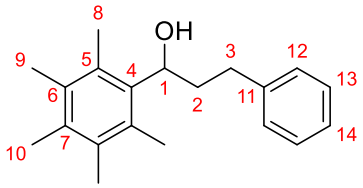
^{13}C NMR ($CDCl_3$, 126 MHz, major isomer) δ = 138.5 (C9), 138.0 (C7), 129.14 (2C, 2 × C10H), 128.2 (2C, 2 × C11H), 126.13 (C6H), 126.02 (C12H), 69.8 (C2), 30.0 (C4H), 28.99 ($C1_BH_3$), 28.89 ($C1_AH_3$), 20.7 ($C8H_3$), 17.9 (C3H), 9.0 ($C5H_2$).

^{1}H NMR ($CDCl_3$, 500 MHz, minor isomer) δ = 7.34 – 7.26 (2H, m, 2 × C11H), 7.25 – 7.19 (3H, m, 2 × C10H and C12H), 4.71 (1H, td, J = 1.6, 0.6 Hz, C6H_{syn}H$_{anti}$), 4.67 (1H, q, J = 1.3 Hz, C6H$_{syn}$$H_{anti}$), 3.41 (2H, q_{AB}, J_{AB} = 15.0 Hz, Δ_{AB} = 11.0 Hz, $C8H_2$), 1.31 – 1.25 (1H, m, C4H), 1.09 (6H, s, $C1_AH_3$ and $C1_BH_3$), 0.94 (1H, ddd, J = 8.9, 6.3, 5.2 Hz, C3H), 0.68 – 0.61 (2H, m).

^{13}C NMR ($CDCl_3$, 126 MHz, minor isomer) δ = 149.6 (C7), 139.8 (C9), 129.20 (2C, 2 × C10H), 128.5 (2C, 2 × C11H), 126.3 (C12H), 108.6 ($C6H_2$), 69.5 (C2), 43.7 ($C8H_2$), 33.2 (C3H), 28.79 ($C1_AH_3$), 28.6 ($C1_BH_3$), 19.7 (C4H), 9.2 ($C5H_2$).

Note: *syn* and *anti* with respect to C4H for both cases. In addition, the NMR analysis of the crude material showed that the ratio of **320**:*cis*-**319**:*trans*-**319** is 1:4.7:19.8.

1-(2,3,4,5,6-Pentamethylphenyl)-3-phenylpropan-1-ol (324)



To a 10 – 20 mL microwave vial was added ketone **145** (140 mg, 0.500 mmol, 1.0 equiv), $NaBH_4$ (37.8 mg, 1.00 mmol, 2.0 equiv) and EtOH (5.0 mL, 0.1 M). The vial was sealed with a microwave vial cap, then heated to internal reflux for 24 h. The reaction was cooled to RT, then quenched with sat. aq. NH_4Cl (5 mL), and the mixture poured into H_2O (25 mL) and Et_2O (25 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 15 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 75:25) afforded benzylic alcohol **324** (9.3 mg, 33 μmol, 6.6%) as a colourless oil.

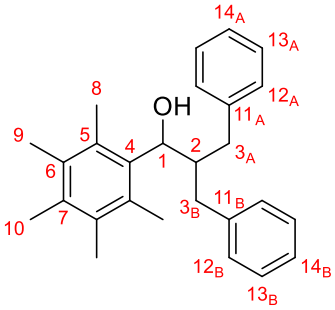
IR (film) ν_{max}/cm^{-1} 3421, 3084, 3061, 3026, 2923, 2857, 1701, 1603, 1495, 1454, 1382, 1296, 1168, 1055, 1031, 917.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.30 (2H, m, 2 × C13H), 7.26 – 7.22 (2H, m, 2 × C12H), 7.22 – 7.17 (1H, m, C14H), 5.29 (1H, dd, J = 9.5, 4.6 Hz, C1H), 2.94 (1H, ddd, J = 14.2, 9.5, 5.0 Hz, C3H_AH$_B$), 2.73 (1H, ddd, J = 13.8, 9.2, 7.4 Hz, C3H$_A$$H_B$), 2.44 (1H, ddt, J = 18.9, 9.3, 5.1 Hz, C2H_AH$_B$), 2.31 (6H, s, 2 × C10H$_3$), 2.25 (3H, s, C9H$_3$), 2.22 (6H, s, 2 × C8H$_3$), 2.02 (1H, dddd, J = 14.1, 9.5, 7.2, 4.4 Hz, C2H$_A$$H_B$), 1.74 (1H, br. s, OH).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 142.0 (C11), 137.6 (C4), 134.3 (C7), 133.6 (2C, v. br. s, 2 × C6H), 132.0 (2C, br. s, 2 × C5H), 128.63 (2C, 2 × C12H), 128.48 (2C, 2 × C13H), 125.9 (C19H), 71.4 (C1H), 37.6 (C3H$_2$), 33.0 (C2H$_2$), 17.22 (C10H$_3$), 17.14 (2C, br. s, 2 × C8H$_3$), 16.8 (2C, 2 × C9H$_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 305.18756; $C_{20}H_{26}ONa$ requires 305.18759, Δ –0.08 ppm.

2-Benzyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylpropan-1-ol (325)



Ketone **79** (92.6 mg, 0.250 mmol, 1.0 equiv), DIBAL-H (0.3 mL, 1.0 M in DCM, 0.300 mmol, 1.2 equiv) and DCM (2.5 mL, 0.1 M) were subjected to **General Procedure H**. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10) afforded benzylic alcohol **325** (86.1 mg, 0.231 mmol, 92%) as a colourless solid.

m.p. = 83 – 85 °C.

IR (film) ν_{max}/cm^{-1} 3517, 3451, 3083, 3061, 3026, 3001, 2924, 2860, 1602, 1494, 1453, 1382, 1295, 1180, 1155, 1062, 1043, 1031, 999, 942, 908, 885, 839, 809, 780, 747, 699.

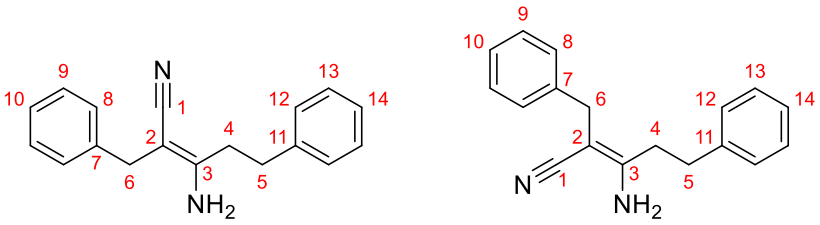
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 – 7.28 (2H, m, 2 × $C13_AH$), 7.28 – 7.25 (2H, m, 2 × $C12_AH$), 7.24 – 7.18 (1H, m, $C14_AH$), 7.14 – 7.08 (2H, m, 2 × $C13_BH$), 7.08 – 7.03 (1H, m, $C14_BH$), 6.86 – 6.78 (2H, m, 2 × $C12_BH$), 5.22 (1H, d, J = 9.1 Hz, C1H), 2.98 (1H, dd, J = 13.3, 4.5 Hz, $C3_AH_AH_B$), 2.92 (1H, dd, J = 13.3, 6.5 Hz, $C3_AH_AH_B$), 2.90 – 2.83 (1H, m, C2H), 2.34 (1H, dd, J = 14.1, 8.1 Hz, $C3_BH_AH_B$), 2.28 (6H, br. s, 2 × $C8H_3$), 2.25 (1H, dd, J = 14.2, 5.5 Hz, $C3_BH_AH_B$), 2.21 (3H, s, $C10H_3$), 2.15 (6H, s, 2 × $C9H_3$), 1.69 (1H, br. s, OH).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 141.0 ($C11_B$), 140.5 ($C11_A$), 135.9 (C4), 134.4 (C7), 133.5 (2C, v. br. s, 2 × C6), 132.7 (2C, br. s, 2 × C5), 130.0 (2C, 2 × $C12_AH$), 128.9 (2C, 2 × $C12_BH$), 128.3 (2C, 2 × $C13_AH$), 128.0 (2C, 2 × $C13_BH$), 126.0 ($C14_AH$), 125.5 ($C14_BH$), 74.1 (C1H), 46.8 (C2H), 37.0 ($C3_AH_2$), 36.2 ($C3_BH_2$), 17.6 (2C, br. s, 2 × $C8H_3$), 17.2 ($C10H_3$), 16.9 (2C, br. s, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 395.23459; $C_{27}H_{32}ONa$ requires 395.23563, Δ –2.64 ppm.

(*E*)-3-Amino-2-benzyl-5-phenylpent-2-enenitrile ((*E*)-327, major), and

(*Z*)-3-Amino-2-benzyl-5-phenylpent-2-enenitrile ((*Z*)-327, minor)



(*E*) : (*Z*)

4 : 1

To a solution of 3-phenylpropionitrile **324** (150 µL, 150 mg, 1.14 mmol, 1.0 equiv) in THF (5.7 mL, 0.2 M) was added 2-mesitylmagnesium bromide (1.1 mL, 1.0 M in THF, 1.10 mmol, 1.0 equiv) at RT and stirred for 2 h. The reaction was quenched with H_2O (10 mL) and diluted with Et_2O (25 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 20 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 75:25) afforded enamine **327** (138 mg, 0.526 mmol, 92%, *E*:*Z* = 4:1) as a colourless solid.

m.p. = 66 – 75 °C.

IR (film) ν_{max}/cm^{-1} 3472, 3355, 3236, 3085, 3062, 3027, 3004, 2964, 2926, 2861, 2181, 1635, 1599, 1495, 1453, 1383, 1074, 1030.

^{1}H NMR ($CDCl_3$, 400 MHz, *E*-isomer) δ = 7.34 – 7.27 (4H, m, 2 × C9H and 2 × C13H), 7.25 – 7.20 (4H, m, C10H, 2 × C12H and C14H), 7.20 – 7.15 (2H, m, 2 × C8H), 4.01 (2H, s, NH_2), 3.40 (2H, s, C6H_2), 2.94 (2H, t, *J* = 7.6 Hz, C4H_2), 2.76 (2H, t, *J* = 7.5 Hz, C5H_2).

^{13}C NMR ($CDCl_3$, 101 MHz, *E*-isomer) δ = 158.3 (C3), 140.0 (C11), 137.9 (C7), 128.89 (2C, 2 × C9H), 128.75 (2C, 2 × C13H), 128.63 (2C, 2 × C12H), 128.0 (2C, 2 × C8H), 126.9 (C10H), 126.7 (C14H), 122.9 (C2), 77.9 (C1≡N), 36.5 (C5H_2), 34.6 (C4H_2), 33.5 (C6H_2).

^{1}H NMR ($CDCl_3$, 400 MHz, *Z*-isomer) δ = 7.34 – 7.20 (6H, m, 2 × C9H, C10H, 2 × C13H and C14H), 7.20 – 7.15 (2H, m, 2 × C8H), 7.15 – 7.11 (2H, m, 2 × C12H), 4.41 (2H, s, NH_2), 3.34 (2H, s, $C6H_2$), 2.78 (2H, t, *J* = 7.8 Hz, $C4H_2$), 2.53 (2H, t, *J* = 7.7 Hz, $C5H_2$).

^{13}C NMR ($CDCl_3$, 101 MHz, *Z*-isomer) δ = 158.9 (C3), 140.0 (C11), 139.7 (C7), 128.86 (2C, 2 × C9H), 128.73 (2C, 2 × C13H), 128.4 (2C, 2 × C12H), 128.1 (2C, 2 × C8H), 126.81 (C10H), 126.65 (C14H), 121.3 (C2), 77.4 (C1≡N), 34.1 ($C4H_2$), 33.51 ($C3H_2$), 33.34 ($C6H_2$).

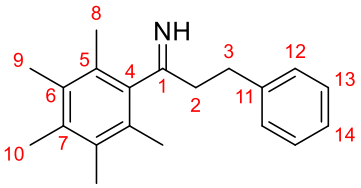
HRMS (ESI^+) Found $[M+H]^+$ = 263.15430; $C_{18}H_{19}N_2$ requires 263.15428, Δ 0.08 ppm.

The analytical data are identical to those reported in literature.[40]

1-(2,3,4,5,6-Pentamethylphenyl)-3-phenylpropan-1-imine (328),

(*Z*)-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylprop-1-en-1-amine (328), and

(*E*)-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylprop-1-en-1-amine (328)[41,42]



A rigorously flame-dried two-neck round bottom flask equipped with a water condenser was charged with crushed beads of anhydrous $CeCl_3$ (493 mg, 2.00 mmol, 1.0 equiv) in a dry box. The reaction setup was removed from the dry box, and the reaction atmosphere flushed with a balloon of Ar. To the flask was added THF (2 mL), and the suspension cooled to 0 °C and stirred for 10 min. To the suspension was added phenethylmagnesium chloride (2.0 mL, 1 M in THF, 2.00 mmol, 1.0 equiv) dropwise over 5 min, then stirred for 1 h at 0 °C. A solution of pentamethylbenzonitrile (347 mg, 2.00 mmol, 1.0 equiv) in THF (2.7 mL, final concentration 0.33 M) was added dropwise to the organocerium suspension over 5 min, then the reaction was heated to reflux for 24 h. The reaction was then cooled to RT over 10 – 30 min, then further cooled to 0 °C, and quenched with H_2O (5 mL). The reaction mixture was allowed to warm up to RT, then diluted with H_2O (10 mL) and EtOAc (20 mL). The layers were separated, the aqueous layer extracted with EtOAc (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10 → 85:15) afforded imine **328** (191 mg, 0.685 mmol, 34%) as a viscous yellow oil.

IR (film) ν_{max}/cm^{-1} 3237 (v. br.), 3084, 3061, 3025, 2989, 2922, 1632, 1603, 1495, 1453, 1416, 1381, 1339, 1325, 1286, 1242, 1235, 1177, 1085, 1077, 1028, 998, 903, 840, 816, 753, 739, 698.

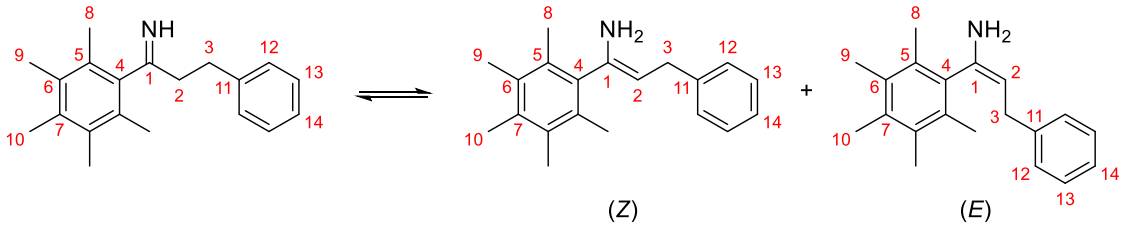
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 9.16 (1H, v. br. s, NH), 7.31 – 7.27 (2H, m, 2 × C13H), 7.26 – 7.23 (2H, m, 2 × C12H), 7.21 – 7.16 (1H, m, C14H), 3.13 – 3.04 (2H, m, $C3H_2$), 2.85 – 2.76 (2H, m, $C2H_2$), 2.25 (3H, s, $C10H_3$), 2.20 (6H, s, 2 × $C9H_3$), 2.13 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 185.1 (C1=NH), 141.7 (C11), 141.0 (C4), 134.8 (C7), 133.2 (2C, 2 × C6), 128.5 (4C, 2 × C12H and 2 × C13H), 128.2 (2C, 2 × C5), 126.1 (C14H), 42.3 ($C2H_2$), 31.4 ($C3H_2$), 17.7 (2C, 2 × $C8H_3$), 16.8 ($C10H_3$), 16.4 (2C, 2 × $C9H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 299.5 (C1=NH).

HRMS (ESI^+) Found $[M+H]^+$ = 280.20575; $C_{20}H_{26}N$ requires 280.20598, Δ –0.81 ppm.

Note: The NMR samples were prepared from freshly sacrificed ampoules of deuterated solvent under a flow of Ar to minimise water contamination. No trace of any enamine tautomer was observed in $CDCl_3$ solution, however in CD_3CN and DMSO-d_6 solutions the imine equilibrates with both *E*- and *Z*-enamine tautomers. Due to the highly crowded nature of the ^{13}C NMR and the complexity of the various 2D NMR spectra, only the imine tautomer in CD_3CN and DMSO-d_6 solutions could be fully assigned. Partial ^{13}C NMR data for the enamine tautomers in DMSO-d_6 are also provided for comparison. Only partial ^{1}H NMR data could be provided for the enamine tautomers in CD_3CN; the NH protons are poorly resolved on the ^{1}H NMR spectrum.



DMSO-d_6	1	:	0.15	:	0.1
CD_3CN	1	:	0.08	:	0.05

^{1}H NMR (DMSO-d_6, 500 MHz, imine tautomer) δ = 9.58 (1H, br. s, NH), 7.34 – 7.23 (2H, m, 2 × C12H), 7.23 – 7.15 (2H, m, 2 × C13H), 7.19 – 7.13 (1H, m, C14H), 2.94 (2H, br. t, J = 7.9 Hz, $C3H_2$), 2.63 (2H, t, J = 7.9 Hz, $C2H_2$), 2.16 (3H, s, $C10H_3$), 2.11 (6H, s, 2 × $C9H_3$), 2.00 (6H, s, 2 × $C8H_3$).

^{13}C NMR (DMSO-d_6, 126 MHz, imine tautomer) δ = 181.8 (C1=NH), 141.6 (C11), 138.7 (v. br. s, C4), 133.5 (C7), 132.0 (2C, 2 × C6), 128.4 (2C, 2 × C12H), 128.2 (2C, 2 × C13H), 125.7 (C14H), 127.6 (2C, br. s, 2 × C5), 41.7 (v. br. s, $C2H_2$), 30.5 ($C3H_2$), 17.08 (2C, 2 × $C8H_3$), 16.32 ($C10H_3$), 16.0 (2C, 2 × $C9H_3$).

^{15}N NMR (DMSO-d_6, 50.7 MHz, imine tautomer) δ = 305.0 (C1=NH).

^{1}H NMR (DMSO-d_6, 500 MHz, *Z*-enamine tautomer) δ = 7.34 – 7.23 (2H, m, 2 × C12H), 7.23 – 7.12 (3H, m, 2 × C13H and C14H), 4.37 (2H, br. s, NH_2), 3.79 (1H, t, J = 7.3 Hz, C2H), 3.40 (2H, d, J = 7.3 Hz, $C3H_2$), 2.20 (6H, s, 2 × $C8H_3$), 2.15 (3H, s, $C10H_3$), 2.11 (6H, s, 2 × $C9H_3$).

^{13}C NMR (DMSO-d_6, 126 MHz, *Z*-enamine tautomer, partial data) δ = 143.0 (C11), 138.7 (C1), 125.27 (C14H), 96.06 (C2H), 31.7 ($C3H_2$), 17.4 (2C, 2 × $C8H_3$), 16.30 ($C10H_3$), 16.0 (2C, 2 × $C9H_3$).

^{15}N NMR (DMSO-d_6, 50.7 MHz, *Z*-enamine tautomer) δ = 63.9 (NH_2).

^{1}H NMR (DMSO-d_6, 500 MHz, *E*-enamine tautomer) δ = 7.22 – 7.18 (2H, m, 2 × C15H), 7.13 – 7.05 (1H, m, C14H), 7.05 – 6.98 (2H, m, 2 × C12H), 4.66 (1H, t, J = 7.3 Hz, C2H), 4.09 (2H, v. br. s, NH_2), 2.78 (2H, d, J = 7.3 Hz, $C3H_2$), 2.19 (6H, s, 2 × $C8H_3$), 2.14 (3H, s, $C10H_3$), 2.11 (6H, s, 2 × $C9H_3$).

^{13}C NMR (DMSO-d_6, 126 MHz, *E*-enamine tautomer, partial data) δ = 143.6 (C11), 135.5 (C1), 127.9 (2C, 2 × C12H), 125.19 (C14H), 96.12 (C2H), 33.7 ($C3H_2$), 17.13 (2C, 2 × $C8H_3$), 16.23 ($C10H_3$), 16.0 (2C, 2 × $C9H_3$).

^{15}N NMR (DMSO-d_6, 50.7 MHz, *E*-enamine tautomer) δ = 63.9 (NH_2).

^{1}H NMR (CD_3CN, 500 MHz, imine tautomer) δ = 7.27 (4H, app. d, J = 4.4 Hz, 2 × C12H and 2 × C13H), 7.21 – 7.13 (1H, m, C14H), 3.03 – 2.96 (2H, m, $C3H_2$), 2.75 – 2.67 (2H, m, $C2H_2$), 2.20 (3H, s, $C10H_3$), 2.16 (6H, s, 2 × $C9H_3$), 2.06 (6H, s, 2 × $C8H_3$).

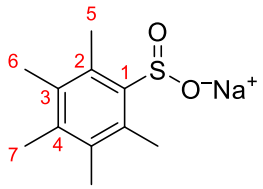
^{13}C NMR (CD_3CN, 126 MHz, imine tautomer) δ = 184.6 (C1=O), 143.0 (C11), 141.8 (C4), 135.2 (C7), 133.6 (2C, 2 × C6), 129.5 (2C, 2 × C12H), 129.3 (2C, 2 × C13H), 129.1 (2C, 2 × C5), 126.8 (C14H), 42.9 ($C2H_2$), 31.8 ($C3H_2$), 17.6 (2C, 2 × $C8H_3$), 16.7 ($C10H_3$), 16.4 (2C, 2 × $C9H_3$).

^{15}N NMR (CD_3CN, 50.7 MHz, imine tautomer) δ = 304.2 (C1=NH). [CD_3CN: 244.8 ppm]

^{1}H NMR (CD_3CN, 500 MHz, *Z*-enamine tautomer) δ 4.03 (1H, t, J = 7.3 Hz, C2H), 3.40 (2H, t, J = 7.3 Hz, $C3H_2$), 3.40 (2H, d, J = 7.3 Hz, $C3H_2$).

^{1}H NMR (CD_3CN, 500 MHz, *E*-enamine tautomer) δ = 4.78 (1H, t, J = 7.3 Hz, C2H), 2.83 (2H, d, J = 7.3 Hz, $C3H_2$).

Sodium 2,3,4,5,6-pentamethylbenzenesulfinate (331)[43]



To a flask equipped with a water condenser was added pentamethylbenzenesulfonyl chloride **330** (814 mg, 3.30 mmol, 1.0 equiv), H_2O (10.0 mL, 0.33 M) was added Na_2SO_3 (665 mg, 4.80 mmol, 1.6 equiv) and $NaHCO_3$ (443 mg, 4.80 mmol, 1.6 equiv), and the reaction heated to reflux for 3 h. The reaction mixture was removed from the oil bath and immediately diluted with EtOH (20 mL), then directly concentrated *in vacuo* over a warm water bath (50 – 60 °C) until approximately one-third of the solvent remained. The warm concentrate was carefully filtered, the residue rinsed with a minimal amount of EtOH (c.a. 5 mL), and the filtrate concentrated *in vacuo*. To the residue was added EtOH (10 mL), then refluxed for 10 min before cooling to RT and filtering and concentrating the filtrate *in vacuo*, with this process being repeated a further two times to give a colourless solid (780 mg) containing an inseparable mixture of sulfinate **331** (2.83 mmol, 80%) and sulfonate **332** (0.471 mmol, 13%).

m.p. = >300 °C.

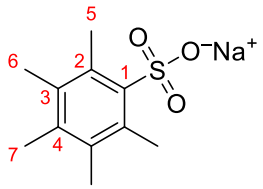
IR (film) ν_{max}/cm^{-1} 3054, 3001, 2926, 1557, 1455, 1409, 1377, 1282, 1208, 1185, 1066, 1021, 1008, 972, 819, 750, 730, 641, 607.

^{1}H NMR (CD_3OD, 500 MHz) δ = 2.61 (6H, s, 2 × $C5H_3$), 2.21 (3H, s, $C7H_3$), 2.17 (6H, s, $C6H_3$).

^{13}C NMR (CD_3OD, 126 MHz) δ = 149.5 (C1), 136.7 (C4), 134.3 (2C, 2 × C3), 132.5 (2C, 2 × C2), 17.1 ($C7H_3$), 16.0 (2C, 2 × $C6H_3$), 15.4 (2C, 2 × $C5H_3$).

HRMS (ESI^-) Found $[M+H]^{+-}$ = 235.07655; $C_{11}H_{16}O_2SNa$ requires 235.07632, Δ 0.99 ppm.

Sodium 2,3,4,5,6-pentamethylbenzenesulfonate (332)



To a well-stirred saturated solution of NaI (2.10g, 14.0 mmol, 3.5 equiv) in acetone was added a solution of pentamethylbenzenesulfonyl chloride **330** (987 mg, 4.00 mmol, 1.0 equiv) dropwise at RT, during which time the solution rapidly turns dark brown with precipitation of the sulfonate salt. The reaction mixture was stirred for a further 30 min before filtering, carefully rinsing the residue with cold acetone until all the brown colouration has been removed. The residue was dried *in vacuo* to afford sulfonate **332** (746 mg, 2.98 mmol, 75%) as a colourless solid.

m.p. = >300 °C.

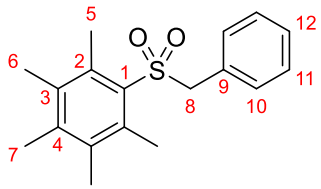
IR (film) ν_{max}/cm^{-1} 3422, 2989, 2918, 1683, 1558, 1455, 1406, 1377, 1209, 1184, 1061, 1015, 981, 749, 642.

^{1}H NMR (D_2O, 500 MHz) δ = 2.51 (6H, s, 2 × $C5H_3$), 2.26 (3H, s, $C7H_3$), 2.23 (6H, s, $C6H_3$).

^{13}C NMR (D_2O, 126 MHz) δ = 140.2 (C1), 139.0 (C4), 135.4 (2C, 2 × C3), 133.6 (2C, 2 × C2), 19.6 (2C, 2 × $C5H_3$), 17.5 ($C7H_3$), 16.9 (2C, 2 × $C6H_3$).

HRMS (ESI^-) Found $[M]^-$ = 227.07475; $C_{11}H_{15}O_3S$ requires 227.07474, Δ 0.06 ppm.

1-(Benzylsulfonyl)-2,3,4,5,6-pentamethylbenzene (333)



To a solution of sulfinate **331** (780 mg, contains c.a. 14 mol% sulfonate **332**, 2.83 mmol, 1.0 equiv) in DMF (12 mL, 0.25 M) was added BnBr (392 µL, 532 mg, 3.11 mmol, 1.1 equiv), and stirred for 3 h. The reaction mixture was diluted with H_2O (75 mL) and Et_2O (40 mL), the layers were separated and the aqueous layer extracted with Et_2O (3 × 30 mL). The combined organics were washed with sat. aq. LiCl (3 × 10 mL), and the combined aq. LiCl washings extracted with Et_2O (15 mL). The combined organics were dried (Na_2SO_4), concentrated *in vacuo*, and purified by flash column chromatography (Pentane:Et_2O:DCM, 75:5:20 → 50:10:40) afforded sulfone **333** (310 mg, 1.03 mmol, 36%) as a colourless solid.

m.p. = 183 – 186 °C.

IR (film) ν_{max}/cm^{-1} 3064, 3030, 2972, 2926, 2854, 1549, 1494, 1455, 1405, 1378, 1297, 1255, 1217, 1204, 1160, 1145, 1123, 1069, 1030, 1011, 945, 908, 879, 787, 747, 732, 700, 615.

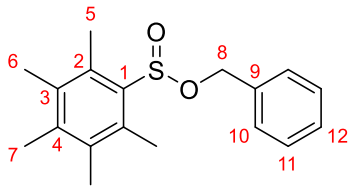
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.30 (1H, m, C12H), 7.30 – 7.26 (2H, m 2 × C11H), 7.22 – 7.16 (2H, m, 2 × C10H), 4.42 (2H, s, C8H_2), 2.36 (6H, s, 2 × C5H_3), 2.28 (3H, s, C7H_3), 2.20 (6H, s, 2 × C6H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 140.8 (C4), 136.2 (2C, 2 × C2), 135.1 (2C, 2 × C3), 134.7 (C1), 131.4 (2C, 2 × C10H), 128.79 (C12H), 128.68 (2C, 2 × C11H), 128.3 (C9), 63.1 (C8H_2), 19.1 (2C, 2 × C5H_3), 18.0 (C7H_3), 17.1 (2C, 2 × C6H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 325.12323; $C_{18}H_{22}O_2SNa$ requires 325.12327, Δ –0.13 ppm.

Note: The numbering for this compound is not based off its systematic name, but rather in an analogous fashion to sulfinate **332**.

Benzyl 2,3,4,5,6-pentamethylbenzenesulfinate (334)



In the preparation of sulfone **333**, sulfinate **334** (155 mg, 0.513 mmol, 18%) was also isolated as a colourless solid.

m.p. = 88 – 90 °C.

IR (film) ν_{max}/cm^{-1} 3089, 3063, 3031, 3006, 2927, 2876, 1557, 1497, 1454, 1415, 1374, 1284, 1266, 1222, 1122, 1068, 1022, 948, 909, 837, 821, 728, 694.

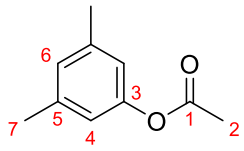
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.41 – 7.34 (4H, m, 2 × C10H and 2 × C11H), 7.34 – 7.29 (1H, m, C12H), 5.18 (1H, d, J = 11.9 Hz, C8H_AH$_B$), 5.08 (1H, d, J = 11.9 Hz, C8H$_A$$H_B$), 2.54 (6H, s, 2 × C5$H_3$), 2.25 (3H, s, C7$H_3$), 2.20 (6H, s, 2 × C6$H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 139.9 (C1), 139.6 (C4), 136.4 (C9), 134.6 (2C, 2 × C3), 133.2 (2C, 2 × C2), 128.7 (2C, 2 × C10H_2), 128.53 (C12H), 128.47 (2C, 2 × C11H_2), 70.6 (C8H_2), 17.6 (C7H_3), 16.2 (2C, 2 × C6H_3), 15.7 (2C, 2 × C5H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 325.12330; $C_{18}H_{22}O_2SNa$ requires 325.12327, Δ 0.09 ppm.

Note: This compound gradually decomposes over a few weeks to a dark amorphous solid, and this process is accelerated in solution. In addition, the sulfinate group is a stereocentre, thus the protons at C8H_2 are diastereotopic.

3,5-Dimethylphenyl acetate (335)[44]



To a round bottom flask equipped with a water condenser was added 3,5-dimethylphenol (244 mg, 2.00 mmol, 1.0 equiv) and Ac_2O (378 μL, 408 mg, 4.00 mmol, 2.0 equiv), and the reaction mixture heated to reflux for 1 h, then allowed to gradually cool down to RT over 16 h. The reaction mixture was poured into H_2O (50 mL) and Et_2O (30 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ester **335** (286 mg, 1.74 mmol, 87%) as a colourless oil.

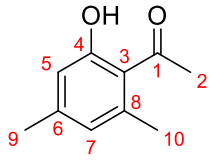
IR (film) ν_{max}/cm^{-1} 3017, 2921, 2865, 1760, 1618, 1590, 1469, 1438, 1368, 1295, 1201, 1136, 1031, 1001, 950, 902, 871, 836.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 6.87 (1H, s, C6H), 6.70 (2H, s, 2 × C4H), 2.32 (6H, s, 2 × $C7H_3$), 2.28 (3H, s, $C2H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 169.9 (C1=O), 150.7 (C3), 139.4 (2C, 2 × C5), 127.7 (C6H), 119.3 (2C, 2 × C4H), 21.36 (2C, 2 × $C7H_3$), 21.28 ($C2H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 187.07309; $C_{10}H_{12}O_2Na$ requires 187.07295, Δ 0.72 ppm.

1-(2-Hydroxy-4,6-dimethylphenyl)ethan-1-one (336)[44]



To an open 10 – 20 mL microwave vial was added ester **335** (275 mg, 1.68 mmol, 1.0 equiv) and $AlCl_3$ (224 mg, 1.68 mmol, 1.0 equiv), and the reaction mixture directly heated to 110 °C for 1 h (caution: *very* vigorous foaming and evolution of HCl gas upon immersion into pre-heated oil bath). The reaction mixture was cooled to RT, then redissolved in DCM (30 mL) and poured into H_2O (30 mL). The layers were separated, the aqueous layer extracted with DCM (3 × 20 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded phenol **336** (144 mg, 0.876 mmol, 52%) as a pale yellow solid.

m.p. = 56 – 58 °C.

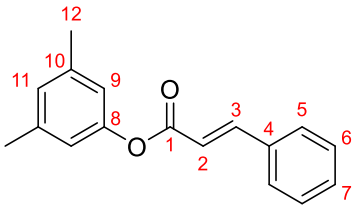
IR (film) ν_{max}/cm^{-1} 3028, 2977, 2931, 2863, 2777, 2658, 2601, 2468, 2424, 1621, 1602, 1568, 1490, 1455, 1427, 1402, 1377, 1353, 1299, 1281, 1259, 1218, 1167, 1067, 1035, 1020, 977, 947, 887, 860, 834.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 12.63 (1H, s, OH), 6.65 (1H, s, C5H), 6.54 (1H, s, C7H), 2.64 (3H, s, C2H_3), 2.56 (3H, s, C10H_3), 2.27 (3H, s, C8H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 205.5 (C1=O), 163.7 (C4), 146.2 (C6), 139.6 (C10), 124.6 (C7H), 119.2 (C3), 116.8 (C5H), 33.4 (C2H_3), 24.8 (C10H_3), 21.7 (C9H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 165.09103; $C_{10}H_{13}O_2$ requires 165.09101, Δ 0.17 ppm.

3,5-Dimethylphenyl (*E*)-3-phenylprop-2-enoate (337)[45]



A solution of 3,5-dimethylphenol (1.53 g, 12.5 mmol, 1.0 equiv) in DCM (75 mL, 0.2 M) was cooled to 0 °C, then Et_3N (1.92 mL, 1.39 g, 13.8 mmol, 1.1 equiv), cinnamoyl chloride (2.21 g, 13.1 mmol, 1.05 equiv) and DMAP (305 mg, 2.50 mmol, 0.2 equiv) were added and stirred for 1.5 h at 0 °C. The reaction was quenched with sat. aq. NH_4Cl (20 mL), then diluted with H_2O (15 mL) and DCM (30 mL). The layers were separated, the aqueous layer extracted with DCM (3 × 30 mL), and the combined organics washed with 1 M NaOH (20 mL). The organics were dried (Na_2SO_4), concentrated *in vacuo* to directly give a yellow oil (3.32 g) that was directly used in the next reaction without further purification.

An analytically pure sample was prepared by flash column chromatography (Pentane:Et_2O, 95:5) to give ester **335** as a pale yellow solid.

m.p. = 40 – 43 °C.

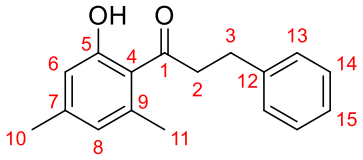
IR (film) ν_{max}/cm^{-1} 3061, 3027, 2919, 1730, 1686, 1635, 1618, 1592, 1578, 1496, 1470, 1449, 1377, 1329, 1308, 1292, 1279, 1236, 1201, 1144, 1072, 1026, 1000, 978.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.86 (1H, d, J = 16.0 Hz, C3H), 7.63 – 7.55 (2H, m, 2 × C5H), 7.47 – 7.38 (3H, m, 2 × C6H and C7H), 6.89 (1H, s, C11H), 6.80 (2H, s, 2 × C9H), 6.63 (1H, d, J = 16.0 Hz, C2H), 2.34 (6H, s, 2 × C12H$_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 165.7 (C1=O), 150.9 (C8), 146.5 (C3H), 139.4 (2C, 2 × C10), 134.4 (C4), 130.8 (C7H), 129.1 (2C, 2 × C6H), 128.4 (2C, 2 × C5H), 127.7 (C11H), 119.3 (2C, 2 × C9H), 117.7 (C2H), 21.4 (2C, 2 × C12H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 253.12241; $C_{17}H_{17}O_2$ requires 253.12231, Δ 0.39 ppm.

1-(2-Hydroxy-4,6-dimethylphenyl)-3-phenylpropan-1-one (338)[44]



To an open 10 – 20 mL microwave vial was added ester **S38** (1.91 g, assumed 7.50 mmol, 1.0 equiv) and $AlCl_3$ (1.00 g, 7.50 mmol, c.a. 1.0 equiv), and the reaction mixture directly heated to 110 °C for 1 h (caution: vigorous foaming and evolution of HCl gas upon immersion into pre-heated oil bath). The reaction mixture was cooled to RT, then redissolved in DCM (30 mL) and poured into H_2O (30 mL). The layers were separated, the aqueous layer extracted with DCM (3 × 20 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded phenol **336** (1.28 g, 5.04 mmol, 69% over 3 steps) as a pale yellow solid.

m.p. = 61 – 63 °C.

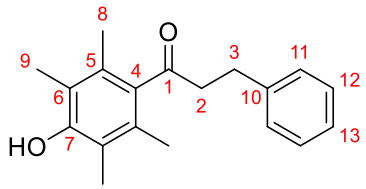
IR (film) ν_{max}/cm^{-1} 3358, 3107, 3085, 3062, 3027, 2923, 2860, 1681, 1624, 1567, 1496, 1452, 1409, 1350, 1303, 1278, 1225, 1189, 1161, 1077, 1059, 1030, 989, 947.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 12.25 (1H, s, OH), 7.51 – 7.28 (2H, m, 2 × C14H), 7.26 – 7.01 (3H, m, 2 × C13H and C15H), 6.67 (1H, s, C6H), 6.54 (1H, s, C8H), 3.46 – 3.16 (2H, m, $C2H_2$), 3.16 – 2.90 (2H, m, $C3H_2$), 2.54 (3H, s, $C11H_3$), 2.28 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.0 (C1=O), 163.0 (C5), 145.8 (C7), 141.1 (C12), 138.9 (C9), 128.7 (2C, 2 × C14H), 128.5 (2C, 2 × C13H), 126.3 (C15H), 124.7 (C8H), 119.5 (C4), 116.8 (C6H), 46.2 ($C2H_2$), 30.8 ($C3H_2$), 24.8 ($C11H_3$), 21.7 ($C10H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 255.13802; $C_{17}H_{19}O_2$ requires 255.13796, Δ 0.25 ppm.

1-(4-Hydroxy-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (339)



Ketone **181** (266 mg, 1.00 mmol, 1.0 equiv), phthaloyl peroxide **S52** (213 mg, 1.30 mmol, 1.3 equiv) and HFIP (10 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 80:20 → 60:40) afforded phenol **339** (194 mg, 0.686 mmol, 69%) as a colourless solid that gradually turns pale yellow solid on exposure to air.

m.p. = 96 – 99 °C.

IR (film) ν_{max}/cm^{-1} 3464, 3086, 3062, 3027, 2925, 1685, 1603, 1576, 1496, 1454, 1400, 1385, 1359, 1295, 1260, 1216, 1122, 1090, 1029, 944, 917.

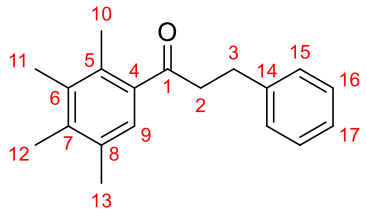
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.27 (2H, m, 2 × C12H), 7.26 – 7.22 (2H, m, 2 × C11H), 7.22 – 7.18 (1H, m, C13H), 4.82 (1H, s, OH), 3.06 (2H, m, $C3H_2$), 2.99 (2H, m, $C2H_2$), 2.12 (6H, s, 2 × $C9H_3$), 2.02 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.9 (C1=O), 151.9 (C7), 141.1 (C10), 135.7 (C4), 129.1 (2C, 2 × C5), 128.62 (2C, 2 × C11H), 128.58 (2C, 2 × C12H), 126.2 (C13H), 120.0 (2C, 2 × C6), 47.4 ($C2H_2$), 29.6 ($C3H_2$), 16.7 (2C, 2 × $C8H_3$), 11.8 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 305.15090; $C_{19}H_{22}O_2Na$ requires 305.15120, Δ –0.98 ppm.

Note: The compound gradually turns yellow on exposure to air, owing to oxidation of the phenolic group to duroquinone.

3-Phenyl-1-(2,3,4,5-tetramethylphenyl)prop-2-en-1-one (340)



Prehnitene (1.34 g, 10.0 mmol, 1.0 equiv), hydrocinnamoyl chloride (1.63 mL, 1.86 g, 11.0 mmol, 1.1 equiv), $AlCl_3$ (1.67 g, 12.5 mmol, 1.25 equiv) and DCM (50 mL, 0.2 M) were subjected to **General Procedure B** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded ketone **340** (1.69 g, 6.34 mmol, 63%) as a colourless oil.

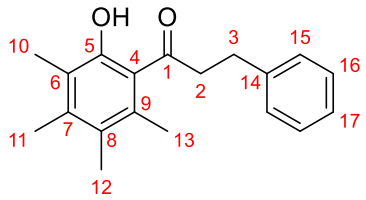
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 2924, 2868, 1682, 1602, 1562, 1496, 1453, 1407, 1382, 1355, 1302, 1244, 1119, 1074, 1030, 1003, 947, 863.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.33 – 7.27 (2H, m, 2 × C16H), 7.26 – 7.23 (2H, m, 2 × C15H), 7.23 – 7.18 (1H, m, C17H), 7.09 (1H, s, C9H), 3.22 – 3.12 (2H, m, $C2H_2$), 3.09 – 2.99 (2H, m, $C3H_2$), 2.28 (3H, s, $C13H_3$), 2.28 (3H, s, $C10H_3$), 2.23 (6H, s, $C11H_3$ and $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.7 (C1=O), 141.4 (C14), 138.3 (C8), 137.8 (C5), 136.8 (C6), 133.4 (C7), 132.4 (C4), 128.59 (2C, 2 × C16H), 128.56 (2C, 2 × C15H), 126.25 (C9H), 126.19 (C17H), 44.4 ($C2H_2$), 30.6 ($C3H_2$), 20.9 ($C13H_3$), 17.2 ($C10H_3$), 16.6 ($C11H_3$), 16.2 ($C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 267.17428; $C_{19}H_{23}O$ requires 267.17434, Δ –0.22 ppm.

1-(2-Hydroxy-3,4,5,6-tetramethylphenyl)-3-phenylpropan-1-one (341)



Ketone **340** (986 mg, 3.70 mmol, 1.0 equiv), phthaloyl peroxide (789 mg, 4.81 mmol, 1.3 equiv) and HFIP (37 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 95:5) afforded phenol **341** (278 mg, 0.984 mmol, 27%, 49% BRSM) as a pale yellow oil. Ketone **340** (440 mg, 1.65 mmol, 45%) was also recovered from the reaction.

IR (film) ν_{max}/cm^{-1} 3294, 3086, 3062, 3027, 3001, 2925, 2871, 1687, 1618, 1496, 1454, 1404, 1381, 1344, 1308, 1262, 1154, 1126, 1086, 1031, 1002, 943, 919.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 10.34 (1H, s, OH), 7.33 – 7.26 (2H, m, 2 × C16H), 7.24 – 7.15 (3H, m, 2 × C15H and C17H), 3.24 – 3.12 (2H, m, $C2H_2$), 3.09 – 2.95 (2H, m, $C3H_2$), 2.33 (3H, s, $C13H_3$), 2.24 (3H, s, $C11H_3$), 2.20 (3H, s, $C10H_3$), 2.15 (3H, s, $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.2 (C1=O), 154.7 (C5), 142.1 (C7), 141.0 (C14), 132.4 (C9), 128.7 (2C, 2 × C15H), 128.5 (2C, 2 × C16H), 127.2 (C8), 126.3 (C17H), 122.5 (C4), 122.3 (C6), 46.4 ($C2H_2$), 31.7 ($C3H_2$), 20.5 ($C13H_3$), 17.3 ($C11H_3$), 15.8 ($C12H_3$), 12.2 ($C11H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 283.16934; $C_{19}H_{23}O_2$ requires 283.16926, Δ 0.30 ppm.

1,2,4,5-Tetramethyl-3-nitrobenzene (342), or Nitrodurene (342)



Durene (1.34 g, 10.0 mmol, 1.0 equiv), HNO_3 (637 µL, 70% aq. solution, 10.0 mmol, 1.0 equiv), and TFA:H_2O (9:1, 33 mL, 0.33 M) were subjected to **General Procedure O**. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded nitrodurene **342** (1.26 g, 7.03 mmol, 70%) as a colourless solid.

m.p. = >60 °C (decomposition).

IR (film) ν_{max}/cm^{-1} 2973, 2950, 2925, 2867, 1621, 1513, 1446, 1379, 1366, 1281, 1015, 907, 769, 731.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.04 (1H, s, C4H), 2.25 (6H, s, 2 × C5H_3), 2.12 (6H, s, 2 × C6H_3).

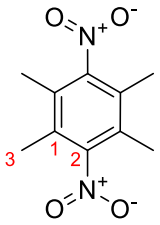
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 153.3 (C3), 135.4 (2C, 2 × C1), 132.5 (C4H), 124.5 (2C, 2 × C2), 19.7 (2C, 2 × C5H_3), 14.0 (2C, 2 × C6H_3).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 382.8 (NO_2).

HRMS (EI) Found $[M]^+$ = 179.0949; $C_{10}H_{13}NO_2$ requires 179.0941, Δ 4.47 ppm.

The analytical data are identical to those reported in literature.[46]

1,2,4,5-Tetramethyl-3,6-dinitrobenzene (343), or Dinitrodurene (343)



In the preparation of nitrodurene **342**, dinitrodurene **343** (53.0 mg, 0.236 mmol, 2.4%) was also isolated as a colourless solid.

m.p. = 133 – 136 °C.

IR (film) ν_{max}/cm^{-1} 3005, 2924, 1642, 1530, 1468, 1386, 1367, 1274, 1217, 1027, 853, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.20 (12H, s, 4 × $C3H_3$).

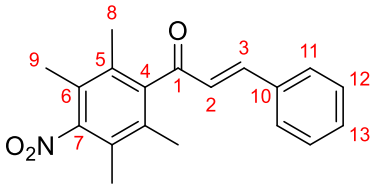
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 153.2 (2C, 2 × C2), 127.1 (4C, 4 × C1), 14.7 (4C, 4 × $C3H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 379.9 (2 × NO_2).

HRMS (EI) Found $[M]^+$ = 224.0796; $C_{10}H_{12}N_2O_4$ requires 224.0792, Δ 1.79 ppm.

The analytical data are identical to those reported in literature.[47]

(*E*)-3-Phenyl-1-(2,3,5,6-tetramethyl-4-nitrophenyl)prop-2-en-1-one (344)



Enone **345** (264 mg, 1.00 mmol, 1.0 equiv), HNO_3 (64 μL, 70% aq. solution, 1.00 mmol, 1.0 equiv), and TFA:H_2O (9:1, 3.3 mL, 0.33 M) were subjected to **General Procedure O**. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded enone **344** (190 mg, 0.613 mmol, 61%) as a yellow solid.

m.p. = 141 – 144 °C.

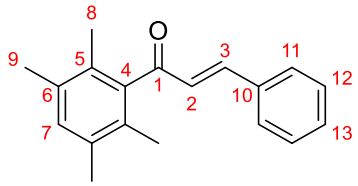
IR (film) ν_{max}/cm^{-1} 3060, 3029, 2993, 2929, 1646, 1621, 1597, 1575, 1524, 1495, 1449, 1375, 1319, 1256, 1179, 1122, 1072, 1024, 979, 951, 911, 884, 849, 821, 776, 734, 692.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.59 – 7.49 (2H, m, 2 × C11H), 7.47 – 7.39 (3H, m, 2 × C12H and C13H), 7.15 (1H, d, J = 16.3 Hz, C3H), 6.96 (1H, d, J = 16.3 Hz, C2H), 2.18 (6H, s, 2 × $C9H_3$), 2.14 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.4 (C1=O), 153.3 (C7), 148.0 (C3H), 141.6 (C4), 134.1 (C10), 132.1 (2C, 2 × C5), 131.4 (C13H), 129.2 (2C, 2 × C12H), 128.8 (2C, 2 × C11H), 128.1 (C2H), 125.4 (2C, 2 × C6), 17.0 (2C, 2 × $C8H_3$), 14.4 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 310.14377; $C_{19}H_{20}NO_3$ requires 310.14377, Δ –0.01 ppm.

(*E*)-3-Phenyl-1-(2,3,5,6-tetramethylphenyl)prop-2-en-1-one (345)



Durene (6.71 g, 50.0 mmol, 1.0 equiv), cinnamoyl chloride (9.16 g, 55.0 mmol, 1.1 equiv), $AlCl_3$ (8.33 g, 62.5 mmol, 1.25 equiv) and DCM (100 mL) were subjected to **General Procedure B** for 1.5 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **345** (13.2 g, 50.0 mmol, 100%) as a pale yellow solid.

m.p. = 86 – 89 °C.

IR (film) ν_{max}/cm^{-1} 3060, 3028, 3003, 2970, 2939, 2921, 2866, 1701, 1673, 1646, 1621, 1600, 1575, 1494, 1469, 1449, 1376, 1316, 1243, 1173, 1119, 1011, 980, 881.

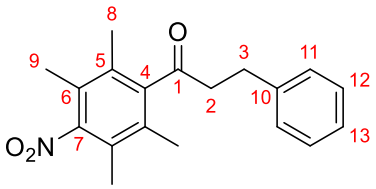
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.56 – 7.48 (2H, m, 2 × C11H), 7.44 – 7.35 (3H, m, 2 × C12H and C13H), 7.18 (1H, d, J = 16.2 Hz, C3H), 7.02 (1H, s, C7H), 6.96 (1H, d, J = 16.3 Hz, C2H), 2.25 (6H, s, 2 × $C9H_3$), 2.09 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 202.6 (C1=O), 146.9 (C3H), 140.3 (C4), 134.6 (C10), 134.3 (2C, 2 × C6), 131.9 (C7H), 130.9 (C13H), 129.8 (2C, 2 × C5), 129.1 (2C, 2 × C12H), 128.8 (C2H), 128.6 (2C, 2 × C11H), 19.7 (2C, 2 × $C9H_3$), 16.4 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 287.14063; $C_{19}H_{20}ONa$ requires 287.14064, Δ –0.04 ppm.

The analytical data are identical to those reported in literature.[48]

3-Phenyl-1-(2,3,5,6-tetramethyl-4-nitrophenyl)propan-1-one (346)



Ketone **181** (266 mg, 1.00 mmol, 1.0 equiv), HNO_3 (64 µL, 70% aq. solution, 1.00 mmol, 1.0 equiv), and TFA:H_2O (9:1, 3.3 mL, 0.33 M) were subjected to **General Procedure O**. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **346** (178 mg, 0.572 mmol, 57%) as a pale yellow solid.

Enone **344** (173 mg, 0.559 mmol, 1.0 equiv), $Pd(OH)_2/C$ (17.3 mg, 10 wt%) and EtOAc (2.8 mL, 0.2 M) were subjected to **General Procedure C** for 3 h. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **346** (155 mg, 0.498 mmol, 89%) as a pale yellow solid.

m.p. = 105 – 108 °C.

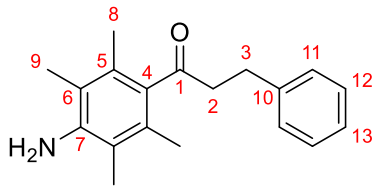
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3027, 2989, 2928, 1704, 1603, 1525, 1496, 1454, 1383, 1311, 1271, 1113, 1076, 1029, 989, 934, 912, 851, 812, 774, 746, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.27 (2H, m, 2 × C12H), 7.26 – 7.23 (2H, m, 2 × C11H), 7.23 – 7.19 (1H, m, C13H), 3.10 – 3.04 (2H, m, $C3H_2$), 3.02 – 2.96 (2H, m, $C2H_2$), 2.11 (6H, s, 2 × $C9H_3$), 2.03 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 208.7 (C1=O), 153.2 (C7), 143.8 (C4), 140.6 (C10), 130.3 (2C, 2 × C5), 128.68 (2C, 2 × C12H), 128.67 (2C, 2 × C11H), 126.5 (C13H), 125.5 (2C, 2 × C6), 46.8 ($C2H_2$), 29.2 ($C3H_2$), 16.5 (2C, 2 × $C8H_3$), 14.3 (2C, 2 × $C9H_3$).

HRMS (EI) Found $[M]^+$ = 311.1529; $C_{19}H_{21}NO_3$ requires 311.1516, Δ –4.18 ppm.

1-(4-Amino-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (347)



Ketone **346** (155 mg, 0.500 mmol, 1.0 equiv), $Pd(OH)_2/C$ (31.3 mg, 20 wt%) and EtOAc/EtOH (1:1, 2.5 mL, 0.2 M) were subjected to a modification of **General Procedure C** by heating at reflux for 14 h. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 50:50) afforded aniline **347** (84.2 mg, 0.299 mmol, 60%) as a colourless solid.

m.p. = 62 – 64 °C.

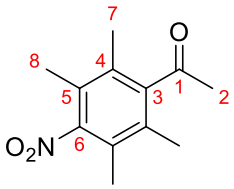
IR (film) ν_{max}/cm^{-1} 3484, 3396, 3085, 3061, 3026, 2922, 1692, 1626, 1577, 1496, 1473, 1454, 1403, 1384, 1355, 1324, 1291, 1126, 1075, 1029, 989, 944, 917, 770, 753, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.26 (2H, m, 2 × C12H), 7.25 – 7.21 (2H, m, 2 × C11H), 7.21 – 7.16 (1H, m, C13H), 3.66 (2H, s, NH_2), 3.09 – 3.02 (2H, m, 2 × $C3H_2$), 3.02 – 2.92 (2H, m, 2 × $C2H_2$), 2.06 (6H, s, 2 × $C9H_3$), 2.05 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.1 (C1=O), 143.1 (C7), 141.3 (C10), 134.1 (C4), 128.63 (2C, 2 × C11H), 128.56 (2C, 2 × C12H), 128.44 (2C, 2 × C5), 126.2 (C13H), 118.3 (2C, 2 × C6), 47.6 ($C2H_2$), 29.8 ($C3H_2$), 17.1 (2C, 2 × $C8H_3$), 13.1 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 282.18512; $C_{19}H_{24}NO$ requires 282.18524, Δ –0.43 ppm.

1-(2,3,5,6-Tetramethyl-4-nitrophenyl)ethan-1-one (348)[6]



Acetyldurene (176 mg, 1.00 mmol, 1.0 equiv), HNO_3 (64 µL, 70% aq. solution, 1.00 mmol, 1.0 equiv), and TFA:H_2O (9:1, 3.3 mL, 0.33 M) were subjected to **General Procedure O**. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **348** (160 mg, 0.723 mmol, 72%) as a colourless solid.

m.p. = 158 – 161 °C (gradual sublimation above 90 °C).

IR (film) ν_{max}/cm^{-1} 2989, 2957, 1704, 1528, 1471, 1415, 1394, 1353, 1312, 1252, 1169, 1039, 999, 934, 817.

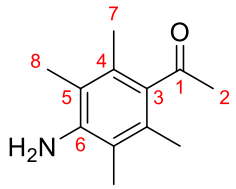
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.46 (3H, s, C2H_3), 2.15 (6H, s, 2 × C7H_3), 2.14 (6H, s, 2 × C8H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.7 (C1=O), 153.1 (C6), 144.3 (C3), 129.9 (2C, 2 × C4), 125.5 (2C, 2 × C5), 32.7 (C2H_3), 16.5 (2C, 2 × C7H_3), 14.3 (2C, 2 × C8H_3).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 381.2 (NO_2).

HRMS (EI) Found $[M]^{\bullet+}$ = 221.1055; $C_{12}H_{15}NO$ requires 221.1046, Δ 3.68 ppm.

1-(4-Amino-2,3,5,6-tetramethylphenyl)ethan-1-one (349)[6]



Ketone **348** (553 mg, 2.50 mmol, 1.0 equiv), activated zinc dust (2.16 g, 33.0 mmol, 13.2 equiv), $CaCl_2 \cdot 2H_2O$ (368 mg, 2.50 mmol, 1.0 equiv) and EtOH:H_2O (4:1, 8.0 mL, 0.3 M) were subjected to **General Procedure P** to afford aniline **349** (478 mg, 2.50 mmol, 100%) as a pale yellow solid.

m.p. = 136 – 138 °C (gradual sublimation above 80 °C).

IR (film) ν_{max}/cm^{-1} 3453, 3377, 2983, 2923, 2866, 1688, 1637, 1577, 1475, 1417, 1383, 1347, 1322, 1285, 1170, 1105, 1016, 990, 943.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.67 (2H, br. s, NH_2), 2.44 (3H, s, $C2H_3$), 2.14 (6H, s, 2 × $C7H_3$), 2.08 (6H, s, 2 × $C8H_3$).

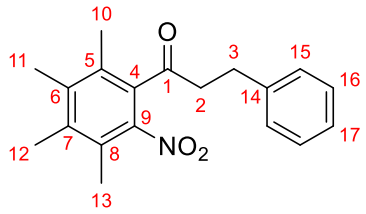
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.3 (C1=O), 143.0 (C6), 134.5 (C3), 128.1 (2C, 2 × C4), 118.3 (2C, 2 × C5), 33.6 ($C2H_3$), 17.1 (2C, 2 × $C7H_3$), 13.1 (2C, 2 × $C8H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 53.5 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 192.13832; $C_{12}H_{18}NO$ requires 192.13829, Δ 0.16 ppm.

Note: The compound slowly gains a pale pink colouration on sustained exposure to air.

3-Phenyl-1-(2,3,4,5-tetramethyl-6-nitrophenyl)propan-1-one (350)



Ketone **340** (1.69 g, 6.34 mmol, 1.0 equiv), HNO_3 (450 μL, 70% aq. solution, 6.34 mmol, 1.0 equiv), and TFA:H_2O (9:1, 19 mL, 0.33 M) were subjected to **General Procedure O**. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 97:3 → 95:5) afforded ketone **350** (492 mg, 1.58 mmol, 25%) as a yellow oil.

IR (film) ν_{max}/cm^{-1} 3085, 3063, 3027, 3002, 2929, 2871, 1703, 1630, 1603, 1523, 1497, 1454, 1389, 1358, 1306, 1275, 1108, 1075, 1030, 1000, 939, 914, 852, 812, 749, 726, 700.

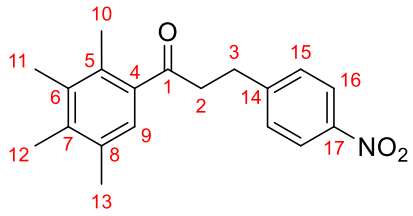
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.27 (2H, m, 2 × C16H), 7.25 – 7.22 (2H, m, 2 × C15H), 7.23 – 7.16 (1H, m, C17H), 3.11 – 3.00 (4H, m, $C2H_2$ and $C3H_2$), 2.28 (3H, s, $C12H_3$), 2.27 (3H, s, $C13H_3$), 2.24 (3H, s, $C11H_3$), 2.09 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 204.4 (C1=O), 146.7 (C9), 140.8 (C14), 140.2 (C6), 138.2 (C7), 133.8 (C4), 130.5 (C5), 128.59 (2C, 2 × C16H), 128.58 (2C, 2 × C15H), 127.2 (C8), 126.3 (C17H), 46.3 ($C2H_2$), 29.8 ($C3H_2$), 17.4 ($C10H_3$), 16.93 ($C12H_3$), 16.76 ($C11H_3$), 15.8 ($C13H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 377.8 (NO_2).

HRMS (ESI^+) Found $[M+H]^+$ = 312.15956; $C_{19}H_{22}NO_3$ requires 312.15942, Δ 0.46 ppm.

3-(4-Nitrophenyl)-1-(2,3,4,5-tetramethylphenyl)propan-1-one (351)



In the preparation of ketone **350**, ketone **351** (35.0 mg, 0.112 mmol, 1.8%) was also isolated as a yellow solid.

m.p. = 86 – 88 °C.

IR (film) ν_{max}/cm^{-1} 3077, 2926, 2866, 1681, 1600, 1560, 1517, 1495, 1445, 1382, 1343, 1302, 1246, 1180, 1121, 1015, 946, 856, 749, 734, 698.

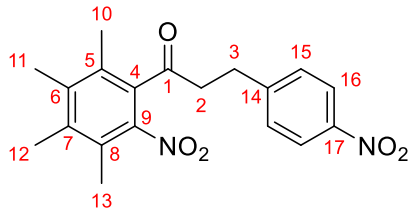
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.15 (2H, d, J = 8.7 Hz, 2 × C16H), 7.40 (2H, d, J = 8.7 Hz, 2 × C15H), 7.08 (1H, s, C9H), 3.23 – 3.18 (2H, m, 2 × $C2H_2$), 3.17 – 3.13 (2H, m, $C3H_2$), 2.28 (3H, s, $C13H_3$), 2.25 (3H, s, $C10H_3$), 2.23 (3H, s, $C12H_3$), 2.22 (3H, s, $C11H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 204.3 (C1=O), 149.4 (C14), 146.6 (C17), 138.8 (C7), 137.2 (C4), 137.0 (C6), 133.6 (C8), 132.6 (C5), 129.5 (2C, 2 × C15H), 126.2 (C9H), 123.8 (2C, 2 × C16H), 43.2 ($C2H_2$), 30.3 ($C3H_2$), 20.9 ($C13H_3$), 17.2 ($C10H_3$), 16.6 ($C12H_3$), 16.3 ($C11H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 370.1 (NO_2).

HRMS (ESI^+) Found $[M+H]^+$ = 312.15930; $C_{19}H_{22}NO_3$ requires 312.15942, Δ –0.38 ppm.

3-(4-Nitrophenyl)-1-(2,3,4,5-tetramethyl-6-nitrophenyl)propan-1-one (352)



In the preparation of ketone **350**, ketone **352** (300 mg, 0.842 mmol, 13%) was also isolated as a yellow solid.

m.p. = 155 – 158 °C.

IR (film) ν_{max}/cm^{-1} 3111, 3080, 2935, 2872, 1703, 1600, 1518, 1447, 1390, 1344, 1274, 1180, 1110, 1015, 1000, 937, 912, 860, 839, 809, 747, 698.

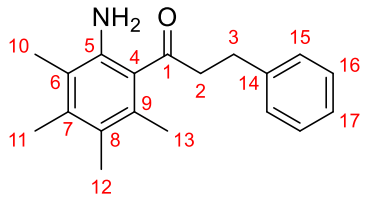
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.15 (2H, d, J = 8.6 Hz, 2 × C15H), 7.41 (2H, d, J = 8.6 Hz, 2 × C16H), 3.19 – 3.12 (2H, m, $C3H_2$), 3.11 – 3.04 (2H, m, $C2H_2$), 2.29 (3H, s, $C12H_3$), 2.27 (3H, s, $C13H_3$), 2.25 (3H, s, $C11H_3$), 2.08 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.4 (C1=O), 148.7 (C14), 146.7 (C17), 146.6 (C9), 140.4 (C6), 138.6 (C7), 133.4 (C4), 130.4 (C5), 129.6 (2C, 2 × C15H), 127.5 (C8), 123.9 (2C, 2 × C16H), 45.4 ($C2H_2$), 29.6 ($C3H_2$), 17.5 ($C10H_3$), 17.0 ($C12H_3$), 16.8 ($C11H_3$), 15.9 ($C13H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 369.9 ($C17NO_2$), 376.9 ($C9NO_2$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 379.12518; $C_{19}H_{20}N_2O_5Na$ requires 379.12644, Δ –3.32 ppm.

1-(2-Amino-3,4,5,6-tetramethylphenyl)-3-phenylpropan-1-one (353)



Ketone **350** (443 mg, 1.42 mmol, 1.0 equiv), activated zinc dust (1.23 g, 18.8 mmol, 13.2 equiv), $CaCl_2 \cdot 2H_2O$ (209 mg, 1.42 mmol, 1.0 equiv) and EtOH:H_2O (4:1, 5 mL, 0.3 M) were subjected to **General Procedure P**. Further purification by flash column chromatography (Pentane:Et_2O:DCM, 98:1:1 → 96:2:2 → 90:5:5 → 80:10:10) afforded aniline **353** (478 mg, 2.50 mmol, 100%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3470, 3384, 3085, 3061, 3026, 2924, 2872, 1686, 1617, 1581, 1496, 1453, 1384, 1355, 1320, 1282, 1269, 1178, 1116, 1066, 1029, 1002, 939, 914, 846, 745, 699.

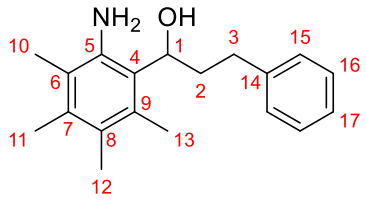
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.25 (2H, m, 2 × C16H), 7.25 – 7.22 (2H, m, 2 × C15H), 7.22 – 7.16 (1H, m, C14H), 3.73 (2H, s, NH_2), 3.12 – 3.00 (4H, m, $C2H_2$ and $C3H_2$), 2.22 (3H, s, $C11H_3$), 2.11 (3H, s, $C12H_3$), 2.09 (3H, s, $C13H_3$), 2.09 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.4 (C1=O), 141.2 (C14), 138.5 (C5), 137.0 (C7), 129.4 (C9), 128.64 (2C, 2 × C15H), 128.57 (2C, 2 × C16H), 126.6 (C4), 126.2 (C17H), 125.7 (C8), 119.5 (C6), 46.7 ($C2H_2$), 30.3 ($C3H_2$), 18.4 ($C13H_3$), 17.0 ($C11H_3$), 15.6 ($C12H_3$), 13.6 ($C10H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 49.6 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 282.1861; $C_{19}H_{24}NO$ requires 282.1858, Δ 1.06 ppm.

1-(2-Amino-3,4,5,6-tetramethylphenyl)-3-phenylpropan-1-ol (354)



In the preparation of aniline **353**, benzylic alcohol **354** (21.0 mg, 71 μmol, 5.0%) was also isolated as a colourless solid.

m.p. = 166 – 169 °C.

IR (film) ν_{max}/cm^{-1} 3385, 3295, 3152, 3085, 3061, 3025, 3001, 2924, 2859, 1620, 1603, 1584, 1495, 1454, 1381, 1315, 1255, 1144, 1097, 1079, 1055, 1030, 914, 882, 856, 823, 777, 740, 697.

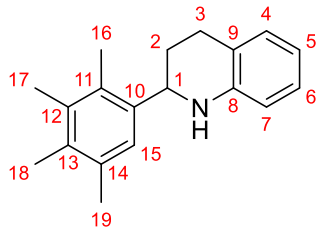
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.27 (2H, m, 2 × C16H), 7.26 – 7.22 (2H, m, 2 × C15H), 7.22 – 7.16 (1H, m, C17H), 5.22 (1H, dd, J = 9.5, 4.5 Hz, C1H), 3.78 (3H, v. br. s, NH_2 and OH), 2.90 (1H, ddd, J = 14.1, 9.3, 5.0 Hz, C3H_AH$_B$), 2.72 (1H, ddd, J = 13.9, 8.9, 7.6 Hz, C3H$_A$$H_B$), 2.50 (1H, dtd, J = 14.2, 9.3, 5.0 Hz, C2H_AH$_B$), 2.22 (3H, s, C11H_3), 2.14 (3H, s, C12H_3), 2.11 (3H, s, C10H_3), 2.03 (3H, s, C13H_3), 2.02 (1H, dddd, J = 13.9, 9.3, 7.6, 4.5 Hz, C2H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 142.0 (C14), 141.5 (C9), 134.5 (C7), 130.9 (C9), 128.6 (2C, 2 × C15H), 128.4 (2C, 2 × C16H), 125.9 (C17H), 125.1 (C8), 123.7 (C4), 120.3 (C6), 71.5 (C1), 35.3 (C2H_2), 32.7 (C3H_2), 17.2 (C11H_3), 16.5 (C12H_3), 15.8 (C13H_3), 13.5 (C10H_3).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 51.8 (NH_2).

HRMS (ESI$^+$) Found [M+H]$^+$ = 284.2010; $C_{19}H_{26}NO$ requires 284.2014, Δ –1.41 ppm.

2-(2,3,4,5-tetramethylphenyl)-1,2,3,4-tetrahydroquinoline (355)



In the preparation of aniline **353**, tetrahydroquinoline **355** (13.1 mg, 49.4 μmol, 3.5%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3402, 3050, 3012, 2923, 2854, 1733, 1607, 1585, 1501, 1477, 1444, 1380, 1353, 1339, 1310, 1259, 1208, 1154, 1111, 1067, 1017, 908, 875, 800, 743.

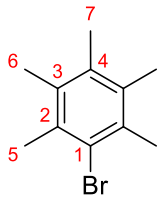
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.21 (1H, s, C15H), 7.03 (1H, d, J = 7.4 Hz, C4H), 7.02 (1H, t, J = 7.1 Hz, C6H), 6.65 (1H, td, J = 7.4, 1.1 Hz, C5H), 6.55 (1H, dd, J = 8.4, 1.2 Hz, C7H), 4.70 (1H, dd, J = 9.8, 3.1 Hz, C1H), 3.90 (1H, v. br. s, NH), 2.97 (1H, ddd, J = 16.7, 11.4, 5.5 Hz, C3H_AH$_B$), 2.79 (1H, ddd, J = 16.3, 4.8, 4.0 Hz, C3H$_A$$H_B$), 2.29 (3H, s, C19$H_3$), 2.28 (3H, s, C16$H_3$), 2.26 (3H, s, C17$H_3$), 2.23 (3H, s, C18$H_3$), 2.10 (1H, ddt, J = 12.7, 5.4, 3.5 Hz, C2H_AH$_B$), 1.93 (1H, dddd, J = 12.9, 11.1, 9.7, 5.0 Hz, C2H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 145.3 (C8), 139.3 (C10), 135.6 (C12), 134.15 (C14), 134.16 (C13), 131.0 (C11), 129.4 (C4H), 127.0 (C6H), 125.1 (C15H), 121.1 (C9), 117.1 (C5H), 114.1 (C7H), 52.9 (C1H), 29.7 (C2H_2), 27.1 (C3H_2), 21.0 (C19H_3), 16.6 (C18H_3), 16.2 (C17H_3), 15.2 (C16H_3).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 75.3 (NH).

HRMS (ESI^+) Found $[M+H]^+$ = 266.1910; $C_{19}H_{24}N$ requires 266.1909, Δ 0.38 ppm.

1-Bromo-2,3,4,5,6-pentamethylbenzene (358)[5]



Following the NMR experiment of ketone **121** and Br_2 (see Section 8.3.3), the reaction was worked up according to **General Procedure Q** with H_2O as the nucleophile. The crude material was purified by preparative TLC (Pentane) to give bromoarene **358** (9.0 mg, 40 μmol, 16%) as a colourless solid for analysis.

m.p. = 150 – 152 °C.

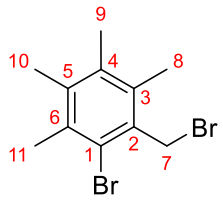
IR (film) ν_{max}/cm^{-1} 2999, 2924, 2856, 1456, 1387, 1221, 1206, 1063, 1014, 999, 915, 722, 668.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.45 (6H, s, 2 × $C5H_3$), 2.27 (6H, s, 2 × $C6H_3$), 2.21 (3H, s, $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 134.96 (C4), 133.93 (2C, 2 × C3), 133.5 (2C, 2 × C2), 126.8 (C1), 21.6 (2C, 2 × $C5H_3$), 17.9 (2C, 2 × $C6H_3$), 17.0 ($C7H_3$).

Note: A stable molecular ion could not be detected by ESI or APCI.

1-Bromo-2-(bromomethyl)-3,4,5,6-tetramethylbenzene (359)



Following the NMR experiment of ketone **121** and Br_2 (see Section 8.3.3), the reaction was worked up according to **General Procedure Q** with H_2O as the nucleophile. The crude material was purified by preparative TLC (Pentane) to give dibromoarene **359** (17.7 mg, 57.8 μmol, 23%) as a colourless solid for analysis.

m.p. = 88 – 91 °C.

IR (film) ν_{max}/cm^{-1} 3004, 2924, 2857, 1572, 1548, 1441, 1383, 1294, 1264, 1216, 1201, 1126, 1064, 1014, 997, 960, 922, 891, 813, 739, 643.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.84 (2H, br. s, C7H_2), 2.45 (3H, s, C11H_3), 2.39 (3H, s, C8H_3), 2.29 (3H, s, C10H_3), 2.21 (3H, s, C9H_3).

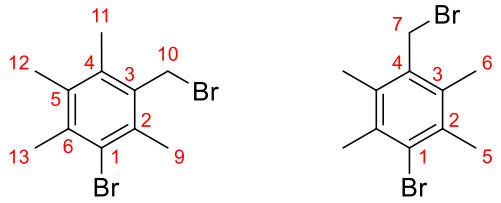
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 137.7 (C5), 135.21 (C3), 135.08 (C4), 134.5 (C6), 132.4 (C2), 126.5 (C1), 35.1 (C7H_2), 21.5 (C11H_3), 18.2 (C10H_3), 17.1 (C8H_3), 16.9 (C9H_3).

HRMS (ESI$^+$) Found $[M–Br]^+$ = 225.02757; $C_{11}H_{14}{}^{79}Br$ requires 225.02734, Δ 1.04 ppm.

Note: The molecular ion could not be detected by HRMS. However, the ion derived from the loss of $Br^–$ could be detected, and that data is given instead.

1-Bromo-3-(bromomethyl)-2,4,5,6-tetramethylbenzene (360), and

1-Bromo-4-(bromomethyl)-2,4,5,6-tetramethylbenzene (361)



(*meta*) : (*para*)

2 : 1

Following the NMR experiment of ketone **121** and Br_2 (see Section 8.3.3), the reaction was worked up according to **General Procedure Q** with H_2O as the nucleophile. The crude material was purified by preparative TLC (Pentane) to give a colourless solid (28.6 mg) that contained an inseparable mixture of dibromoarenes **360** (62.4 μmol, 25%) and **361** (31.2 μmol, 12%) suitable for analysis.

IR (film) ν_{max}/cm^{-1} 2999, 2920, 2871, 1572, 1549, 1440, 1382, 1293, 1262, 1219, 1197, 1073, 1010, 944, 926, 875, 820, 800, 744, 724, 642.

^{1}H NMR ($CDCl_3$, 500 MHz, *meta*-isomer) δ = 4.65 (2H, s, $C10H_2$), 2.57 (3H, s, $C11H_3$), 2.48 (3H, s, $C13H_3$), 2.34 (3H, s, $C9H_3$), 2.30 (3H, s, $C12H_3$).

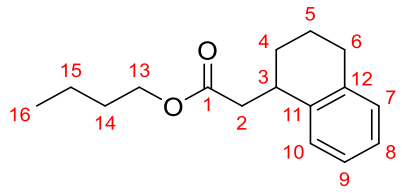
^{13}C NMR ($CDCl_3$, 126 MHz, *meta*-isomer) δ = 137.4 (C6), 135.0 (2C, C1 and C2), 134.70 (C4), 132.97 (C3), 127.3 (C5), 31.5 ($C10H_2$), 21.9 ($C13H_3$), 20.7 ($C11H_3$), 17.8 ($C12H_3$), 16.2 ($C9H_3$).

^{1}H NMR ($CDCl_3$, 500 MHz, *para*-isomer) δ = 4.61 (2H, s, $C7H_2$), 2.47 (6H, s, 2 × $C5H_3$), 2.41 (6H, s, 2 × $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, *para*-isomer) δ = 134.80 (2C, 2 × C3), 134.71 (2C, 2 × C2), 133.08 (C4), 130.5 (C1), 30.9 ($C7H_2$), 21.5 (2C, 2 × $C5H_3$), 17.0 (2C, 2 × $C6H_3$).

Note: A stable molecular ion could not be detected by ESI or APCI.

Butyl 2-(1,2,3,4-tetrahydronaphthalen-1-yl)acetate (362)[6]



Ketone **151** (32.1 mg, 0.100 mmol, 1.0 equiv), Br_2 (10 µL, 32 mg, 0.200 mmol, 2.0 equiv) and DCM (0.50 mL, 0.2 M) were subjected to **General Procedure Q** with *n*-butanol (28 µL, 23 mg, 0.300 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded ester **362** (23.7 mg, 96.2 µmol, 96%) as a colourless oil.

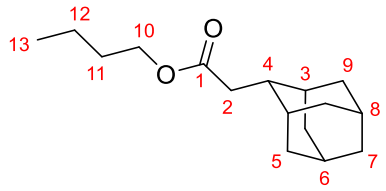
IR (film) ν_{max}/cm^{-1} 3060, 3017, 2957, 2931, 2871, 1732, 1491, 1452, 1434, 1385, 1351, 1286, 1248, 1166, 1075, 1023, 965.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.19 – 7.15 (1H, m, C10H), 7.15 – 7.10 (2H, m, C8H and C9H), 7.10 – 7.05 (1H, m, C7H), 4.12 (2H, t, J = 6.7 Hz, C13H_2), 3.36 (1H, dq, J = 10.1, 5.1 Hz, C3H), 2.85 – 2.74 (2H, m, C6H_2), 2.71 (1H, dd, J = 15.2, 4.8 Hz, C2H_AH$_B$), 2.54 (1H, dd, J = 15.2, 9.9 Hz, C2H$_A$$H_B$), 1.98 – 1.88 (1H, m, C4H_AH$_B$), 1.88 – 1.74 (2H, m, C5H_2), 1.74 – 1.67 (1H, m, C4H$_A$$H_B$), 1.67 – 1.58 (2H, m, C14H_2), 1.44 – 1.33 (2H, sext., J = 7.4 Hz, C15H_2), 0.95 (3H, t, J = 7.4 Hz, C16H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 173.1 (C1=O), 139.4 (C11), 137.2 (C12), 129.4 (C7H), 128.4 (C10H), 126.1 (C9H), 125.9 (C8H), 64.5 (C13H_2), 42.2 (C2H_2), 34.7 (C3H), 30.8 (C14H_2), 29.7 (C6H_2), 28.3 (C4H_2), 19.7 (C5H_2), 19.3 (C15H_2), 13.9 (C16H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 247.16944; $C_{16}H_{23}O_2$ requires 247.16926, Δ 0.72 ppm.

Butyl 2-(adamantan-2-yl)acetate (363)[6]



Ketone **148** (32.5 mg, 0.100 mmol, 1.0 equiv), Br_2 (10 μL, 32 mg, 0.200 mmol, 2.0 equiv) and DCM (0.50 mL, 0.2 M) were subjected to **General Procedure Q** with *n*-butanol (28 μL, 23 mg, 0.300 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded ester **363** (20.0 mg, 79.9 μmol, 80%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2957, 2906, 2852, 1734, 1454, 1416, 1388, 1368, 1352, 1327, 1314, 1294, 1275, 1250, 1215, 1177, 1153, 1118, 1099, 1065, 1026, 971.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.06 (2H, t, J = 6.7 Hz, C10H_2), 2.45 (2H, d, J = 7.6 Hz, C2H_2), 2.23 (1H, br. t, J = 7.6 Hz, C2H), 1.90 – 1.83 (3H, m, C8H and 2 × C5H$_{cis}$*H$_{trans}$*), 1.86 – 1.76 (5H, m, 2 × C9H_2 and C6H), 1.74 – 1.71 (2H, m, C7H_2), 1.69 (2H, tdt, J = 3.4, 2.1, 1.1 Hz, 2 × C3H), 1.64 – 1.57 (2H, m, C11H_2), 1.57 – 1.51 (2H, m, 2 × C5*H$_{cis}$*H$_{trans}$), 1.37 (2H, sext., J = 7.4 Hz, C12H_2), 0.93 (3H, t, J = 7.4 Hz, C13H_3).

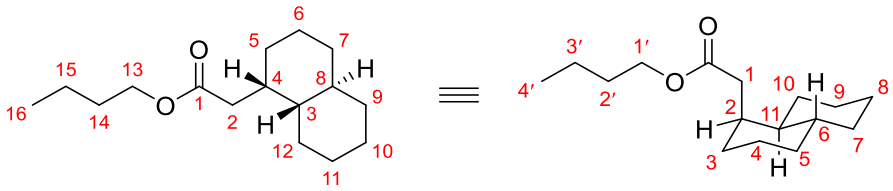
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.9 (C1=O), 64.2 (C10H_2), 41.4 (C4H), 39.0 (2C, 2 × C9H_2), 38.38 (C7H_2), 38.22 (C2H_2), 32.0 (2C, 2 × C3H), 31.7 (2C, 2 × C5H_2), 30.9 (C11H_2), 28.06 (C6H), 28.00 (C8H), 19.3 (C12H_2), 13.8 (C13H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 251.20071; $C_{16}H_{27}O_2$ requires 251.20056, Δ 0.63 ppm.

Note: *cis* and *trans* with respect to C3H.

Butyl *rel*-2-((1*S*,2*S*,6*S*)bicyclo[4.4.0]decan-2-yl]acetate (364), or

Butyl *rel*-2-((1*S*,4a*R*,8a*S*)-decahydronaphthalen-1-yl)acetate (364)[6]



Ketone **173** (32.7 mg, 0.100 mmol, 1.0 equiv), Br_2 (10 µL, 32 mg, 0.20 mmol, 2.0 equiv) and DCM (0.50 mL, 0.2 M) were subjected to **General Procedure Q** with *n*-butanol (28 µL, 23 mg, 0.300 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded ester **364** (18.0 mg, 71.3 µmol, 71%) as a colourless oil.

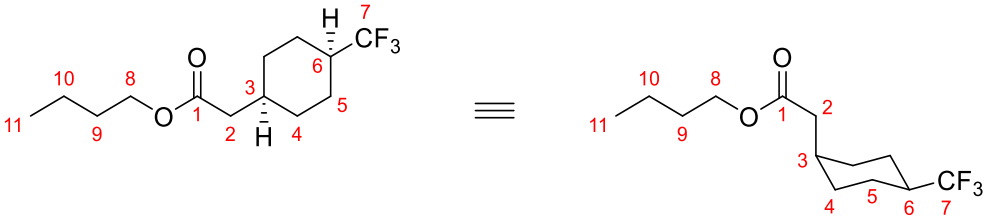
IR (film) ν_{max}/cm^{-1} 2957, 2921, 2853, 1735, 1449, 1381, 1350, 1307, 1290, 1253, 1238, 1163, 1128, 1098, 1063, 1023.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.06 (2H, t, J = 6.7 Hz, C13H_2), 2.37 (1H, dd, J = 14.8, 5.2 Hz, C2H_AH$_B$), 2.28 (1H, dd, J = 14.7, 9.9 Hz, C2H$_A$$H_B$), 2.18 – 2.11 (1H, m, C3H), 1.71 (1H, dtd, J = 12.1, 3.1, 1.8 Hz, C7H$_{ax}$$H_{eq}$), 1.68 – 1.62 (1H, m, C12H$_{ax}$$H_{eq}$), 1.65 – 1.59 (2H, m, C5H$_{ax}$$H_{eq}$ and C11H$_{ax}$$H_{eq}$), 1.63 – 1.56 (2H, m, C14H_2), 1.58 – 1.54 (1H, m, C9H$_{ax}$$H_{eq}$), 1.49 – 1.41 (4H, m, C5H_{ax}H$_{eq}$, C6H$_{ax}$$H_{eq}$ and C10H_2), 1.38 (2H, sext., J = 7.4 Hz, C15H_2), 1.28 – 1.17 (1H, m, C7H_{ax}H$_{eq}$), 1.22 – 1.15 (1H, m, C3H), 1.23 – 1.11 (1H, m, C12H_{ax}H$_{eq}$), 1.09 (1H, qt, J = 11.1, 3.6 Hz, C8H), 1.05 (1H, qd, J = 12.3, 3.7 Hz, C6H_{ax}H$_{eq}$), 0.93 (3H, t, J = 7.4 Hz, C16H_3), 0.96 – 0.84 (2H, m, C9H_{ax}H$_{eq}$ and C11H_{ax}H$_{eq}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 174.6 (C1=O), 64.2 (C13H_2), 46.0 (C3H), 36.4 (C8H), 35.6 (C4H), 35.0 (C11H_2), 34.7 (C9H_2), 33.0 (C2H_2), 31.16 (C5H_2), 31.07 (C6H_2), 30.8 (C14H_2), 27.1 (C7H_2), 26.6 (C12H_2), 20.7 (C10H_2), 19.3 (C15H_2), 13.9 (C16H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 253.21632; $C_{16}H_{29}O_2$ requires 253.21621, Δ 0.57 ppm.

Butyl 2-(*cis*-4-(trifluoromethyl)cyclohexyl)acetate (365)[6]



Ketone *cis*-**168** (32.1 mg, 0.100 mmol, 1.0 equiv), Br_2 (10 μL, 32 mg, 0.20 mmol, 2.0 equiv) and DCM (0.50 mL, 0.2 M) were subjected to **General Procedure Q** with *n*-butanol (28 μL, 23 mg, 0.300 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 99:1) afforded ester **365** (19.5 mg, 73.2 μmol, 73%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2949, 2936, 2874, 1733, 1457, 1419, 1393, 1377, 1361, 1338, 1330, 1281, 1260, 1220, 1203, 1171, 1146, 1120, 1092, 1066, 1034, 1023, 1005, 952, 934.

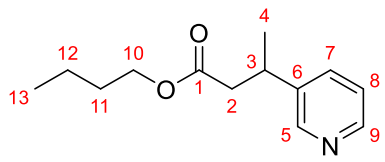
^{1}H{^{19}F} NMR ($CDCl_3$, 500 MHz) δ = 4.08 (2H, t, J = 6.7 Hz, C8H_2), 2.34 (2H, d, J = 7.6 Hz, C2H_2), 2.25 – 2.15 (1H, m, C3H), 2.07 (1H, tt, J = 8.7, 3.9 Hz, C6H), 1.75 – 1.65 (2H, m, 2 × C5H$_{ax}$*H$_{eq}$*), 1.64 – 1.54 (9H, m, 2 × C4H_2 and 2 × C5*H$_{ax}$*H$_{eq}$ and C9H_2), 1.38 (2H, sext., J = 7.4 Hz, C10H_2), 0.94 (3H, t, J = 7.4 Hz, C11H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.2 (C1=O), 128.1 (q, $^1J_{CF}$ = 279.1 Hz, C7F_3), 64.4 (C8H_2), 40.5 (q, $^2J_{CF}$ = 26.3 Hz, C6H), 37.7 (C2H_2), 30.8 (C9H_2), 30.4 (C3H), 28.4 (2C, 2 × C4H_2), 20.7 (2C, q, $^3J_{CF}$ = 2.6 Hz, 2 × C5H_2), 19.3 (C10H_2), 13.8 (C10H_3).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –72.1 (3F, s, C7F_3).

HRMS (ESI$^+$) Found [M+H]$^+$ = 267.15669; $C_{13}H_{22}F_3O_2$ requires 267.15664, Δ 0.20 ppm.

Butyl 3-(pyridin-3-yl)butanoate (366)[6]



Ketone **140** (59.1 mg, 0.200 mmol, 1.0 equiv), Br_2 (41 μL, 128 mg, 0.400 mmol, 4.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to a modification of **General Procedure Q** with *n*-butanol (55 μL, 44 mg, 0.600 mmol, 3.0 equiv) as the nucleophile and using 5% aq. NaOH for workup instead of sat. aq. Na_2SO_3. Purification by flash column chromatography (Pentane:Et_2O, 80:20 → 50:50) afforded ester **366** (33.7 mg, 0.152 mmol, 76%) as a colourless oil.

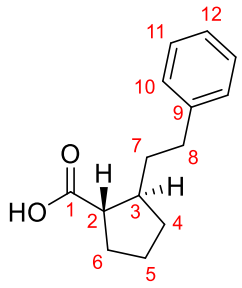
IR (film) ν_{max}/cm^{-1} 3029, 2961, 2932, 2874, 1732, 1591, 1576, 1478, 1459, 1426, 1381, 1348, 1285, 1255, 1189, 1166, 1129, 1107, 1071, 1024.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.51 (1H, br. s, C5H), 8.46 (1H, br. d, J = 4.7 Hz, C9H), 7.54 (1H, dddd, J = 7.9, 2.3, 1.6, 0.5 Hz, C7H), 7.23 (1H, dd, J = 7.9, 4.8 Hz, C8H), 4.01 (2H, t, J = 6.7 Hz, C10H_2), 3.31 (1H, sext., J = 7.2 Hz, C3H), 2.60 (2H, dq_{AB}, J = 7.5 Hz, J_{AB} = 15.2 Hz, Δ_{AB} = 9.8 Hz, C2H_2), 1.56 – 1.47 (2H, m, C11H_2), 1.33 (3H, d, J = 7.0 Hz, C12H_3), 1.29 (2H, sext., J = 7.5 Hz, C12H_2), 0.89 (3H, t, J = 7.4 Hz, C13H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 172.0 (C1=O), 149.0 (C5H), 148.1 (C9H), 141.0 (C6), 134.3 (C7H), 123.6 (C8), 64.6 (C10H_2), 42.7 (C2H_2), 34.3 (C3H_2), 30.7 (C11H_2), 21.8 (C4H_3), 19.2 (C12H_2), 13.8 (C13H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 222.14920; $C_{13}H_{20}O_2N$ requires 222.14886, Δ 1.55 ppm.

***rel*-(1*S*,2*R*)-2-Phenethylcyclopentane-1-carboxylic acid (367)**



Ketone **241** (69.7 mg, 0.200 mmol, 1.0 equiv), Br_2 (20 μL, 64 mg, 0.40 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to a modification of **General Procedure Q** without a nucleophile added. After 2 h, the reaction was directly quenched with sat. aq. Na_2SO_3 (2 mL) and diluted with DCM (2 mL). The layers were separated, the organic layer extracted with 6 M NaOH (2 × 2 mL). The combined aqueous layer were extracted with Et_2O (2 × 2 mL) and the combined organics discarded. The aqueous extracts were acidified with 6 M HCl (5 – 6 mL), saturated with NaCl, and extracted with EtOAc (5 × 5 mL). The combined organics were then dried (Na_2SO_4) and concentrated *in vacuo* to directly afford carboxylic acid **367** (37.9 mg, 0.174 mmol, 87%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 2937, 2858, 2656, 1698, 1603, 1496, 1453, 1421, 1292, 1231, 1031, 942, 748, 698.

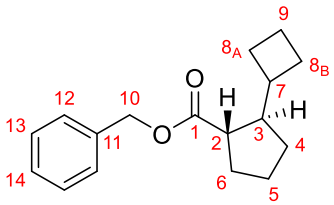
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 9.71 (1H, v. br. s, OH), 7.33 – 7.22 (2H, m, 2 × C11H), 7.23 – 7.10 (3H, m, 2 × C10H and C12H), 2.66 (1H, ddd, J = 13.2, 10.7, 5.5 Hz, C8H_AH$_B$), 2.63 (1H, ddd, J = 13.7, 10.3, 5.9 Hz, C8H$_A$$H_B$), 2.44 (1H, q, J = 8.1 Hz, C2H), 2.21 (1H, quint.d, J = 8.2, 5.8 Hz, C3H), 2.05 – 1.93 (2H, m, C4H$_{cis}$$H_{trans}$ and C6H_{cis}H$_{trans}$), 1.96 – 1.86 (2H, m, C6H$_{cis}$$H_{trans}$ and C7H_AH$_B$), 1.78 – 1.66 (2H, m, C5H$_2$), 1.62 (1H, dtd, J = 14.1, 9.3, 5.6 Hz, C7H$_A$$H_B$), 1.31 (1H, dq, J = 13.0, 8.7 Hz, C4H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 183.3 (C1=O), 142.5 (C9), 128.45 (2C, 2 × C11H), 128.42 (2C, 2 × C10H), 125.9 (C12H), 50.4 (C2H), 44.4 (C3H), 37.4 ($C7H_2$), 34.7 ($C8H_2$), 32.8 ($C4H_2$), 30.4 ($C6H_2$), 25.0 ($C5H_2$).

HRMS (ESI^-) Found $[M–H]^-$ = 217.12312; $C_{14}H_{17}O_2$ requires 217.12340, Δ –1.29 ppm.

Note: *cis* and *trans* with respect to C2H.

Benzyl *rel*-(1*S*,2*R*)-2-cyclobutylcyclopentane-1-carboxylate (368)



Ketone **236** (59.7 mg, 0.200 mmol, 1.0 equiv), Br_2 (20 μL, 64 mg, 0.40 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to **General Procedure Q** with BnOH (62 μL, 65 mg, 0.600 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ester **368** (33.4 mg, 0.129 mmol, 65%) as a colourless oil.

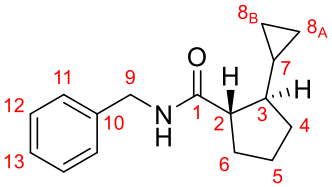
IR (film) ν_{max}/cm^{-1} 3090, 3066, 3033, 2954, 2867, 1730, 1498, 1454, 1385, 1352, 1303, 1254, 1213, 1146, 1079, 1028, 1003, 910, 825, 736, 697.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.41 – 7.33 (4H, m, 2 × C12H and 2 × C13H), 7.36 – 7.28 (1H, m, C14H), 5.11 (2H, q_{AB}, J_{AB} = 12.4 Hz, Δ_{AB} = 12.7 Hz, $C10H_2$), 2.40 – 2.32 (1H, m, C2H), 2.30 – 2.16 (2H, m, C3H and C7H), 2.01 – 1.92 (2H, m, $C8_AH_AH_B$ and $C8_BH_AH_B$), 1.84 – 1.76 (1H, m, $C4H_AH_B$), 1.83 – 1.69 (2H, m, $C9H_2$), 1.73 – 1.64 (1H, m, $C5H_AH_B$), 1.70 – 1.60 (2H, m, $C8_AH_AH_B$ and $C8_BH_AH_B$), 1.64 – 1.54 (1H, m, $C5H_AH_B$), 1.23 (1H, dq, J = 12.3, 7.5 Hz, $C4H_AH_B$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 177.0 (C1=O), 136.4 (C11), 128.6 (2C, 2 × C13H), 128.19 (2C, 2 × C12H), 128.18 (C14H), 66.2 ($C10H_2$), 50.3 (C2H), 48.5 (C3H), 40.7 (C7H), 31.0 ($C4H_2$), 30.1 ($C6H_2$), 26.98 ($C8_AH_2$), 26.90 ($C8_BH_2$), 25.1 ($C5H_2$), 18.2 ($C9H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 259.16931; $C_{17}H_{23}O_2$ requires 259.16926, Δ 0.21 ppm.

***rel*-(1*S*,2*R*)-*N*-Benzyl-2-cyclopropylcyclopentane-1-carboxamide (369)**



Ketone **166** (56.9 mg, 0.200 mmol, 1.0 equiv), Br_2 (20 μL, 64 mg, 0.40 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to **General Procedure Q** with $BnNH_2$ (66 μL, 64 mg, 0.60 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:EtOAc, 90:10 → 85:15) afforded amide **369** (45.6 mg, 0.187 mmol, 94%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3280, 3076, 3031, 3000, 2952, 2870, 1640, 1545, 1497, 1454, 1426, 1385, 1357, 1304, 1235, 1080, 1029, 1017, 919, 892, 864, 817, 697.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.36 – 7.30 (2H, m, 2 × C12H), 7.31 – 7.23 (3H, m, 2 × C11H and C13H), 5.96 (1H, br. s, NH), 4.44 (2H, dq_{AB}, J = 5.7 Hz, J_{AB} = 14.7 Hz, Δ_{AB} = 38.6 Hz, $C9H_2$), 2.26 (1H, q, J = 8.6 Hz, C2H), 1.94 – 1.80 (3H, m, $C4H_{cis}H_{trans}$ and $C6H_2$), 1.76 – 1.58 (2H, m, $C5H_2$), 1.51 (1H, quint., J = 8.7 Hz, C3H), 1.36 (1H, dq, J = 12.6, 8.7 Hz, $C4H_{cis}H_{trans}$), 0.58 (1H, ddq, J = 13.3, 8.7, 4.8 Hz, C7H), 0.44 – 0.32 (1H, m, $C8_AH_{cis}H_{trans}$), 0.37 – 0.25 (1H, m, $C8_BH_{cis}H_{trans}$), 0.15 – 0.09 (1H, m, $C8_BH_{cis}H_{trans}$), 0.09 – 0.02 (1H, m, $C8_AH_{cis}H_{trans}$).

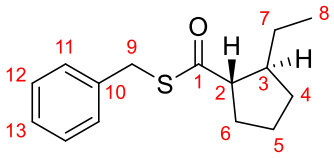
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 176.1 (C1=O), 138.7 (C10), 128.7 (2C, 2 × C12H), 128.0 (2C, 2 × C11H), 127.5 (C13H), 53.1 (C2H), 49.8 (C3H), 43.8 ($C9H_2$), 32.5 ($C4H_2$), 30.8 ($C6H_2$), 24.6 ($C5H_2$), 15.4 (C7H), 3.8 ($C8_BH_2$), 3.1 ($C8_AH_2$).

^{15}N NMR ($CDCl_3$, 126 MHz) δ = 119.2 (NH).

HRMS (ESI^+) Found $[M+H]^+$ = 244.16954; $C_{16}H_{22}NO$ requires 244.17069, Δ –4.70 ppm.

Note: *cis* and *trans* with respect to C2H for the cyclopentane ring, and with respect to C7H for the cyclopropane ring.

_S_-Benzyl _rel_-(1_S_,2_S_)-2-ethylcyclopentane-1-carbothioate (370)



Ketone **232** (54.5 mg, 0.200 mmol, 1.0 equiv), Br_2 (20 μL, 64 mg, 0.40 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to a modification of **General Procedure Q** with BnSH (70 μL, 75 mg, 0.600 mmol, 3.0 equiv) as the nucleophile (caution: stench). The reaction was directly blown down with a gentle stream of Ar, and the residue purified by flash column chromatography (Pentane:Et_2O, 100:0 → 99.75:0.25 → 99.5:0.5) to afford thioester **370** (36.7 mg, 0.148 mmol, 74%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3087, 3063, 3030, 2958, 2927, 2872, 1686, 1603, 1585, 1495, 1454, 1412, 1379, 1361, 1290, 1241, 1180, 1098, 1071, 1029, 1002, 936, 914, 890, 816, 769, 699.

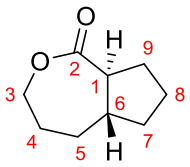
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 (4H, s, 2 × C11H and 2 × C12H), 7.28 – 7.20 (1H, m, C13H), 4.13 (2H, q_{AB}, J_{AB} = 13.7 Hz, Δ_{AB} = 4.7 Hz, $C9H_2$), 2.61 (1H, q, J = 8.1 Hz, C2H), 2.12 (1H, quint.d, J = 8.2, 5.6 Hz, C3H), 2.00 – 1.90 (1H, m, C6H_AH$_B$), 1.93 (1H, dtd, J = 12.6, 7.7, 5.2 Hz, C4H_AH$_B$), 1.86 (1H, dq, J = 13.3, 7.5 Hz, C6H$_A$$H_B$), 1.76 – 1.59 (2H, m, $C5H_2$), 1.55 (1H, dqd, J = 13.2, 7.5, 5.7 Hz, C7H_AH$_B$), 1.29 (1H, dquint., J = 13.5, 7.7 Hz, C7H$_A$$H_B$), 1.23 (1H, dq, J = 12.5, 8.3 Hz, C4H$_A$$H_B$), 0.90 (3H, t, J = 7.4 Hz, $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.6 (C1=O), 137.9 (C10), 128.9 (2C, 2 × C11H), 128.7 (2C, 2 × C12H), 127.3 (C13H), 59.5 (C2H), 46.6 (C3H), 33.3 ($C9H_2$), 32.4 ($C4H_2$), 31.5 ($C6H_2$), 28.1 ($C7H_2$), 25.0 ($C5H_2$), 12.8 ($C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 249.13078; $C_{15}H_{21}OS$ requires 249.13076, Δ 0.08 ppm.

***rel*-(1*S*,7*R*)-3-Oxabicyclo[5.3.0]decan-2-one (371), or**

***rel*-(5a*R*,8a*S*)-Octahydro-1*H*-cyclopenta[*c*]oxepin-1-one (371)**



Ketone **243** (98.2 mg, 0.250 mmol, 1.0 equiv), Br_2 (26 μL, 80 mg, 0.50 mmol, 2.0 equiv) and DCM (1.3 mL, 0.2 M) were subjected to a modification of **General Procedure Q** with no nucleophile being added and the reaction being stirred for 2 h. Purification by flash column chromatography (Pentane:Et_2O, 100:0 → 80:20) afforded lactone **371** (34.2 mg, 0.222 mmol, 89%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2928, 2870, 1730, 1473, 1451, 1431, 1393, 1364, 1334, 1297, 1268, 1173, 1147, 1108, 1079, 1033, 1009, 966, 919, 894, 837, 680.

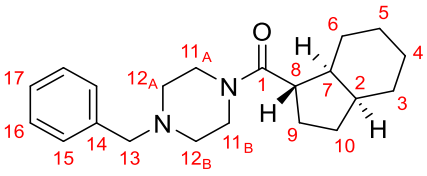
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.32 – 4.20 (2H, m, C3H_2), 2.71 (1H, dt, J = 10.9, 8.5 Hz, C1H), 2.22 (1H, dq, J = 13.5, 8.0 Hz, C9$H_{cis}H_{trans}$), 2.12 (1H, dqd, J = 13.6, 3.4, 1.1 Hz, C5$H_{cis}H_{trans}$), 1.97 (1H, ddt, J = 12.5, 7.6, 5.8 Hz, C7$H_{cis}H_{trans}$), 1.91 (1H, dqd, J = 15.7, 4.3, 1.3 Hz, C4$H_{cis}H_{trans}$), 1.86 (1H, ddd, J = 13.7, 8.5, 7.2 Hz, C9$H_{cis}H_{trans}$), 1.81 (1H, dddd, J = 11.2, 10.2, 7.5, 3.5 Hz, C6H), 1.75 (1H, dddt, J = 15.8, 13.3, 9.9, 3.5 Hz, C4$H_{cis}H_{trans}$), 1.65 (2H, ddq_{AB}, J = 6.9, 5.8 Hz, J_{AB} = 8.2 Hz, Δ_{AB} = 3.8 Hz, C8H_2), 1.37 (1H, tdd, J = 13.3, 11.8, 4.0 Hz, C5$H_{cis}H_{trans}$), 1.28 (1H, ddt, J = 12.6, 9.9, 8.8 Hz, C7$H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 176.8 (C2=O), 68.9 (C3H_2), 48.1 (C1H), 43.5 (C6H), 35.0 (C7H_2), 34.8 (C5H_2), 28.9 (C4H_2), 28.4 (C9H_2), 23.9 (C8H_2).

HRMS (ESI^+) Found $[M+Na]^+$ = 177.08881; $C_9H_{14}O_2Na$ requires 177.08860, Δ 1.16 ppm.

Note: *cis* and *trans* with respect to C1H.

***rel*-(4-Benzylpiperazin-1-yl)((1*S*,6*S*,7*S*)-Bicyclo[4.3.0]nonan-7-yl)methanone (372), or *rel*-(4-Benzylpiperazin-1-yl)((1*S*,3a*S*,7a*S*)-octahydro-1*H*-inden-1-yl)methanone (372)**



Ketone **266** (40.0 mg, 0.134 mmol, 1.0 equiv), Br_2 (14 µL, 44 mg, 0.28 mmol, 2.0 equiv) and DCM (0.70 mL, 0.2 M) were subjected to **General Procedure Q** with *N*-benzylpiperazine (70 µL, 71 mg, 0.40 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:EtOAc, 60:40) afforded amide **372** (22.6 mg, 69.2 µmol, 52%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3061, 3027, 3003, 2921, 2852, 2807, 2766, 1638, 1494, 1432, 1366, 1348, 1298, 1275, 1238, 1218, 1146, 1103, 1074, 1038, 1001, 964, 909, 891, 849, 800, 740, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.36 – 7.29 (4H, m, 2 × C15H and 2 × C16H), 7.31 – 7.23 (1H, m, C17H), 3.68 (2H, app. ddq_{AB}, J = 3.6, 5.9 Hz, J_{AB} = 13.0 Hz, Δ_{AB} = 34.7 Hz, $C11_AH_2$), 3.52 (2H, s, $C13H_2$), 3.50 (2H, t, J = 5.0 Hz, $C11_BH_2$), 2.83 (1H, dt, J = 10.0, 6.2 Hz, C8H), 2.47 – 2.36 (4H, m, $C12_AH_2$ and $C12_BH_2$), 2.30 (1H, tt, J = 6.2, 5.8 Hz, C7H), 2.10 – 2.01 (1H, app. sext., J = 6.0 Hz, C2H), 2.02 – 1.90 (1H, m, $C9H_{cis}H_{trans}$), 1.86 – 1.74 (1H, m, $C9H_{cis}H_{trans}$), 1.84 – 1.70 (1H, m, $C10H_{cis}H_{trans}$), 1.59 – 1.48 (3H, m, $C3H_{cis}H_{trans}$, $C4H_{cis}H_{trans}$ and $C6H_{cis}H_{trans}$), 1.52 – 1.43 (1H, m, $C10H_{cis}H_{trans}$), 1.45 – 1.37 (1H, m, $C6H_{cis}H_{trans}$), 1.40 – 1.33 (2H, m, $C5H_2$), 1.32 – 1.27 (1H, m, $C4H_{cis}H_{trans}$), 1.27 – 1.21 (1H, m, $C3H_{cis}H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 174.9 (C1=O), 137.8 (C14), 129.3 (2C, 2 × C15H), 128.4 (2C, 2 × C16H), 127.4 (C17H), 63.0 ($C13H_2$), 53.5 ($C12_AH_2$), 53.1 ($C12_BH_2$), 45.7 ($C11_AH_2$), 43.10 (C8H), 43.03 (C7H), 42.0 ($C11_BH_2$), 39.1 (C2H), 29.8 ($C10H_2$), 27.99 ($C3H_2$), 27.89 ($C9H_2$), 27.0 ($C6H_2$), 23.9 ($C4H_2$), 23.3 ($C5H_2$).

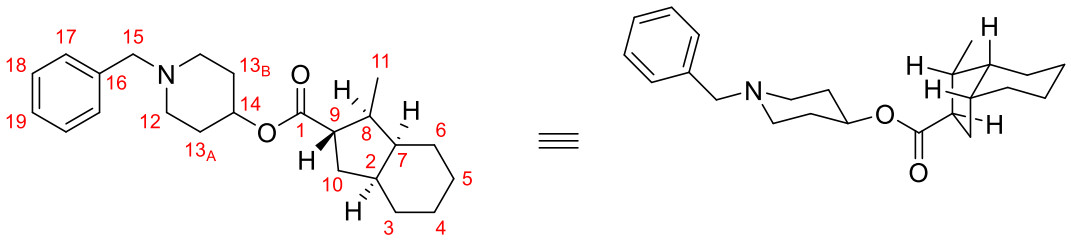
^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 49.9 (NBn), 116.4 (C1N).

HRMS (ESI^+) Found $[M+H]^+$ = 327.24289; $C_{21}H_{31}NO_2$ requires 327.24309, Δ –0.61 ppm.

Note: *cis* and *trans* with respect to C7H.

1-Benzylpiperidin-4-yl *rel*-(1*S*,6*S*,7*S*,8*S*)-7-methylbicyclo[4.3.0]nonane-8-carboxylate (373), or

1-Benzylpiperidin-4-yl *rel*-(1*S*,2*S*,3a*S*,7a*S*)-1-methyloctahydro-1*H*-indene-2-carboxylate (373)



Ketone **267** (62.5 mg, 0.200 mmol, 1.0 equiv), Br_2 (20 µL, 64 mg, 0.40 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to **General Procedure Q** with *N*-benzyl-4-hydroxypiperidine (115 mg, 0.600 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 85:15 → 70:30) afforded ester **373** (55.1 mg, 0.155 mmol, 94%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3062, 3028, 2922, 2873, 2853, 2804, 2764, 1726, 1494, 1453, 1376, 1358, 1340, 1312, 1266, 1248, 1223, 1200, 1181, 1166, 1143, 1109, 1073, 1040, 1009, 978, 950, 927, 904, 859, 807, 794, 737, 698.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.28 (4H, m, 2 × C17H and 2 × C18H), 7.29 – 7.22 (1H, m, C19H), 4.81 (1H, tt, J = 8.0, 4.0 Hz, C14H), 3.51 (2H, s, $C15H_2$), 2.67 (2H, br. dt, J = 10.6, 5.0 Hz, 2 × $C12H_{ax}H_{eq}$), 2.48 (1H, td, J = 10.6, 4.9 Hz, C9H), 2.30 (2H, br. t, J = 10.4 Hz, 2 × $C12H_{ax}H_{eq}$), 2.30 – 2.17 (1H, m, C2H), 2.21 (1H, dquint.d, J = 9.8, 6.8, 5.8 Hz, C8H), 1.91 (1H, dt, J = 13.6, 11.3 Hz, $C10H_{cis}H_{trans}$), 1.94 – 1.86 (2H, m, $C13_AH_{ax}H_{eq}$ and $C13_BH_{ax}H_{eq}$), 1.83 (1H, ddd, J = 13.7, 9.4, 5.0 Hz, $C10H_{cis}H_{trans}$), 1.76 (1H, dq, J = 13.0, 5.5 Hz, C7H), 1.75 – 1.65 (3H, m, $C5H_{cis}H_{trans}$, $C13_AH_{ax}H_{eq}$ and $C13_BH_{ax}H_{eq}$), 1.62 – 1.52 (2H, m, $C3H_2$), 1.53 – 1.43 (2H, m, $C4H_{cis}H_{trans}$ and $C6H_{cis}H_{trans}$), 1.30 (1H, qdd, J = 12.9, 5.0, 3.3 Hz, $C4H_{cis}H_{trans}$), 1.10 (1H, qt, J = 12.9, 3.3 Hz, $C5H_{cis}H_{trans}$), 0.99 (3H, d, J = 6.9 Hz, $C11H_3$), 0.87 (1H, qd, J = 13.0, 3.5 Hz, $C6H_{cis}H_{trans}$).

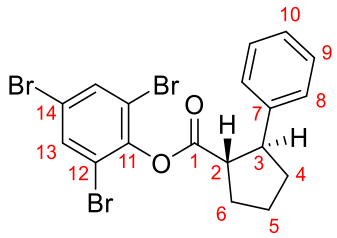
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 177.0 (C1=O), 138.5 (C16), 129.2 (2C, 2 × C17H), 128.3 (2C, 2 × C18H), 127.1 (2C, 2 × C19H), 69.8 (v. br. s, C14H), 63.1 ($C15H_2$), 50.8 (2C, br. s, 2 × $C12H_2$), 48.9 (C9H), 44.5 (C7H), 43.9 (C8H), 38.7 (C2H), 30.96 (br. s, $C13_AH_2$), 30.91 (br. s, $C13_BH_2$), 30.78 ($C10H_2$), 26.7 ($C3H_2$), 25.4 ($C5H_2$), 22.8 ($C6H_2$), 20.9 ($C4H_2$), 14.7 ($C11H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 51.0 (NBn).

HRMS (ESI^+) Found $[M+H]^+$ = 356.25818; $C_{23}H_{34}NO_2$ requires 356.25841, Δ –0.64 ppm.

Note: *cis* and *trans* with respect to C7H.

2,4,6-Tribromophenyl *rel*-(1*S*,2*S*)-2-phenylcyclopentane-1-carboxylate (374)



Ketone **239** (61.5 mg, 0.192 mmol, 1.0 equiv), Br_2 (19 μL, 61 mg, 0.38 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to **General Procedure Q** with 2,4,6-tribromophenol (191 mg, 0.576 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:EtOAc, 100:0 → 99:1) afforded ester **374** (42.8 mg, 85.1 μmol, 44%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3073, 3028, 2956, 2921, 2871, 2851, 1768, 1603, 1561, 1550, 1493, 1437, 1373, 1354, 1296, 1261, 1228, 1200, 1150, 1103, 1087, 1063, 1022, 966, 938, 905, 858, 802, 743, 698, 680.

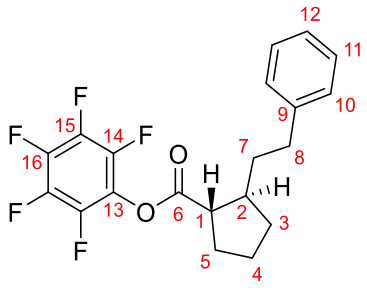
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.66 (2H, s, 2 × C13H), 7.37 – 7.31 (2H, m, 2 × C8H), 7.34 – 7.28 (2H, m, 2 × C9H), 7.25 – 7.18 (1H, m, C10H), 3.60 (1H, td, J = 9.7, 7.9 Hz, C3H), 3.23 (1H, q, J = 8.8 Hz, C2H), 2.36 (1H, ddt, J = 12.9, 8.8, 7.2 Hz, C6H_{cis}H$_{trans}$), 2.34 – 2.23 (2H, m, C4H$_{cis}$$H_{trans}$ and C6H$_{cis}$$H_{trans}$), 2.02 – 1.89 (2H, m, C5H$_2$), 1.84 (1H, ddt, J = 12.6, 9.9, 8.5 Hz, C4H_{cis}H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 172.1 (C1=O), 145.9 (C11), 143.5 (C7), 134.9 (2C, 2 × C13H), 128.6 (2C, 2 × C9H), 127.6 (2C, 2 × C8H), 126.7 (C10H), 119.7 (C14), 118.6 (2C, 2 × C12), 51.7 (C2H), 49.8 (C3H), 35.4 (C4H$_2$), 31.3 (C6H$_2$), 25.4 (C5H$_2$).

HRMS (EI) Found $[M]^{\bullet+}$ = 499.8600; $C_{18}H_{15}Br_3O_2$ requires 499.8617, Δ –3.40 ppm.

Note: *cis* and *trans* with respect to C2H.

Perfluorophenyl *rel*-(1*S*,2*R*)-2-phenethylcyclopentane-1-carboxylate (375)



Ketone **241** (87.1 mg, 0.250 mmol, 1.0 equiv), Br_2 (26 μL, 80 mg, 0.50 mmol, 2.0 equiv) and DCM (1.3 mL, 0.2 M) were subjected to **General Procedure Q** with pentafluorophenol (138 mg, 0.750 mmol, 3.0 equiv) as the nucleophile. Purification by preparative TLC (Pentane:Et_2O, 97.5:2.5) afforded ester **375** (27.1 mg, 70.5 μmol, 28%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3083, 3060, 3026, 2993, 2931, 2826, 1730, 1653, 1603, 1582, 1494, 1452, 1379, 1358, 1334, 1301, 1274, 1244, 1201, 1152, 1090, 1070, 1042, 991, 960.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.33 – 7.24 (2H, m, 2 × C11H), 7.23 – 7.16 (3H, m, 2 × C10H and C12H), 2.75 (1H, td, J = 8.6, 7.7 Hz, C1H), 2.73 (1H, ddd, J = 14.1, 10.6, 5.7 Hz, C8H_AH$_B$), 2.66 (1H, ddd, J = 13.8, 10.3, 6.3 Hz, C8H$_A$$H_B$), 2.33 (1H, quint.d, J = 8.4, 5.7 Hz, C2H), 2.13 (1H, ddt, J = 13.7, 9.0, 7.3 Hz, C5H$_{cis}$$H_{trans}$), 2.14 – 1.99 (2H, m C3$H_{cis}H_{trans}$ and C5H_{cis}H$_{trans}$), 1.99 (1H, ddt, J = 13.4, 10.6, 6.1 Hz, C7H_AH$_B$), 1.79 (2H, app. dtd, J = 8.6, 7.4, 6.1 Hz, C4H$_2$), 1.70 (1H, dddd, J = 13.7, 10.4, 8.6, 5.4 Hz, C7H$_A$$H_B$), 1.38 (1H, dq, J = 12.6, 8.5 Hz, C3H$_A$$H_B$).

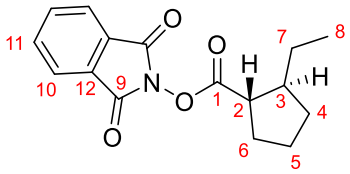
^{13}C{^{19}F} NMR ($CDCl_3$, 126 MHz) δ = 172.7 (C6), 142.1 (C9), 141.3 (2C, 2 × C14F), 139.5 (C16F), 138.0 (2C, 2 × C15F), 128.5 (2C, 2 × C11H), 128.4 (2C, 2 × C10H), 126.0 (C12H), 125.4 (C13), 49.8 (C1H), 44.8 (C2H), 37.2 (C7H$_2$), 34.7 (C8H$_2$), 32.8 (C3H$_2$), 30.6 (C5H$_2$), 25.1 (C4H$_2$).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –152.9 – –153.9 (2F, m, 2 × C14F), –158.4 (1F, t, J = 21.7 Hz, C16F), –162.3 – –162.7 (2F, m, 2 × C15F).

HRMS (CH_4 CI^+) Found $[M+C_2H_5]^+$ = 413.1531; $C_{22}H_{22}F_5O_2$ requires 413.1534, Δ –0.9 ppm.

Note: *cis* and *trans* with respect to C6.

1,3-Dioxoisoindolin-2-yl *rel*-(1*S*,2*S*)-2-ethylcyclopentane-1-carboxylate (376)



Ketone **232** (38.1 mg, 0.140 mmol, 1.0 equiv), Br_2 (14 μL, 45 mg, 0.28 mmol, 2.0 equiv) and DCM (0.7 mL, 0.2 M) were subjected to a modification of **General Procedure Q** with *N*-hydroxyphthalimide (68.5 mg, 0.420 mmol, 3.0 equiv) as the nucleophile. The reaction was diluted with Et_2O (3 mL) and filtered, eluting with Et_2O, and the eluent concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 97.5:2.5 → 95:5 → 60:40) afforded ester **376** (15.6 mg, 54.3 μmol, 39%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2960, 2929, 2875, 2861, 1811, 1784, 1742, 1467, 1370, 1327, 1185, 1136, 1081, 1062, 1018, 975, 913, 878, 785, 697.

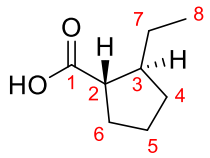
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.91 – 7.85 (2H, m, 2 × C10H), 7.81 – 7.75 (2H, m, 2 × C11H), 2.70 (1H, ddd, J = 9.0, 8.2, 7.5 Hz, C2H), 2.25 (1H, quint.d, J = 8.2, 5.8 Hz, C3H), 2.17 – 2.01 (2H, m, $C6H_2$), 1.99 (1H, dtd, J = 12.6, 7.1, 5.4 Hz, $C4H_{cis}H_{trans}$), 1.81 – 1.72 (2H, m, $C5H_2$), 1.71 (1H, dqd, J = 13.3, 7.4, 6.0 Hz, $C7H_AH_B$), 1.42 (1H, ddq, J = 13.4, 8.1, 7.3 Hz, $C7H_AH_B$), 1.31 (1H, dq, J = 12.6, 8.4 Hz, $C4H_{cis}H_{trans}$), 0.99 (3H, t, J = 7.4 Hz, $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.1 (C1=O), 162.3 (2C, 2 × C9=O), 134.8 (2C, 2 × C11H), 129.2 (2C, 2 × C12), 124.0 (2C, 2 × C10H), 47.04 (C3H), 46.98 (C2H), 32.4 ($C4H_2$), 30.6 ($C6H_2$), 28.0 ($C7H_2$), 25.1 ($C5H_2$), 12.6 ($C8H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 310.10507; $C_{16}H_{17}NO_4Na$ requires 310.10498, Δ 0.30 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-(1*S*,2*S*)-2-Ethylcyclopentane-1-carboxylic acid (377)**



In the preparation of ester **376**, carboxylic acid **377** (10.6 mg, 74.5 μmol, 53%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2960, 2875, 2676, 1701, 1460, 1422, 1381, 1291, 1253, 1222, 1162, 943.

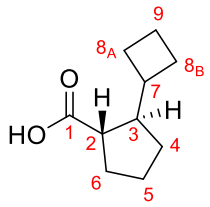
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 11.60 (1H, v. br. s, OH), 2.36 (1H, q, J = 8.3 Hz, C2H), 2.07 (1H, quint.d, J = 8.3, 5.6 Hz, C3H), 2.00 – 1.94 (1H, m, C6H_{cis}H$_{trans}$), 1.94 – 1.90 (1H, m, C6H$_{cis}$$H_{trans}$), 1.90 – 1.82 (1H, m, C6H$_{cis}$$H_{trans}$), 1.76 – 1.61 (2H, m, $C5H_2$), 1.59 (1H, dqd, J = 13.0, 7.5, 5.7 Hz, C7H_AH$_B$), 1.31 (1H, ddq, J = 13.1, 8.3, 7.4 Hz, C7H$_A$$H_B$), 1.23 (1H, dq, J = 12.5, 8.4 Hz, C4H_{cis}H$_{trans}$), 0.92 (3H, t, J = 7.4 Hz, $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 183.3 (C1=O), 50.1 (C2H), 46.3 (C3H), 32.3 ($C4H_2$), 30.5 ($C6H_2$), 28.2 ($C7H_2$), 25.0 ($C5H_2$), 12.7 ($C8H_3$).

HRMS (ESI^-) Found $[M–H]^–$ = 141.09198; $C_8H_{13}O_2$ requires 141.09210, Δ –0.88 ppm.

Note: *cis* and *trans* with respect to C2H.

***rel*-(1*S*,2*R*)-2-Cyclobutylcyclopentane-1-carboxylic acid (379)**



Ketone **236** (59.7 mg, 0.200 mmol, 1.0 equiv), Br_2 (20 μL, 64 mg, 0.40 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to **General Procedure Q** with 2-mercaptobenzothiazole (100 mg, 0.600 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 80:20 → 60:40) afforded carboxylic acid **379** (30.5 mg, 0.181 mmol, 91%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2954, 2867, 2673, 1699, 1420, 1342, 1305, 1291, 1230, 1162, 940, 696.

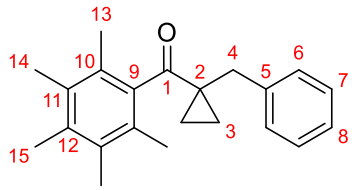
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 11.51 (1H, v. br. s, OH), 2.33 (1H, dt, J = 8.4, 7.0 Hz, C2H), 2.31 – 2.18 (2H, m, C3H and C7H), 2.04 – 1.92 (2H, m, C8$_A$$H_AH_B$ and C8$_B$$H_AH_B$), 1.95 – 1.83 (2H, m, C6H$_2$), 1.86 – 1.76 (2H, m, C4H_AH$_B$ and C9H_AH$_B$), 1.79 – 1.70 (2H, m, C8$_A$H$_A$$H_B$ and C9H$_A$$H_B$), 1.72 – 1.63 (2H, m, C8$_B$H$_A$$H_B$ and C5H_AH$_B$), 1.66 – 1.55 (1H, m, C5H$_A$$H_B$), 1.25 (1H, dq, J = 12.3, 7.3 Hz, C4H$_A$$H_B$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 183.9 (C1=O), 50.1 (C3H), 48.2 (C2H), 40.6 (C7H), 30.9 (C6H$_2$), 30.0 (C4H$_2$), 26.89 (C8$_A$H$_2$), 26.79 (C8$_B$H$_2$), 25.2 (C5H$_2$), 18.1 (C9H$_2$).

HRMS (ESI$^-$) Found [M–H]$^-$ = 167.10756; $C_{10}H_{15}O_2$ requires 167.10775, Δ –1.16 ppm.

Note: The desired thioester **376** was not observed.

(1-Benzylcyclopropyl)(2,3,4,5,6-pentamethylphenyl)methanone (381)



Enone **383** (292 mg, 1.00 mmol, 1.0 equiv), NaH (48.0 mg, 60% dispersion in mineral oil, 1.20 mmol, 1.2 equiv), trimethylsulfoxonium iodide (245 mg, 1.20 mmol, 1.2 equiv) and anhydrous DMSO (5.0 mL, 0.2 M) were subjected to **General Procedure L**. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **381** (281 mg, 0.917 mmol, 92%) as a colourless solid.

m.p. = 73 – 75 °C.

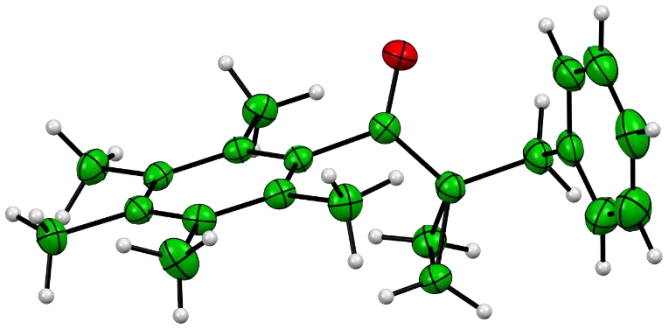
IR (film) ν_{max}/cm^{-1} 3085, 3061, 3027, 2922, 2857, 1671, 1603, 1582, 1495, 1453, 1383, 1342, 1308, 1280, 1266, 1176, 1094, 1030, 997, 917.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.25 – 7.16 (3H, m, 2 × C7H and C8H), 7.14 – 7.08 (2H, m, 2 × C6H), 3.06 (2H, s, $C4H_2$), 2.21 (3H, s, $C15H_3$), 2.14 (6H, s, 2 × $C14H_3$), 1.97 (6H, s, 2 × $C13H_3$), 1.20 (2H, q_{AB}, J_{AB} = 3.8 Hz, Δ_{AB} = 5.6 Hz, 2 × C3$H_A$$H_B$), 0.99 (2H, q_{AB}, J_{AB} = 4.4 Hz, Δ_{AB} = 5.7 Hz, 2 × C3$H_A$$H_B$).

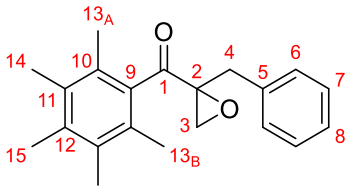
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 212.6 (C1=O), 139.1 (C5), 137.2 (C9), 135.3 (C2), 132.9 (2C, 2 × C11), 130.1 (2C, 2 × C6H), 128.5 (2C, 2 × C10), 128.0 (2C, 2 × C7H), 126.3 (C8H), 37.7 ($C4H_2$), 34.4 (C2), 17.6 (2C, 2 × $C13H_3$), 17.1 (2C, 2 × $C3H_2$), 16.8 ($C15H_3$), 16.0 (2C, 2 × $C14H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 307.20551; $C_{22}H_{27}O$ requires 307.20564, Δ –0.44 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



(2-Benzyloxiran-2-yl)(2,3,4,5,6-pentamethylphenyl)methanone (382)[49]



To a solution of enone **383** (146 mg, 0.500 mmol, 1.0 equiv) in THF (2.5 mL, 0.2 M) was added *tert*-butyl hydroperoxide (129 μL, 70% aq. solution, 90.1 mg, 1.00 mmol, 2.0 equiv) and benzyltrimethylammonium hydroxide (418 μL, 40% aq. solution, 167 mg, 1.00 mmol, 2.0 equiv) at RT and stirred for 18 h. The reaction mixture was diluted with Et_2O (20 mL), passed through a silica plug, eluting with Et_2O, and the filtrate concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded epoxide **382** (146 mg, 0.474 mmol, 95%) as a colourless solid.

m.p. = 83 – 85 °C.

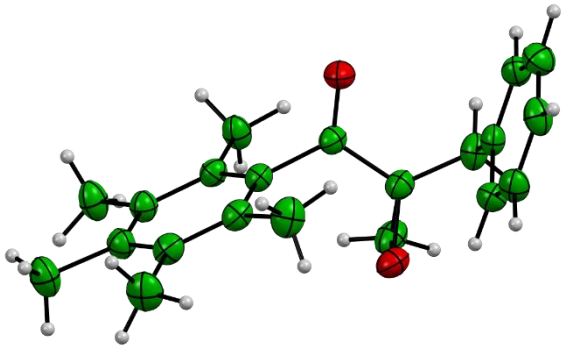
IR (film) ν_{max}/cm^{-1} 3087, 3062, 3031, 2984, 2925, 1693, 1603, 1575, 1496, 1455, 1435, 1383, 1308, 1144, 1083, 1030, 986, 908.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.35 – 7.27 (4H, m, 2 × C6H and 2 × C7H), 7.27 – 7.22 (1H, m, C8H), 3.48 (1H, d, J = 14.5 Hz, C3H_AH$_B$), 3.36 (1H, d, J = 14.5 Hz, C3H$_A$$H_B$), 2.70 (2H, q_{AB}, J_{AB} = 5.6 Hz, Δ_{AB} = 7.4 Hz, $C4H_2$), 2.21 (3H, s, $C15H_3$), 2.14 (6H, s, $C14H_3$), 2.01 (3H, br. s, $C13_AH_3$), 1.92 (3H, br. s, $C13_BH_3$).

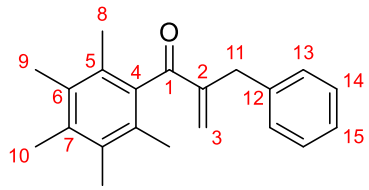
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.3 (C1=O), 136.2 (C12), 135.8 (C5), 134.5 (C9), 132.7 (2C, 2 × C11), 130.6 (2C, 2 × C6H), 128.7 (2C, v. br. s, 2 × C10), 128.3 (2C, 2 × C7H), 126.9 (C8H), 63.0 (C2), 51.3 ($C3H_2$), 35.2 ($C4H_2$), 17.5 (2C, 2 × $C13H_3$), 16.9 ($C15H_3$), 15.9 (2C, br. s, 2 × $C14H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 309.18500; $C_{21}H_{25}O_2$ requires 309.18491, Δ 0.29 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(2,3,4,5,6-pentamethylphenyl)prop-2-en-1-one (383)[50]



To a well-stirred round bottom flask equipped with a water condenser was added ketone **145** (981 mg, 3.50 mmol, 1.0 equiv), morpholine (152 mg, 1.75 mmol, 0.5 equiv), paraformaldehyde (315 mg, 10.5 mmol, 3.0 equiv) and AcOH (7.0 mL, 0.5 M). The mixture was heated to reflux for 1.5 h, during which time two additional portions of paraformaldehyde (105 mg, 3.50 mmol, 1.0 equiv) were added in 30 min intervals. The reaction was cooled to RT, diluted with DCM (40 mL) and ice/H_2O (20 mL), then neutralised with 10% aq. NaOH. The layers were separated, the aqueous layer extracted with DCM (4 × 40 mL), and the combined organics washed with 1 M aq. HCl (20 mL), dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 98.5:1.5) afforded enone **383** (824 mg, 2.82 mmol, 81%) as a colourless solid.

m.p. = 62 – 64 °C.

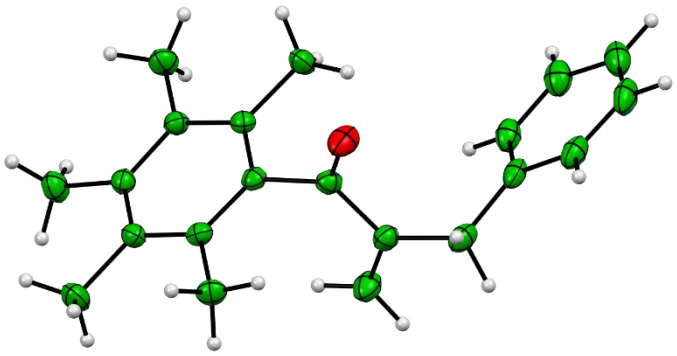
IR (film) ν_{max}/cm^{-1} 3111, 3021, 2979, 2903, 1662, 1599, 1578, 1492, 1450, 1428, 1407, 1342, 1321, 1291, 1255, 1193, 1095, 1073, 1029, 992, 966, 944, 903, 858.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.36 – 7.30 (2H, m, 2 × C14H), 7.30 – 7.27 (2H, m, 2 × C13H), 7.27 – 7.20 (1H, m, C15H), 5.75 (1H, td, J = 1.5, 1.0 Hz, C3H$_{syn}$*H$_{anti}$*), 5.72 (1H, q, J = 0.9 Hz, C3*H$_{syn}$*H$_{anti}$), 3.80 (2H, s, C11H_2), 2.24 (3H, s, C10H_3), 2.18 (6H, s, 2 × C9H_3), 1.98 (6H, s, 2 × C8H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.4 (C1=O), 149.5 (C2), 139.1 (C12), 137.6 (C4), 135.4 (C7), 132.8 (2C, 2 × C6), 130.6 ($C3H_2$), 129.5 (2C, 2 × C13H), 129.2 (2C, 2 × C5), 128.5 (2C, 2 × C14H), 126.4 (C15H), 36.1 ($C11H_2$), 17.4 (2C, 2 × $C8H_3$), 16.8 ($C10H_3$), 16.0 (2C, 2 × $C9H_3$).

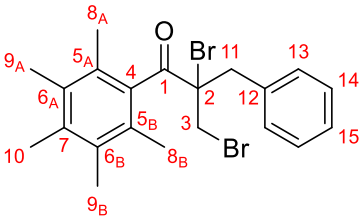
HRMS (ESI^+) Found $[M+H]^+$ = 293.19016; $C_{21}H_{25}O$ requires 293.18999, Δ 0.56 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



Note: *syn* and *anti* with respect to C1.

2-Benzyl-2,3-dibromo-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (386)



Enone **383** (35.0 mg, 0.120 mmol, 1.0 equiv), Br_2 (12 µL, 38 mg, 0.24 mmol, 2.0 equiv) and DCM (0.60 mL, 0.2 M) were subjected to **General Procedure Q** with *n*-butanol (83 µL, 67 mg, 0.42 mmol, 3.0 equiv) as the nucleophile. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded α-bromoketone **386** (42.4 mg, 91.3 µmol, 76%) as a colourless solid.

m.p. = 129 – 131 °C.

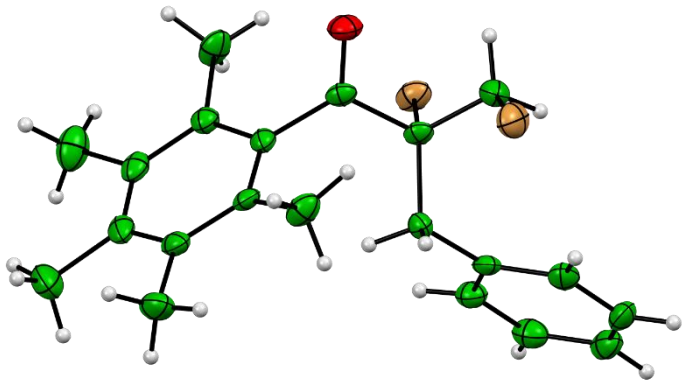
IR (film) ν_{max}/cm^{-1} 3086, 3062, 3031, 3006, 2927, 1698, 1603, 1571, 1495, 1454, 1433, 1412, 1384, 1299, 1259, 1224, 1148, 1089, 1074, 1011, 938, 910, 885.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.49 – 7.43 (2H, m, 2 × C13H), 7.35 – 7.29 (3H, m, 2 × C14H and C15H), 4.25 (1H, dd, J = 10.6, 1.2 Hz, C11H_AH$_B$), 3.88 (1H, d, J = 14.2 Hz, C3H_AH$_B$), 3.65 (1H, d, J = 10.6 Hz, C11H$_A$$H_B$), 3.28 (1H, dd, J = 14.1, 1.1 Hz, C3H$_A$$H_B$), 2.27 (3H, s, C8$_AH_3$), 2.26 (3H, s, C10H$_3$), 2.19 (3H, s, C9$_AH_3$), 2.18 (3H, s, C9$_BH_3$), 2.08 (3H, s, C8$_BH_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 202.0 (C1=O), 136.4 (C7), 135.5 (C4), 135.0 (C12), 133.6 (C6$_B$), 133.2 (C6$_A$), 131.6 (2C, 2 × C13H), 129.65 (C5$_A$), 129.56 (C5$_B$), 128.3 (2C, 2 × C14H), 127.7 (C15H), 71.0 (C2), 40.6 (C11H$_2$), 34.9 (C3H$_2$), 20.1 (C8$_A$H$_3$), 19.8 (C8$_B$H$_3$), 16.9 (C$_{10}$H$_3$), 16.4 (C9$_A$H$_3$), 16.2 (C9$_B$H$_3$).

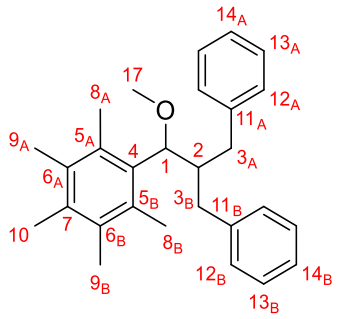
HRMS (ESI$^+$) Found $[M+Na]^+$ = 473.00867; $C_{21}H_{24}{}^{79}Br_2ONa$ requires 473.00861, Δ 0.12 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



Note: This compound displays atropoisomerism due to the significantly hindered rotation about the aryl—C1 bond at RT, thus each pair of *ortho*- and *meta*- methyl groups and their respective aryl *ipso* carbons are magnetically inequivalent within the NMR time scale.

(2-(Methoxy(2,3,4,5,6-pentamethylphenyl)methyl)propane-1,3-diyl)dibenzene (388)



A solution of benzylic alcohol **325** (16.0 mg, 56.7 μmol, 1.0 equiv) in HCl (450 μL, 1.25 M in MeOH, 0.600 mmol, 10 equiv) was stirred at RT for 2.5 h, then blown down by a gentle stream of Ar. Purification by preparative TLC (Pentane:Et_2O, 95:5) afforded ether **388** (16.0 mg, 54.0 μmol, 95%) as a colourless solid.

m.p. = 90 – 92 °C.

IR (film) ν_{max}/cm^{-1} 3084, 3061, 3026, 2923, 2812, 1602, 1494, 1453, 1381, 1289, 1251, 1217, 1182, 1154, 1096, 1030, 1001, 950, 908, 887, 840, 819, 782, 748, 699.

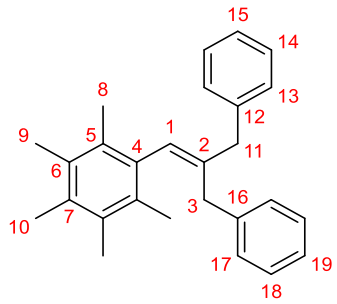
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.27 (2H, m, 2 × $C13_AH$), 7.23 – 7.17 (3H, m, 2 × $C12_AH$ and C14H), 7.17 – 7.11 (2H, m, 2 × $C13_BH$), 7.11 – 7.05 (1H, m, $C14_BH$), 6.91 – 6.82 (2H, m, 2 × $C12_BH$), 4.65 (1H, dd, J = 8.3, 1.2 Hz, C1H), 3.18 (3H, s, $C17H_3$), 2.92 (1H, dd, J = 13.3, 3.9 Hz, $C3_AH_AH_B$), 2.87 (1H, dd, J = 13.3, 7.4 Hz, $C3_AH_AH_B$), 2.67 (1H, qdd, J = 7.8, 6.5, 3.9 Hz, C2H), 2.42 (3H, s, $C8_AH_3$), 2.38 (1H, dd, J = 13.9, 7.7 Hz, $C3_BH_AH_B$), 2.28 (1H, dd, J = 13.9, 6.4 Hz, $C3_BH_AH_B$), 2.21 (3H, s, $C10H_3$), 2.18 (3H, s, $C9_BH_3$), 2.12 (3H, s, $C9_AH_3$), 1.96 (3H, s, $C8_BH_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 141.2 ($C11_B$), 140.6 ($C11_A$), 134.04 ($C6_A$), 134.02 (C10), 133.5 ($C5_A$), 133.2 ($C5_B$), 132.7 (C4), 132.2 ($C6_B$), 130.1 (2C, 2 × $C12_AH$), 129.0 (2C, 2 × $C12_BH$), 128.15 (2C, 2 × $C13_AH$), 127.99 (2C, 2 × $C13_BH$), 125.8 ($C14_AH$), 125.5 ($C14_BH$), 82.1 (C1H), 56.1 ($C17H_3$), 46.7 (C2H), 36.2 ($C3_AH_2$), 35.6 ($C3_BH_2$), 17.29 ($C10H_3$), 17.26 ($C9_BH_3$), 17.1 ($C8_AH_3$), 16.6 ($C8_BH_3$), 16.4 ($C9_AH_3$).

HRMS (EI) Found $[M]^+$ = 386.2586; $C_{28}H_{34}O$ requires 386.2604, Δ –4.66 ppm.

Note: The numbering for this compound is not based off its systematic name, but rather in an analogous fashion to benzylic alcohol **325** to facilitate comparison. In addition, this compound displays atropoisomerism due to the significantly hindered rotation about the aryl—C1 bond at RT, thus each pair of *ortho*- and *meta*- methyl groups and their respective aryl *ipso* carbons are magnetically inequivalent within the NMR time scale.

2-Benzyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylprop-1-ene, or (2-(2,3,4,5,6-Pentamethylbenzylidene)propane-1,3-diyl)dibenzene (389)



To a solution of benzylic alcohol **325** (37.3 mg, 0.100 mmol, 1.0 equiv) in 1,4-dioxane (1.0 mL) was added HCl (250 µL, 4 M in 1,4-dioxane, 1.00 mmol, 10 equiv) at RT and stirred for 2.5 h at RT. The reaction mixture was directly concentrated *in vacuo*, then purified by flash column chromatography (Pentane:Et_2O, 99:1) to afford styrene **389** (6.6 mg, 19 µmol, 19%) as a colourless oil.

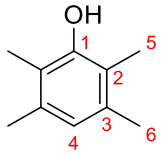
IR (film) ν_{max}/cm^{-1} 3083, 3061, 3026, 3000, 2919, 2851, 1601, 1494, 1453, 1379, 1071, 1029, 744, 728, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 – 7.29 (2H, m, 2 × C14H), 7.26 – 7.20 (5H, m, 2 × C13H, C15H and 2 × C18H), 7.17 – 7.13 (1H, m, C19H), 6.98 – 6.92 (2H, m, 2 × C17H), 6.38 (1H, s, C1H), 3.40 (2H, s, $C11H_2$), 3.04 (2H, s, $C3H_2$), 2.24 (3H, s, $C10H_3$), 2.22 (6H, s, 2 × $C9H_3$), 2.21 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 140.3 (C2), 140.1 (C12), 139.9 (C16), 134.6 (C4), 133.5 (C7), 132.3 (2C, 2 × C6), 131.9 (2C, 2 × C5), 129.42 (2C, 2 × C13H), 129.29 (2C, 2 × C17H), 128.8 (C1H), 128.43 (2C, 2 × C14H), 128.28 (2C, 2 × C18H), 126.2 (C15H), 125.9 (C19H), 42.4 ($C11H_2$), 36.5 ($C3H_2$), 18.0 (2C, 2 × $C8H_3$), 16.84 ($C10H_3$), 16.73 (2C, 2 × $C9H_3$).

HRMS (EI) Found $[M]^+$ = 354.2329; $C_{27}H_{30}$ requires 354.2342, Δ –3.67 ppm.

2,3,5,6-Tetramethylphenol (390), or Durenol (390)



To a vial was added phenol **339** (14.1 mg, 50.0 μmol, 1.0 equiv) and TFA:H_2O (9:1, 1.0 mL, 0.05 M) at RT and stirred for 3 h. The reaction was diluted with H_2O (3 mL) and Et_2O (3 mL) and the layers were separated. The aqueous layer was extracted with Et_2O (3 × 5 mL), the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by preparative TLC (Pentane:Et_2O, 70:30) afforded phenol **390** (3.7 mg, 25 μmol, 49%) as a colourless solid for analysis.

m.p. = 88 – 90 °C.

IR (film) ν_{max}/cm^{-1} 3483, 3015, 2961, 2946, 2921, 2866, 1624, 1568, 1497, 1466, 1442, 1410, 1382, 1304, 1264, 1231, 1213, 1091, 1017, 908, 850, 832, 733.

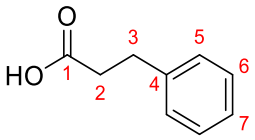
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.60 (1H, s, C4H), 4.60 (1H, s, OH), 2.22 (6H, s, 2 × $C6H_3$), 2.14 (6H, s, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 151.9 (C1), 134.5 (2C, 2 × C3), 123.7 (C4H), 119.1 (2C, 2 × C2), 20.0 (2C, 2 × $C6H_3$), 11.8 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 151.11189; $C_{10}H_{15}O$ requires 151.11174, Δ 1.00 ppm.

The analytical data are identical to those reported in literature.[51]

3-Phenylpropanoic acid (391)



Phenol **339** (28.2 mg, 0.100 mmol, 1.0 equiv), CAN (274 mg, 0.500 mmol, 5.0 equiv) and H_2O (3.5 mL) were subjected to **General Procedure R**. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded carboxylic acid **391** (15.0 mg, 0.100 mmol, 100%) as a colourless oil.

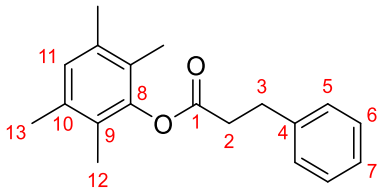
IR (film) ν_{max}/cm^{-1} 3063, 3029, 2931, 2656, 1705, 1605, 1497, 1454, 1412, 1297, 1248, 1215, 1162, 1078, 928, 834, 750, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 11.08 (1H, v. br. s, OH), 7.34 – 7.27 (2H, m, 2 × C6H), 7.26 – 7.19 (3H, m, 2 × C5H and C7H), 3.01 – 2.94 (2H, m, $C3H_2$), 2.73 – 2.67 (2H, m, $C2H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 179.1 (C1=O), 140.3 (C4), 128.7 (2C, 2 × C6H), 128.4 (2C, 2 × C5H), 126.5 (C7H), 35.7 ($C2H_2$), 30.7 ($C3H_2$).

The analytical data were identical to those from a commercial sample (Sigma-Aldrich).

2,3,5,6-Tetramethylphenyl 3-phenylpropanoate (392)



Phenol **339** (56.5 mg, 0.200 mmol, 1.0 equiv), IBr (0.4 mL, 1 M in DCM, 0.400 mmol, 2.0 equiv) and DCM (1.0 mL, 0.2 M) were subjected to a modification of **General Procedure Q** without a nucleophile added, and the reaction worked up after 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 95:5 → 90:10) → 75:25) afforded ester **392** (15.8 mg, 55.9 μmol, 28%) as a colourless solid.

m.p. = 58 – 59 °C.

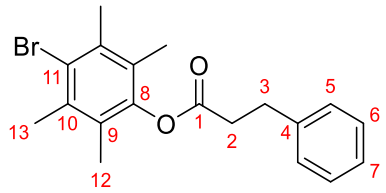
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3027, 2923, 2867, 1753, 1625, 1604, 1567, 1495, 1455, 1419, 1382, 1361, 1291, 1236, 1203, 1187, 1134, 1079, 1029, 1009, 943, 868, 750, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.31 (2H, m, 2 × C6H), 7.31 – 7.28 (2H, m, 2 × C5H), 7.26 – 7.21 (1H, m, C7H), 6.85 (1H, s, C11H), 3.12 (2H, t, J = 7.7 Hz, C3H_2), 3.00 – 2.92 (2H, m, C2H_2), 2.21 (6H, s, 2 × C13H_3), 1.91 (6H, s, 2 × C12H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 171.1 (C1=O), 148.0 (C8), 140.4 (C4), 134.7 (2C, 2 × C10), 129.1 (C11H), 128.70 (2C, 2 × C6H), 128.59 (2C, 2 × C5H), 126.6 (C7H), 125.8 (2C, 2 × C9), 35.7 (C2H_2), 31.1 (C3H_2), 19.8 (2C, 2 × C13H_3), 12.6 (2C, 2 × C12H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 305.15115; $C_{19}H_{22}O_2Na$ requires 305.15120, Δ –0.16 ppm.

4-Bromo-2,3,5,6-tetramethylphenyl 3-phenylpropanoate (393)



In the cleavage of phenol **339** with IBr, ester **393** (25.0 mg, 69.2 μmol, 35%) was also isolated as a colourless solid.

m.p. = 66 – 69 °C.

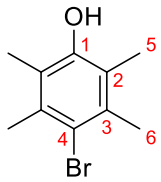
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3028, 2923, 2852, 1754, 1604, 1497, 1454, 1382, 1360, 1292, 1262, 1225, 1198, 1129, 1078, 1017, 946, 927, 870, 803, 772, 742, 698.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.30 (2H, m, 2 × C6H), 7.30 – 7.27 (2H, m, 2 × C5H), 7.26 – 7.21 (1H, m, C7H), 3.12 (2H, t, J = 7.6 Hz, $C3H_2$), 2.97 (2H, t, J = 7.6 Hz, $C2H_2$), 2.39 (6H, s, 2 × $C13H_3$), 1.99 (6H, s, 2 × $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 171.0 (C1=O), 146.9 (C8), 140.2 (C4), 135.1 (2C, 2 × C10), 128.73 (2C, 2 × C6H), 128.59 (2C, 2 × C5H), 127.3 (2C, 2 × C9), 126.6 (C7H), 126.4 (C11), 35.7 ($C2H_2$), 31.0 ($C3H_2$), 21.0 (2C, 2 × $C13H_3$), 14.2 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 383.06168; $C_{19}H_{21}{}^{79}BrO_2Na$ requires 383.06171, Δ –0.10 ppm.

4-Bromo-2,3,5,6-tetramethylphenol (392), or 4-Bromodurenol (394)



In the cleavage of phenol **339** with IBr, phenol **394** (8.8 mg, 69 μmol, 19%) was also isolated as a colourless solid.

m.p. = 99 – 102 °C.

IR (film) ν_{max}/cm^{-1} 3483, 2953, 2918, 2850, 1716, 1638, 1623, 1557, 1455, 1403, 1380, 1283, 1260, 1212, 1083, 1026, 936, 841, 802, 732, 702.

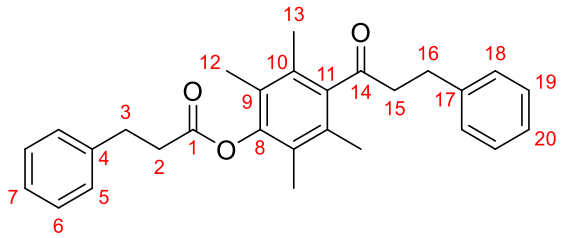
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.60 (1H, s, OH), 2.40 (6H, s, 2 × $C6H_3$), 2.23 (6H, s, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 150.8 (C1), 134.4 (2C, 2 × C3), 120.8 (2C, 2 × C2), 120.2 (C4), 21.0 (2C, 2 × $C6H_3$), 13.5 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 227.00769; $C_{10}H_{12}{}^{79}BrO$ requires 227.00770, Δ –0.05 ppm.

The analytical data are identical to those reported in literature.[51]

2,3,5,6-Tetramethyl-4-(3-phenylpropanoyl)phenyl 3-phenylpropanoate (395)



In the cleavage of phenol **339** with IBr, ester **395** (11.1 mg, 25.8 μmol, 13%) was also isolated as a yellow solid.

m.p. = 73 – 75 °C.

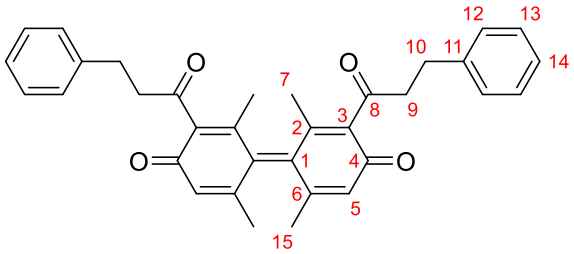
IR (film) ν_{max}/cm^{-1} 3086, 3062, 3028, 2922, 2852, 1753, 1702, 1604, 1573, 1497, 1454, 1402, 1381, 1358, 1316, 1291, 1261, 1216, 1187, 1132, 1114, 1077, 1029, 988, 937, 910, 870, 803, 771, 748, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.30 (2H, m, 2 × C6H), 7.30 – 7.27 (4H, m, 2 × C5H and 2 × C19H), 7.26 – 7.22 (3H, m, C7H and 2 × C18H), 7.22 – 7.17 (1H, m, C20H), 3.11 (2H, t, J = 7.6 Hz, $C3H_2$), 3.08 – 3.03 (2H, m, $C16H_2$), 3.02 – 2.98 (2H, m, $C15H_2$), 2.96 (2H, t, J = 7.6 Hz, $C2H_2$), 1.99 (6H, s, 2 × $C12H_3$), 1.89 (6H, s, 2 × $C13H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.2 (C14=O), 171.0 (C1=O), 148.0 (C8), 141.0 (C17), 140.6 (C11), 140.2 (C4), 129.5 (2C, 2 × C10), 128.73 (2C, 2 × C6H), 128.66 (2C, 2 × C18H), 128.60 (2C, 2 × C19H), 128.58 (2C, 2 × C5H), 126.9 (2C, 2 × C9), 126.6 (C7H), 126.3 (C20H), 47.0 ($C15H_2$), 35.7 ($C2H_2$), 31.0 ($C3H_2$), 29.4 ($C16H_2$), 16.6 (2C, 2 × $C13H_3$), 12.7 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 437.20844; $C_{28}H_{30}O_3Na$ requires 437.20872, Δ –0.64 ppm.

(*Z*)-2,2′,6,6′-tetramethyl-3,3′-bis(3-phenylpropanoyl)-[1,1′-bi(cyclohexylidene)]-2,2′,5,5′-tetraene-4,4′-dione (397)



Phenol **338** (50.9 mg, 0.200 mmol, 1.0 equiv), PIDA (83.8 mg, 0.260 mmol, 1.3 equiv), KOAc (58.9 mg, 0.600 mmol, 3.0 equiv) and HFIP (2.0 mL, 0.1 M) were subjected to **General Procedure S**. Purification by flash column chromatography (Pentane:Et_2O, 95:5) afforded bicyclohexylidene **397** (15.6 mg, 30.9 μmol, 31%) as a yellow oil.

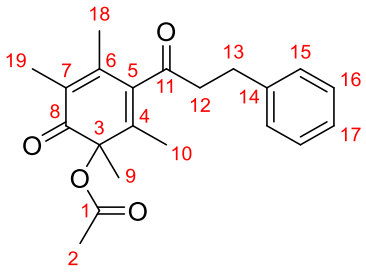
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3028, 2957, 2924, 2853, 1760, 1709, 1651, 1497, 1454, 1380, 1313, 1259, 1230, 1199, 1130, 1110, 1053, 1031, 958, 884.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.24 (4H, m, 4 × C13H), 7.24 – 7.15 (6H, m, 4 × C12H and 2 × C14H), 6.54 (2H, q, J = 1.7 Hz, 2 × C5H), 3.01 (8H, s, 2 × $C9H_2$ and 2 × $C10H_2$), 2.07 (6H, d, J = 1.7 Hz, 2 × $C15H_3$), 1.83 (6H, s, 2 × $C7H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.5, (2C, 2 × C8=O), 187.9 (2C, 2 × C4=O), 185.8 (2C, 2 × C1), 146.3 (2C, 2 × C2), 143.1 (2C, 2 × C6), 141.0 (2C, 2 × C3), 140.5 (2C, 2 × C11), 132.7 (2C, 2 × C5H), 128.7 (4C, 2 × C12H), 128.5 (4C, 4 × C13H), 126.4 (2C, 2 × C14H), 45.8 (2C, 2 × $C9H_2$), 29.2 (2C, 2 × $C10H_2$), 16.2 (2C, 2 × $C15H_3$), 12.7 (2C, 2 × $C3H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 527.21936; $C_{34}H_{32}O_4Na$ requires 527.21928, Δ 0.15 ppm.

1,2,4,5-Tetramethyl-6-oxo-3-(3-phenylpropanoyl)cyclohexa-2,4-dien-1-yl acetate (398)



In the oxidation of phenol **339** with PIDA, cyclohexadienone **398** (18.5 mg, 54.2 μmol, 27%) was also isolated as a yellow oil.

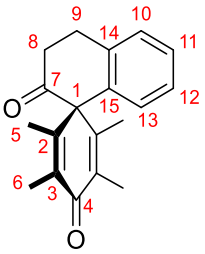
IR (film) ν_{max}/cm^{-1} 3062, 3027, 2954, 2923, 2853, 1740, 1703, 1665, 1577, 1496, 1454, 1370, 1331, 1301, 1246, 1206, 1108, 1072, 1018.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.24 (2H, m, 2 × C16H), 7.24 – 7.16 (3H, m, 2 × C15H and C17H), 3.01 – 2.95 (2H, m, $C13H_2$), 2.95 – 2.82 (2H, m, $C12H_2$), 2.12 (3H, s, $C2H_3$), 1.89 (3H, s, $C19H_3$), 1.79 (3H, s, $C18H_3$), 1.62 (3H, s, $C10H_3$), 1.36 (3H, s, $C9H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.2 (C11=O), 197.8 (C8=O), 169.6 (C1=O), 143.3 (C6), 141.6 (C4), 140.6 (C14), 136.0 (C5), 129.2 (C7), 128.71 (2C, 2 × C15H), 128.63 (2C, 2 × C16H), 126.4 (C17H), 80.7 (C3), 46.4 ($C12H_2$), 29.2 ($C13H_2$), 24.0 ($C9H_3$), 20.6 ($C2H_3$), 17.8 ($C18H_3$), 13.8 ($C10H_3$), 11.2 ($C19H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 363.15656; $C_{21}H_{24}O_4Na$ requires 363.15668, Δ –0.34 ppm.

2,3,5,6-Tetramethyl-3′,4′-dihydro-2′*H*-spiro[cyclohexane-1,1′-naphthalene]-2,5-diene-2′,4-dione (399)



Phenol **339** (56.5 mg, 0.200 mmol, 1.0 equiv), PIDA (83.8 mg, 0.260 mmol, 1.3 equiv), KOAc (58.9 mg, 0.600 mmol, 3.0 equiv) and HFIP (2.0 mL, 0.1 M) were subjected to **General Procedure S**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded spirocycle **399** (35.4 mg, 0.1261 mmol, 63%) as a colourless solid.

m.p. = 124 – 127 °C.

IR (film) ν_{max}/cm^{-1} 3060, 3019, 2953, 2924, 2857, 1718, 1660, 1629, 1486, 1449, 1416, 1385, 1350, 1256, 1223, 1192, 1159, 1118, 1038, 1020, 992, 943.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.23 (2H, m, C10H and C11H), 7.19 – 7.13 (1H, m, C12H), 6.80 – 6.73 (1H, m, C13H), 3.27 (2H, t, J = 7.1 Hz, $C9H_2$), 2.90 (2H, t, J = 7.1 Hz, $C8H_2$), 1.93 (6H, s, 2 × $C6H_3$), 1.62 (6H, s, 2 × $C5H_3$).

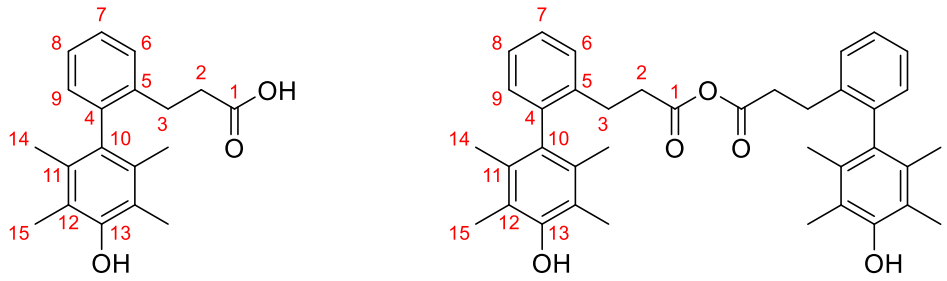
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 208.3 (C7=O), 186.1 (C4=O), 150.0 (2C, 2 × C2), 137.4 (C15), 135.2 (C14), 132.4 (2C, 2 × C3), 129.0 (C11H), 127.88 (C13H), 127.86 (C12H), 127.80 (C10H), 65.6 (C1), 40.3 ($C8H_2$), 28.5 ($C9H_2$), 18.2 (2C, 2 × $C5H_3$), 11.6 (2C, 2 × $C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 281.15369; $C_{19}H_{21}O_2$ requires 281.15361, Δ 0.28 ppm.

Note: An attempted recrystallisation from DCM and subsequent single-crystal X-ray diffraction analysis revealed that the compound had undergone gradual hydrolysis to carboxylic acid **400** as well as the corresponding anhydride **401** (*vide infra*).

3-(4′-Hydroxy-2′,3′,5′,6′-tetramethyl-[1,1′-biphenyl]-2-yl)propanoic acid (400, major), and

3-(4′-Hydroxy-2′,3′,5′,6′-tetramethyl-[1,1′-biphenyl]-2-yl)propanoic anhydride (401, minor)



1.2 : 1

Spirocycle **399** gradually decomposes upon exposure to atmospheric moisture to afford a mixture of carboxylic acid **400** and anhydride **401**.

IR (film) ν_{max}/cm^{-1} 3503 (br.), 3060, 2992, 2924, 2872, 1817, 1709, 1635, 1600, 1576, 1449, 1410, 1382, 1278, 1215, 1161, 1088, 1042, 943, 911, 849, 763, 734.

^{1}H NMR ($CDCl_3$, 500 MHz, carboxylic acid) δ = 10.20 (1H, v. br. s, C1OH), 7.35 – 7.16 (3H, m, C6H, C7H and C8H), 7.03 – 6.93 (1H, m, C9H), 4.66 (1H, s, C13OH), 2.63 – 2.55 (2H, m, $C3H_2$), 2.46 – 2.37 (2H, m, $C2H_2$), 2.19 (6H, s, 2 × $C15H_3$), 1.83 (6H, s, 2 × $C14H_3$).

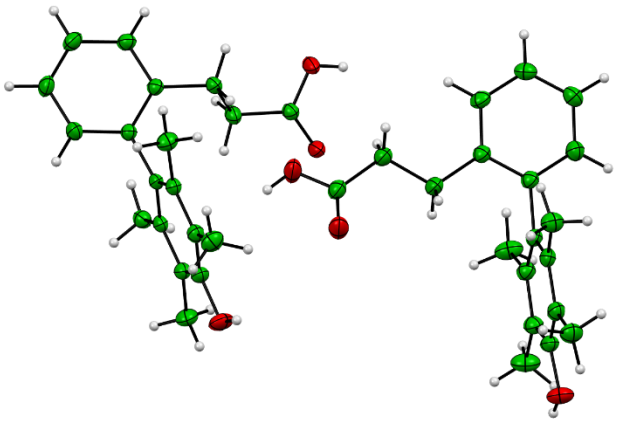
^{13}C NMR ($CDCl_3$, 126 MHz, carboxylic acid) δ = 177.68 (2C, 2 × C1=O), 150.98 (2C, 2 × C13), 142.05 (2C, 2 × C4), 138.5 (2C, 2 × C5), 133.1 (2C, 2 × C10), 132.62 (4C, 4 × C11), 130.65 (2C, 2 × C9H), 128.70 (2C, 2 × C6H), 127.21 (2C, 2 × C7H), 127.0 (2C, 2 × C8H), 119.39 (4C, 4 × C12), 35.4 (2C, 2 × $C2H_2$), 27.7 (2C, 2 × $C3H_2$), 17.73 (4C, 4 × $C14H_3$), 12.46 (4C, 4 × $C15H_3$).

^{1}H NMR ($CDCl_3$, 500 MHz, anhydride) δ = 7.35 – 7.16 (6H, m, 2 × C6H, 2 × C7H and 2 × C9H), 7.03 – 6.93 (2H, m, 2 × C9H), 4.66 (2H, v. br. s, OH), 2.63 – 2.55 (4H, m, 2 × $C3H_2$), 2.46 – 2.37 (4H, m, 2 × $C2H_2$), 2.20 (6H, s, 2 × $C15H_3$), 1.85 (6H, s, 2 × $C14H_3$).

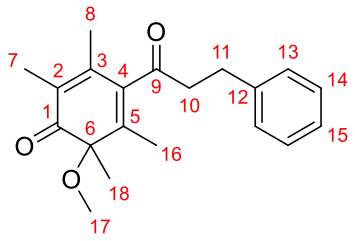
^{13}C NMR ($CDCl_3$, 126 MHz, anhydride) δ = 168.76 (C1=O), 151.06 (C13), 142.04 (C4), 137.9 (C5), 132.9 (C10), 132.53 (2C, 2 × C11), 130.74 (C9H), 128.84 (C6H), 127.28 (C7H), 126.8 (C8H), 119.32 (2C, 2 × C12), 33.9 ($C2H_2$), 28.1 ($C3H_2$), 17.71 (2C, 2 × $C14H_3$), 12.45 (2C, 2 × $C15H_3$).

HRMS (ESI^-) Found $[M–H]^–$ = 297.14957; $C_{19}H_{21}O_3$ requires 297.14962, Δ –0.17 ppm.

Note: The anhydride cannot be detected by ESI due to hydrolysis by the carrier media. The structure of the acid was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule (Z' = 2) is shown below.



6-Methoxy-2,3,5,6-tetramethyl-4-(3-phenylpropanoyl)cyclohexa-2,4-dien-1-one (402)



Phenol **339** (56.5 mg, 0.200 mmol, 1.0 equiv), PIDA (83.8 mg, 0.260 mmol, 1.3 equiv) and HFIP:MeOH (1:1, 2.0 mL, 0.1 M) were subjected to **General Procedure S**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded cyclohexadienone **402** (48.7 mg, 0.1559 mmol, 78%) as a yellow oil.

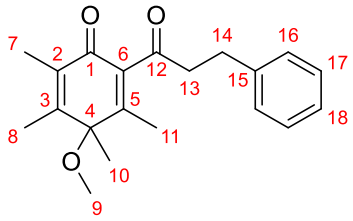
IR (film) ν_{max}/cm^{-1} 3063, 3028, 2954, 2924, 2854, 1737, 1704, 1658, 1604, 1577, 1496, 1454, 1401, 1376, 1360, 1326, 1299, 1260, 1227, 1180, 1157, 1100, 1030, 972.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.27 (2H, m, 2 × C14H), 7.25 – 7.19 (3H, m, 2 × C13H and C15H), 3.05 – 2.99 (2H, m, $C11H_2$), 3.00 (3H, s, $C17H_3$), 2.99 – 2.87 (2H, m, $C10H_2$), 1.88 (3H, s, $C7H_3$), 1.81 (3H, s, $C8H_3$), 1.78 (3H, s, $C16H_3$), 1.30 (3H, s, $C18H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.0 (C9=O), 201.3 (C1=O), 143.48 (C5), 143.43 (C3), 140.5 (C12), 139.1 (C4), 130.0 (C2), 128.74 (2C, 2 × C14H), 128.65 (2C, 2 × C13H), 126.5 (C15H), 81.8 (C6), 54.1 ($C17H_3$), 46.6 ($C10H_2$), 29.3 ($C11H_2$), 26.4 ($C18H_3$), 17.9 ($C8H_3$), 13.9 ($C16H_3$), 11.0 ($C7H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 335.16170; $C_{20}H_{24}O_3Na$ requires 335.16170, Δ –0.19 ppm.

4-Methoxy-2,3,4,5-tetramethyl-6-(3-phenylpropanoyl)cyclohexa-2,5-dien-1-one (403)



Phenol **341** (56.5 mg, 0.200 mmol, 1.0 equiv), PIDA (83.8 mg, 0.260 mmol, 1.3 equiv) and HFIP:MeOH (1:1, 2.0 mL, 0.1 M) were subjected to **General Procedure S**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded cyclohexadienone **403** (46.8 mg, 0.150 mmol, 75%) as a pale yellow oil.

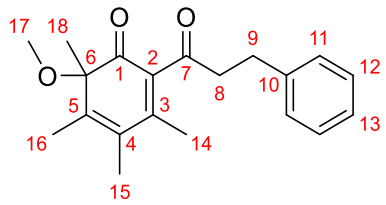
IR (film) ν_{max}/cm^{-1} 3086, 3062, 3027, 2990, 2931, 2825, 1704, 1660, 1628, 1497, 1453, 1380, 1351, 1270, 1219, 1173, 1088, 1048.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.26 (2H, m, 2 × C17H), 7.24 – 7.18 (2H, m, 2 × C16H), 7.21 – 7.13 (1H, m, C18H), 3.05 – 2.89 (4H, m, $C13H_2$ and $C14H_2$), 2.90 (3H, s, $C9H_3$), 1.98 (3H, q, J = 1.0 Hz, $C8H_3$), 1.89 (3H, q, J = 1.0 Hz, $C7H_3$), 1.80 (3H, s, $C11H_3$), 1.34 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.4 (C12=O), 182.6 (C1=O), 156.6 (C5), 155.1 (C3), 141.1 (C15), 140.7 (C6), 133.6 (C2), 128.54 (2C, 2 × C17H), 128.51 (2C, 2 × C16H), 126.2 (C18H), 77.1 (C4), 52.6 ($C9H_3$), 45.7 ($C13H_2$), 29.6 ($C14H_2$), 25.5 ($C10H_3$), 14.6 ($C8H_3$), 14.2 ($C11H_3$), 11.1 ($C7H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 313.17981; $C_{20}H_{25}O_3$ requires 313.17982, Δ –0.04 ppm.

6-Methoxy-3,4,5,6-tetramethyl-2-(3-phenylpropanoyl)cyclohexa-2,4-dien-1-one (404)



In the oxidation of phenol **341** with PIDA, cyclohexadienone **404** (11.0 mg, 35.2 μmol, 18%) was also isolated as a yellow oil.

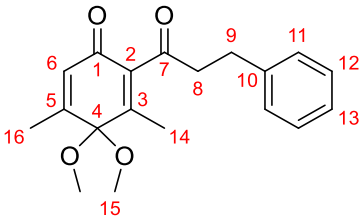
IR (film) ν_{max}/cm^{-1} 3086, 3062, 3027, 2926, 2854, 2827, 1701, 1656, 1633, 1605, 1558, 1497, 1454, 1377, 1357, 1339, 1291, 1227, 1195, 1158, 1100, 1075, 1032.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.23 (2H, m, 2 × C12H), 7.23 – 7.20 (2H, m, 2 × C11H), 7.20 – 7.15 (1H, m, C13H), 3.01 (3H, s, $C17H_3$), 3.00 – 2.97 (4H, m, $C8H_2$ and $C9H_2$), 1.96 (3H, s, $C16H_3$), 1.92 (3H, s, $C15H_3$), 1.91 (3H, s, $C14H_3$), 1.33 (3H, s, $C18H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.4 (C7=O), 200.6 (C3=O), 153.9 (C3), 148.3 (C5), 141.1 (C10), 134.5 (C2), 129.2 (C4), 128.6 (4C, 2 × C11H and 2 × C12H), 126.2 (C13H), 83.1 (C6), 54.2 ($C17H_3$), 46.0 ($C8H_2$), 29.9 ($C9H_2$), 26.2 ($C18H_3$), 18.9 ($C14H_3$), 15.4 ($C15H_3$), 14.3 ($C16H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 335.16189; $C_{20}H_{24}O_3Na$ requires 335.16177, Δ 0.37 ppm.

4,4-Dimethoxy-3,5-dimethyl-2-(3-phenylpropanoyl)cyclohexa-2,5-dien-1-one (405)



Phenol **338** (50.9 mg, 0.200 mmol, 1.0 equiv), PIDA (83.8 mg, 0.260 mmol, 1.3 equiv) and HFIP:MeOH (1:1, 2.0 mL, 0.1 M) were subjected to **General Procedure S**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded cyclohexadienone **405** (26.8 mg, 85.2 μmol, 43%) as a pale yellow oil.

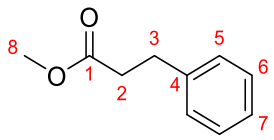
IR (film) ν_{max}/cm^{-1} 3086, 3062, 3027, 2996, 2937, 2850, 2833, 1760, 1704, 1672, 1639, 1605, 1496, 1454, 1439, 1381, 1313, 1244, 1224, 1199, 1141, 1077, 1038.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.24 (2H, m, 2 × C12H), 7.24 – 7.15 (3H, m, 2 × C11H and C13H), 6.33 (1H, q, J = 1.4 Hz, C6H), 3.05 (6H, s, 2 × C15H_3), 3.04 – 2.94 (4H, m, C8H_2 and C9H_2), 1.94 (3H, d, J = 1.4 Hz, C15H_3), 1.76 (3H, s, C14H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.6 (C7=O), 182.5 (C1=O), 155.7 (C5), 152.0 (C3), 143.8 (C2), 140.8 (C10), 131.4 (C6H), 128.60 (2C, 2 × C12H), 128.48 (2C, 2 × C11H), 126.3 (C13H), 97.8 (C4), 51.1 (2C, 2 × C15H_3), 46.1 (C2H_2), 29.5 (C3H_2), 16.6 (C16H_3), 13.1 (C14H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 315.15909; $C_{19}H_{23}O_4$ requires 315.15909, Δ 0.01 ppm.

Methyl 3-phenylpropanoate (406)



Phenol **339** (28.2 mg, 0.100 mmol, 1.0 equiv), CAN (274 mg, 0.500 mmol, 5.0 equiv) and MeOH (3.5 mL) were subjected to **General Procedure R**. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ester **406** (10.1 mg, 61.4 μmol, 61%) as a volatile colourless oil.

IR (film) ν_{max}/cm^{-1} 3087, 3064, 3028, 3002, 2952, 1735, 1604, 1497, 1454, 1436, 1365, 1293, 1255, 1195, 1161, 1079, 1029, 986, 950, 896, 837, 771, 750, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 – 7.26 (2H, m, 2 × C6H), 7.25 – 7.17 (3H, m, 2 × C5H and C7H), 3.68 (3H, s, $C8H_3$), 3.05 – 2.90 (2H, m, $C3H_2$), 2.68 – 2.58 (2H, m, $C2H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.5 (C1=O), 140.6 (C4), 128.6 (2C, 2 × C6H), 128.4 (2C, 2 × C5H), 126.4 (C7H), 51.8 ($C8H_3$), 35.8 ($C2H_2$), 31.1 ($C3H_2$).

The analytical data matches that obtained from a commercial sample (Sigma-Aldrich).

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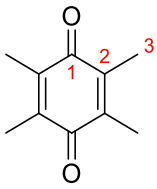
2,3,5,6-Tetramethylcyclohexa-2,5-diene-1,4-dione (405), or Duroquinone (407)



In the oxidative cleavage of phenol **339** with CAN, duroquinone **407** (14.3 mg, 87.2 μmol, 87%) was also isolated as a yellow solid.

m.p. = 102 – 105 °C.

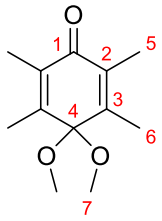
IR (film) ν_{max}/cm^{-1} 2956, 2925, 2855, 1730, 1635, 1444, 1375, 1306, 1260, 1124, 1073, 1029.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.01 (12H, s, 4 × $C3H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 187.6 (2C, 2 × C1=O), 140.5 (4C, 4 × C2), 12.5 (4C, 4 × $C3H_3$).

The analytical data matches that obtained from a commercial sample (Sigma-Aldrich).

4,4-Dimethoxy-2,3,5,6-tetramethylcyclohexa-2,5-dien-1-one (408), or Duroquinone dimethyl acetal (408)



In the oxidative cleavage of phenol **339** with CAN, acetal **408** can sometimes be isolated in varying quantities as a pale yellow solid.

m.p. = 76 – 78 °C.

IR (film) ν_{max}/cm^{-1} 2988, 2932, 2856, 2829, 1733, 1708, 1677, 1638, 1452, 1376, 1341, 1267, 1228, 1189, 1160, 1128, 1070, 1027.

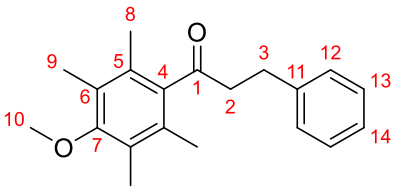
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.94 (6H, s, 2 × $C7H_3$), 1.93 (6H, q, J = 0.9 Hz, 2 × $C6H_3$), 1.87 (6H, q, J = 0.9 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 184.9 (C1=O), 147.8 (2C, 2 × C3), 136.7 (2C, 2 × C2), 98.3 (C4), 50.7 (2C, 2 × $C7H_3$), 13.0 (2C, 2 × $C6H_3$), 11.4 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 233.11470; $C_{12}H_{18}O_3Na$ requires 233.11482, Δ –0.49 ppm.

Note: The acetal is formed in significantly greater quantities if the step involving stirring with water is omitted. The analytical data are identical to those reported in literature.[52]

1-(4-Methoxy-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (410)



Phenol **339** (169 mg, 0.600 mmol, 1.0 equiv), NaH (24.0 mg, 60% dispersion in mineral oil, 0.600 mmol, 1.0 equiv), iodomethane (37 μL, 142 mg, 0.600 mmol, 1.0 equiv) and DMF (3.0 mL, 0.2 M) were subjected to **General Procedure G** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **410** (129 mg, 0.436 mmol, 72%) as a colourless solid.

m.p. = 132 – 134 °C.

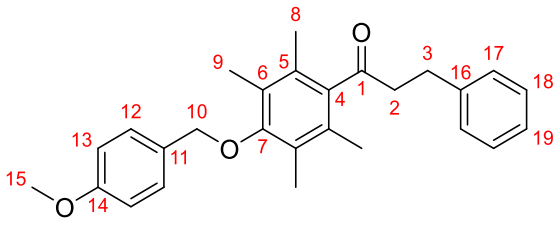
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3027, 2987, 2936, 2828, 1700, 1604, 1573, 1496, 1454, 1402, 1384, 1355, 1310, 1263, 1249, 1189, 1154, 1117, 1094, 1004, 986, 932, 910.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.26 (2H, m, 2 × C13H), 7.26 – 7.22 (2H, m, 2 × C12H), 7.22 – 7.17 (1H, m, C14H), 3.64 (3H, s, C10H_3), 3.10 – 3.03 (2H, m, C3H_2), 3.03 – 2.97 (2H, m, C2H_2), 2.16 (6H, s, 2 × C9H_3), 2.02 (6H, s, 2 × C8H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.7 (C1=O), 156.8 (C7), 141.1 (C11), 138.8 (C4), 129.6 (2C, 2 × C5), 128.63 (2C, 2 × C12H), 128.59 (2C, 2 × C13H), 127.7 (2C, 2 × C6), 126.2 (C14H), 60.2 (C10H_3), 47.1 (C2H_2), 29.5 (C3H_2), 16.6 (2C, 2 × C8H_3), 12.4 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 319.16675; $C_{20}H_{24}O_2Na$ requires 319.16685, Δ –0.32 ppm.

1-(4-((4-Methoxybenzyl)oxy)-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (411)



Phenol **339** (141 mg, 0.500 mmol, 1.0 equiv), NaH (20.0 mg, 60% dispersion in mineral oil, 0.500 mmol, 1.0 equiv), *para*-methoxybenzyl chloride (65 μL, 78 mg, 0.50 mmol, 1.0 equiv) and DMF (2.5 mL, 0.2 M) were subjected to **General Procedure G** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **411** (173 mg, 0.430 mmol, 86%) as a colourless solid.

m.p. = 134 – 135 °C.

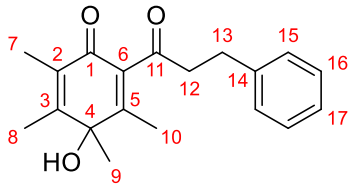
IR (film) ν_{max}/cm^{-1} 3107, 3086, 3064, 3029, 3004, 2956, 2910, 2864, 2838, 1699, 1612, 1585, 1570, 1516, 1497, 1467, 1454, 1407, 1365, 1313, 1302, 1253, 1221, 1176, 1120, 1088, 1029, 997.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 (2H, app. d, J = 8.6 Hz, 2 × C12H), 7.25 – 7.19 (2H, m, 2 × C18H), 7.18 – 7.15 (2H, m, 2 × C17H), 7.15 – 7.08 (1H, m, C19H), 6.86 (2H, app. d, J = 8.6 Hz, 2 × C13H), 4.55 (2H, s, C10H_2), 3.76 (3H, s, C15H_3), 3.04 – 2.97 (2H, m, C3H_2), 2.97 – 2.89 (2H, m, C2H_2), 2.10 (6H, s, 2 × C9H_3), 1.95 (6H, s, 2 × C8H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.8 (C1=O), 159.7 (C14), 155.6 (C7), 141.1 (C16), 138.9 (C6), 129.73 (2C, 2 × C12H), 129.71 (C11), 129.57 (2C, 2 × C5), 128.64 (2C, 2 × C17H), 128.59 (2C, 2 × C18H), 127.9 (2C, 2 × C6), 126.3 (C19H), 114.1 (2C, 2 × C13H), 74.5 (C10H_2), 55.5 (C15H_3), 47.2 (C2H_2), 29.5 (C3H_2), 16.7 (2C, 2 × C8H_3), 12.8 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found [M+Na]$^+$ = 425.20856; $C_{27}H_{30}O_3Na$ requires 425.20872, Δ –0.37 ppm.

4-Hydroxy-2,3,4,5-tetramethyl-6-(3-phenylpropanoyl)cyclohexa-2,5-dien-1-one (412)



Phenol **341** (56.5 mg, 0.200 mmol, 1.0 equiv), CAN (548 mg, 1.00 mmol, 5.0 equiv) and MeOH (7.0 mL) were subjected to **General Procedure R**. Purification by preparative TLC (Pentane:Et_2O, 75:25) afforded cyclohexadienone **412** (11.7 mg, 39.1 μmol, 20%) as a yellow solid.

m.p. = 123 – 125 °C.

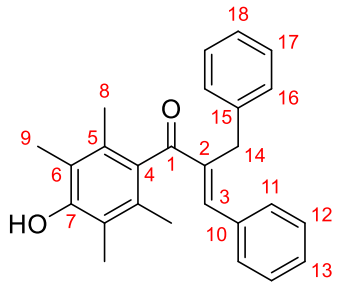
IR (film) ν_{max}/cm^{-1} 3401, 3087, 3062, 3028, 2960, 2923, 2851, 1702, 1659, 1628, 1553, 1529, 1496, 1453, 1369, 1262, 1220, 1088, 1029.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.24 (2H, m, 2 × C16H), 7.24 – 7.19 (2H, m, 2 × C15H), 7.19 – 7.14 (1H, m, C17H), 3.08 – 2.90 (4H, m, $C12H_2$ and $C13H_2$), 2.01 (3H, q, J = 1.0 Hz, $C8H_3$), 1.92 (3H, q, J = 1.0 Hz, $C7H_3$), 1.79 (3H, s, $C10H_3$), 1.59 (1H, s, OH), 1.51 (3H, s, $C9H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 204.5 (C11=O), 182.2 (C1=O), 153.0 (C5), 150.8 (C3), 140.8 (C14), 139.2 (C6), 133.1 (C2), 128.58 (2C, 2 × C16H), 128.53 (2C, 2 × C15H), 126.3 (C17H), 85.5 (C4), 45.4 ($C12H_2$), 29.6 ($C13H_2$), 24.3 ($C9H_3$), 14.3 ($C8H_3$), 13.9 ($C10H_3$), 11.3 ($C7H_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 321.14633; $C_{19}H_{22}O_3Na$ requires 321.14612, Δ 0.67 ppm.

(*E*)-2-Benzyl-1-(4-hydroxy-2,3,5,6-tetramethylphenyl)-3-phenylprop-2-en-1-one (413)



Enone **436** (142 mg, 0.400 mmol, 1.0 equiv), phthaloyl peroxide **S52** (85.3 mg, 0.520 mmol, 1.3 equiv) and HFIP (4.0 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 85:15) afforded phenol **413** (122 mg, 0.329 mmol, 82%) as a colourless solid that gradually turns pale yellow solid on exposure to air.

m.p. = 188 – 190 °C.

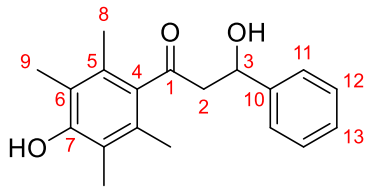
IR (film) ν_{max}/cm^{-1} 3411, 3084, 3060, 3027, 2924, 2870, 1641, 1616, 1574, 1494, 1451, 1383, 1329, 1297, 1205, 1168, 1097, 1030, 1014, 987, 947, 934, 912.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.42 (1H, s, C3H), 7.38 – 7.31 (5H, m, 2 × C11H, 2 × C12H and C13H), 7.30 – 7.26 (4H, m, 2 × C16H and 2 × C17H), 7.24 – 7.18 (1H, m, C18H), 4.83 (1H, s, OH), 4.11 (2H, s, $C14H_2$), 2.15 (6H, s, 2 × $C9H_3$), 2.00 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.7 (C1=O), 151.9 (C7), 146.1 (C3H), 140.9 (C2), 139.4 (C15), 135.5 (C10), 132.7 (C4), 131.1 (2C, 2 × C5), 129.6 (2C, 2 × C11H), 129.4 (C13H), 128.8 (2C, 2 × C12H), 128.58 (2C, 2 × C16H), 128.57 (2C, 2 × C17H), 126.2 (C18H), 119.7 (2C, 2 × C6), 31.8 ($C14H_2$), 17.0 (2C, 2 × $C8H_3$), 11.9 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 371.20050; $C_{26}H_{27}O_2$ requires 371.20056, Δ 0.15 ppm.

3-Hydroxy-1-(4-hydroxy-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (414)



3-Hydroxy-3-phenyl-1-(2,3,5,6-tetramethylphenyl)propan-1-one [*] (141 mg, 0.500 mmol, 1.0 equiv), phthaloyl peroxide **S52** (123 mg, 0.750 mmol, 1.5 equiv) and HFIP (5.0 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 85:15 → 70:30) afforded phenol **414** (89.0 mg, 0.308 mmol, 62%) as a yellow solid.

m.p. = 142 – 144 °C.

IR (film) ν_{max}/cm^{-1} 3422, 3087, 3063, 3031, 2924, 1685, 1623, 1575, 1494, 1454, 1385, 1353, 1332, 1296, 1215, 1122, 1090, 1055, 1029, 1015, 946, 911.

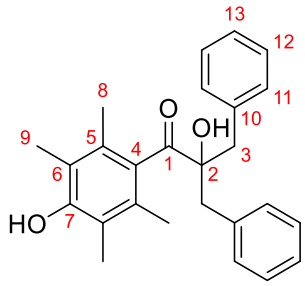
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.45 – 7.38 (2H, m, 2 × C11H), 7.37 – 7.32 (2H, m, 2 × C12H), 7.31 – 7.24 (1H, m, C13H), 5.35 (1H, dd, J = 8.5, 3.6 Hz, C3H), 4.81 (1H, br. s, C7OH), 3.53 (1H, v. br. s, C3HO*H*), 3.12 (1H, dd, J = 18.5, 8.5 Hz, C2H_AH$_B$), 3.05 (1H, dd, J = 18.5, 3.6 Hz, C2H$_A$$H_B$), 2.13 (6H, s, 2 × C9$H_3$), 2.11 (6H, s, 2 × C8$H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 212.2 (C1=O), 152.2 (C7), 142.8 (C10), 135.1 (C4), 129.2 (2C, 2 × C5), 128.7 (2C, 2 × C12H), 127.8 (C13H), 125.9 (2C, 2 × C11H), 120.0 (2C, 2 × C6), 69.9 (C3H), 54.2 (C2H_2), 16.8 (2C, 2 × C8H_3), 11.8 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found [M+Na]$^+$ = 321.14615; $C_{19}H_{22}O_3Na$ requires 321.13612, Δ 0.10 ppm.

[*] The material was provided by Dr. James Frost.

2-Benzyl-2-hydroperoxy-1-(4-hydroxy-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (415)



α-Hydroxyketone **437** (112 mg, 0.300 mmol, 1.0 equiv), phthaloyl peroxide **S52** (64.0 mg, 0.390 mmol, 1.3 equiv) and HFIP (3.0 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O:DCM, 92.5:5:02.5 → 85:10:5 → 70:20:10) afforded phenol **415** (46.0 mg, 0.118 mmol, 40%) as a colourless solid.

m.p. = 214 – 216 °C.

IR (film) ν_{max}/cm^{-1} 3411, 3230, 3085, 3060, 3029, 3005, 2973, 2946, 2923, 1661, 1602, 1570, 1494, 1455, 1433, 1383, 1371, 1321, 1303, 1246, 1192, 1147, 1113, 1101, 1089, 1044, 1030, 921, 907, 862, 775, 760, 736, 721, 699.

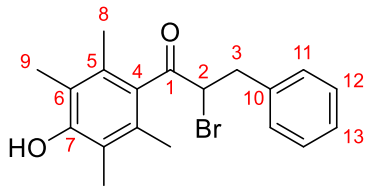
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.21 (10H, m, 4 × C11H, 4 × C12H and 2 × C13H), 4.72 (1H, s, C7OH), 3.32 (2H, d, J = 13.4 Hz, 2 × C3H_AH$_B$), 2.77 (2H, d, J = 13.4 Hz, 2 × C3H$_A$$H_B$), 2.11 (1H, s, C2OH), 2.07 (6H, s, 2 × C9H$_3$), 1.68 (6H, s, 2 × C8H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 213.8 (C1=O), 152.3 (C7), 136.0 (2C, 2 × C10), 131.8 (2C, 2 × C5), 131.5 (4C, 4 × C11H), 131.0 (C4), 128.3 (4C, 4 × C12H), 127.0 (2C, 2 × C13H), 119.9 (2C, 2 × C6), 84.3 (C2), 43.3 (2C, 2 × C3H$_2$), 17.5 (2C, 2 × C8H$_3$), 11.9 (2C, 2 × C9H$_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 411.19296; $C_{26}H_{28}O_3Na$ requires 411.19307, Δ –0.25 ppm.

HRMS (ESI$^-$) Found $[M–H]^-$ = 387.19675; $C_{26}H_{27}O_3$ requires 387.19657, Δ 0.46 ppm.

2-Bromo-1-(4-hydroxy-2,3,5,6-tetramethylphenyl)-3-phenylpropan-1-one (416)



2-Bromo-3-phenyl-1-(2,3,5,6-tetramethylphenyl)propan-1-one [*] (425 mg, 1.23 mmol, 1.0 equiv), phthaloyl peroxide **S52** (303 mg, 1.85 mmol, 1.5 equiv) and HFIP (12 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 90:10) afforded phenol **416** (146 mg, 0.406 mmol, 33%) as a colourless solid.

m.p. = 92 – 94 °C.

IR (film) ν_{max}/cm^{-1} 3511, 3087, 3063, 3029, 3003, 2927, 1691, 1603, 1571, 1496, 1454, 1384, 1349, 1322, 1296, 1217, 1118, 1095, 1030, 1013, 948, 908.

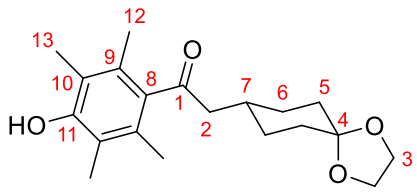
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.34 – 7.24 (5H, m, 2 × C11H, 2 × C12H and C13H), 4.86 (1H, dd, J = 8.3, 6.2 Hz, C2H), 4.82 (1H, br. s, OH), 3.67 (1H, dd, J = 14.4, 6.2 Hz, C3H_AH$_B$), 3.27 (1H, dd, J = 14.4, 8.3 Hz, C3H$_A$$H_B$), 2.13 (6H, s, 2 × C9$H_3$), 2.06 (6H, s, 2 × C8$H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.2 (C1=O), 152.8 (C7), 137.6 (C10), 132.3 (C1), 131.4 (2C, br. s, 2 × C5), 129.8 (2C, 2 × C11H), 128.7 (2C, 2 × C12H), 127.2 (C13H), 120.0 (2C, 2 × C6), 56.0 (C2H), 39.4 (C3H_2), 17.8 (2C, 2 × C8H_3), 11.9 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found [M+Na]$^+$ = 383.06180; $C_{19}H_{21}{}^{79}BrO_2Na$ requires 383.06171, Δ 0.22 ppm.

[*] The material was provided by Dr. James Frost.

1-(4-Hydroxy-2,3,5,6-tetramethylphenyl)-2-(1,4-dioxaspiro[4.5]decan-8-yl)ethan-1-one (417)



Ketone **S35** (316 mg, 1.00 mmol, 1.0 equiv), phthaloyl peroxide **S52** (246 mg, 1.50 mmol, 1.5 equiv) and HFIP (10 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 85:15 → 80:20 → 75:25) afforded phenol **417** (91.3 mg, 0.275 mmol, 28%) as a pale yellow solid.

m.p. = 173 – 175 °C.

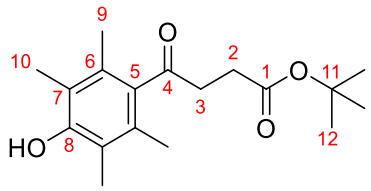
IR (film) ν_{max}/cm^{-1} 3473, 2928, 2883, 1694, 1576, 1446, 1399, 1379, 1355, 1337, 1292, 1216, 1173, 1146, 1105, 1033, 1009, 974, 928.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 4.76 (1H, s, OH), 3.99 – 3.90 (4H, m, 2 × C3H_2), 2.61 (2H, d, J = 6.5 Hz, C2H_2), 2.13 (6H, s, 2 × C13H_3), 2.16 – 2.00 (1H, m, C7H), 1.89 (2H, dq, J = 12.9, 4.4 Hz, 2 × C6H_{ax}*H_{eq}*), 1.76 (2H, dq, J = 14.0, 3.0 Hz, 2 × C5*H_{ax}*H_{eq}), 1.64 (2H, td, J = 13.3, 4.3 Hz, 2 × C5*H_{ax}*H_{eq}), 1.31 (2H, qd, J = 13.1, 3.9 Hz, 2 × C6*H_{ax}*H_{eq}).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.8 (C8=O), 151.9 (C11), 136.0 (C8), 129.0 (2C, 2 × C9), 119.9 (2C, 2 × C10), 108.9 (C4), 64.4 (2C, 2 × C3H_2), 52.3 (C2H_2), 34.5 (2C, 2 × C5H_2), 31.3 (C7H), 30.3 (2C, 2 × C6H_2), 16.6 (2C, 2 × C12H_3), 11.8 (2C, 2 × C13H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 333.20627; $C_{20}H_{29}O_4$ requires 333.20604, Δ 0.70 ppm.

***tert*-Butyl 4-(4-hydroxy-2,3,5,6-tetramethylphenyl)-4-oxobutanoate (418)**



Ester **S41** (145 mg, 0.500 mmol, 1.0 equiv), phthaloyl peroxide (123 mg, 0.750 mmol, 1.5 equiv) and HFIP (5.0 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 87.5:12.5) afforded phenol **418** (72.3 mg, 0.249 mmol, 50%) as a pale yellow solid.

m.p. = 94 – 96 °C.

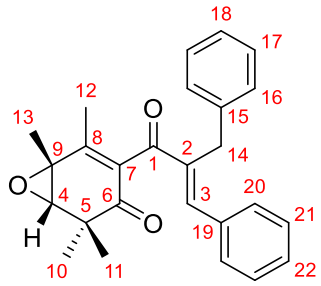
IR (film) ν_{max}/cm^{-1} 3491, 2980, 2929, 1728, 1699, 1577, 1456, 1392, 1366, 1295, 1236, 1153, 1122, 1093, 1032, 1016, 976, 954, 927, 889.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 4.79 (1H, s, OH), 2.96 (2H, t, J = 6.6 Hz, C3H_2), 2.60 (2H, t, J = 6.6 Hz, C2H_2), 2.13 (6H, s, 2 × C10H_3), 2.10 (6H, s, 2 × C9H_3), 1.48 (9H, s, 3 × C12H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.8 (C4=O), 172.1 (C1=O), 152.0 (C8), 135.2 (C5), 129.3 (2C, 2 × C6), 119.9 (2C, 2 × C7), 80.8 (C11), 40.8 (C3H_2), 29.2 (C2H_2), 28.2 (3C, 3 × C12H_3), 16.7 (2C, 2 × C9H_3), 11.8 (2C, 2 × C10H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 329.17227; $C_{18}H_{26}O_4Na$ requires 329.17233, Δ –0.18 ppm.

4-((*E*)-2-Benzyl-3-phenylacryloyl)-2,2,5,6-tetramethyl-7-oxabicyclo[4.1.0]hept-4-en-3-one (421)



In the preparation of phenol **413**, epoxycyclohexenone **422** (5.8 mg, 15 μmol, 3.7%) was also isolated as a yellow solid.

m.p. = 168 – 171 °C.

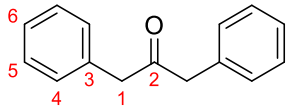
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3027, 2964, 2919, 2850, 1672, 1651, 1620, 1575, 1495, 1451, 1387, 1376, 1312, 1261, 1217, 1166, 1090, 1027, 926.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.50 (1H, s, C3H), 7.39 – 7.35 (2H, m, 2 × C20H), 7.35 – 7.31 (3H, m, 2 × C21H and C22), 7.31 – 7.28 (2H, m, 2 × C17H), 7.28 – 7.24 (2H, m, 2 × C16H), 7.21 – 7.16 (1H, m, C18H), 4.00 (2H, q_{AB}, J_{AB} = 15.5 Hz, Δ_{AB} = 39.2 Hz, $C14H_2$), 3.25 (1H, s, C4H), 1.93 (3H, s, $C12H_3$), 1.58 (3H, s, $C13H_3$), 1.39 (3H, s, $C10H_3$), 1.26 (3H, s, $C11H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 198.5 (C6=O), 198.0 (C1=O), 153.7 (C8), 146.2 (C3), 139.7 (C2), 139.2 (C15), 136.7 (C7), 135.1 (C19), 129.9 (2C, 2 × C20H), 129.6 (C22H), 128.75 (2C, 2 × C21H), 128.66 (2C, 2 × C17H), 128.3 (2C, 2 × C16H), 126.2 (C18H), 68.6 (C4H), 55.7 (C9), 43.8 (C5), 31.7 ($C14H_2$), 24.4 ($C11H_3$), 21.4 ($C10H_3$), 19.4 ($C13H_3$), 18.5 ($C12H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 387.19498; $C_{26}H_{27}O_3$ requires 387.19547, Δ –1.28 ppm.

1,3-Diphenylpropan-2-one (423)



In the preparation of phenol **415**, ketone **423** (15.9 mg, 75.6 μmol, 25%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3086, 3063, 3029, 2956, 2918, 2849, 1715, 1602, 1584, 1496, 1454, 1409, 1331, 1213, 1187, 1156, 1091, 1076, 1056, 1030, 1003, 790, 753, 731, 698.

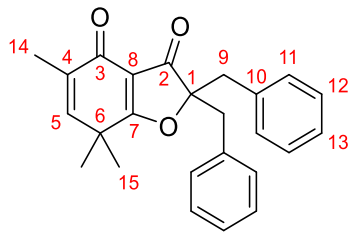
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.36 – 7.29 (4H, m, 4 × C5H), 7.29 – 7.24 (2H, m, 2 × C6H), 7.19 – 7.11 (4H, m, 4 × C4H), 3.73 (4H, s, 2 × C1H_2).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 205.8 (C2), 134.1 (2C, 2 × C3), 129.6 (4C, 4 × C4H), 128.9 (4C, 4 × C5H), 127.2 (2C, 2 × C6H), 49.3 (2C, 2 × C1H_2).

HRMS (ESI^+) Found $[M+H]^+$ = 211.11194; $C_{15}H_{15}O$ requires 211.11174, Δ 0.93 ppm.

The analytical data are identical to those from a commercial sample (Sigma-Aldrich).

2,2-Dibenzyl-5,7,7-trimethylbenzofuran-3,4(2*H*,7*H*)-dione (424)



In the preparation of phenol **413**, cyclohexadienone **424** (8.5 mg, 23 μmol, 7.6%) was also isolated as a colourless solid.

m.p. = 172 – 175 °C.

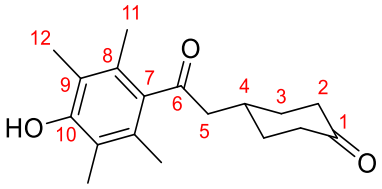
IR (film) ν_{max}/cm^{-1} 3088, 3063, 3031, 2978, 2923, 2854, 1720, 1658, 1635, 1581, 1496, 1475, 1454, 1433, 1387, 1357, 1293, 1255, 1203, 1149, 1080, 1029, 977, 908, 847, 810, 789, 763, 742, 733, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.20 – 7.12 (10H, m, 4 × C11H, 4 × C12H, 2 × C13H), 6.00 (1H, q, J = 1.4 Hz, C5H), 3.36 (2H, d, J = 14.0 Hz, 2 × C9H_AH$_B$), 3.11 (2H, d, J = 14.0 Hz, 2 × C9H$_A$$H_B$), 1.72 (3H, d, J = 1.4 Hz, C14H_3), 0.97 (6H, s, 2 × C15H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.2 (C7), 198.5 (C2=O), 180.4 (C3=O), 145.0 (C5H), 134.0 (C4), 133.5 (2C, 2 × C10), 130.5 (4C, 4 × C11H), 128.3 (4C, 4 × C12H), 127.3 (2C, 2 × C13H), 112.6 (C8), 94.9 (C1), 42.5 (2C, 2 × C9H_2), 37.8 (C6), 25.4 (2C, 2 × C15H_3), 15.3 (C14H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 373.18010; $C_{25}H_{25}O_3$ requires 373.17982, Δ 0.76 ppm.

4-(2-(4-Hydroxy-2,3,5,6-tetramethylphenyl)-2-oxoethyl)cyclohexan-1-one (425)



In the preparation of phenol **417**, phenol **425** (42.6 mg, 0.148 mmol, 15%) was also isolated as a pale yellow solid.

m.p. = 193 – 196 °C.

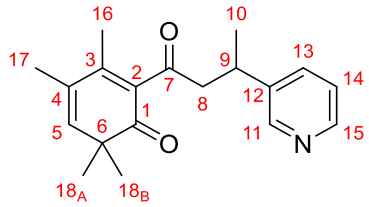
IR (film) ν_{max}/cm^{-1} 3476, 2957, 2929, 2882, 2863, 1702, 1686, 1574, 1450, 1404, 1374, 1355, 1333, 1318, 1294, 1256, 1225, 1180, 1155, 1128, 1105, 1030, 1013.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 4.80 (1H, s, OH), 2.68 (2H, d, J = 6.4 Hz, C5H$_2$), 2.57 – 2.47 (1H, m, C4H), 2.47 – 2.36 (4H, m, 2 × C2H$_2$), 2.22 (2H, dtd, J = 13.4, 6.3, 3.2 Hz, 2 × C3H$_{ax}$*H$_{eq}$*), 2.14 (6H, s, 2 × C12H$_3$), 2.09 (6H, s, 2 × C11H$_3$), 1.48 (2H, dtd, J = 12.7, 12.3, 5.0 Hz, 2 × C3*H$_{ax}$*H$_{eq}$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 211.6 (C1=O), 210.2 (C6=O), 152.0 (C10), 135.6 (C7), 129.0 (2C, 2 × C8), 120.0 (2C, 2 × C9), 51.5 (C5H$_2$), 40.9 (2C, 2 × C2H$_2$), 32.8 (2C, 2 × C3H$_2$), 31.3 (C4H), 16.7 (2C, 2 × C11H$_3$), 11.8 (2C, 2 × C12H$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 289.17999; $C_{18}H_{25}O_3$ requires 289.17982, Δ 0.59 ppm.

3,4,6,6-Tetramethyl-2-(3-(pyridin-3-yl)butanoyl)cyclohexa-2,4-dien-1-one (426)



Ketone **S39** (113 mg, 0.400 mmol, 1.0 equiv), phthaloyl peroxide (85.3 mg, 0.520 mmol, 1.3 equiv) and HFIP (4.0 mL, 0.1 M) were subjected to **General Procedure N**. Purification by flash column chromatography (Pentane:Et_2O, 40:60, then DCM:MeOH flush) followed by preparative TLC (DCM:MeOH, 90:10) afforded cyclohexadienone **426** (4.1 mg, 14 μmol, 3.4%) as a yellow oil.

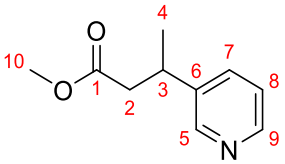
IR (film) ν_{max}/cm^{-1} 3028, 2966, 2928, 2871, 1699, 1656, 1640, 1592, 1573, 1454, 1426, 1376, 1355, 1328, 1280, 1260, 1240, 1228, 1190, 1122, 1105, 1025, 941, 900, 847, 809, 716, 628.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.49 (1H, d, J = 2.1 Hz, C11H), 8.43 (1H, dd, J = 4.7, 1.3 Hz, C15H), 7.57 (1H, dt, J = 7.9, 2.0 Hz, C13H), 7.22 (1H, ddd, J = 7.9, 4.8, 0.8 Hz, C14H), 6.06 (1H, q, J = 1.5 Hz, C5H), 3.42 (1H, sext., J = 7.1 Hz, C9H), 3.04 (1H, dd, J = 17.5, 7.1 Hz, C8H_AH$_B$), 2.96 (1H, dd, J = 17.5, 7.4 Hz, C8H$_A$$H_B$), 1.90 (3H, d, J = 1.5 Hz, C17H_3), 1.74 (3H, s, C16H_3), 1.33 (3H, d, J = 7.0 Hz, C10H_3), 1.20 (3H, s, C18$_A$H$_3$), 1.19 (3H, s, C18$_B$H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.4, (C7=O), 203.4 (C5=O), 153.3 (C3), 149.0 (C11H), 147.7 (C15H), 145.2 (C5H), 141.8 (C12), 134.75 (C13H), 134.74 (C2), 128.4 (C4), 123.6 (C14H), 51.8 (C8H_2), 46.7 (C6), 33.0 (C9H), 25.76 (C18$_B$H$_3$), 25.69 (C18$_A$H$_3$), 22.3 (C10H_3), 19.6 (C17H_3), 17.8 (C16H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 298.18024; $C_{19}H_{24}NO_2$ requires 298.18016, Δ 0.27 ppm.

Methyl 3-(pyridin-3-yl)butanoate (427)



In the oxidation of ketone **S39** with phthaloyl peroxide using **General Procedure N**, ester **427** (2.5 mg, 14 μmol, 3.5%) was also isolated as a yellow oil.

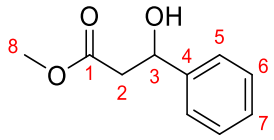
IR (film) ν_{max}/cm^{-1} 3030, 2956, 2919, 2850, 1736, 1591, 1576, 1479, 1457, 1427, 1365, 1287, 1257, 1197, 1167, 1130, 1106, 1074, 1048, 1024, 811, 716, 629.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.51 (1H, dd, J = 2.3, 0.6 Hz, C5H), 8.47 (1H, ddd, J = 4.9, 1.6, 0.4 Hz, C9H), 7.54 (1H, ddd, J = 7.9, 2.3, 1.7 Hz, C7H), 7.24 (1H, ddd, J = 7.9, 4.8, 0.8 Hz, C8H), 3.63 (3H, s, C10H_3), 3.32 (1H, sext., J = 7.2 Hz, C3H), 2.62 (2H, dq$_{AB}$, J = 7.4 Hz, J_{AB} = 15.5 Hz, Δ_{AB} = 11.3 Hz, C2H_2), 1.33 (3H, d, J = 7.0 Hz, C4H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 172.4 (C1=O), 149.0 (C5H), 148.1 (C9H), 140.9 (C6), 134.3 (C7H), 123.6 (C8H), 51.8 (C10H_3), 42.4 (C2H_2), 34.2 (C3H), 21.8 (C4H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 180.10191; $C_{10}H_{14}NO_2$ requires 180.10191, Δ 0.05 ppm.

Methyl 3-hydroxy-3-phenylpropanoate (430)



Phenol **414** (44.8 mg, 0.150 mmol, 1.0 equiv), CAN (411 mg, 0.750 mmol, 5.0 equiv) and MeOH (5.3 mL) were subjected to **General Procedure R**. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 80:20) afforded β-hydroxyester **430** (20.2 mg, 0.112 mmol, 75%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3459, 3087, 3064, 3031, 3005, 2953, 2924, 2852, 1728, 1495, 1453, 1438, 1402, 1360, 1294, 1268, 1199, 1161, 1083, 1060, 1025, 987.

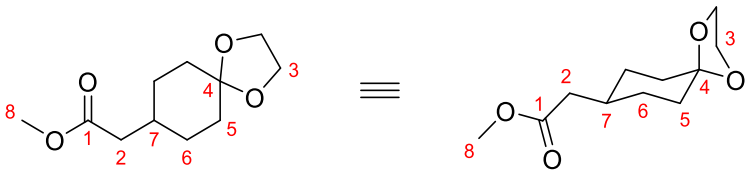
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.41 – 7.33 (4H, m, 2 × C5H and 2 × C6H), 7.32 – 7.27 (1H, m, C7H), 5.14 (1H, dd, J = 8.9, 4.0 Hz, C3H), 3.73 (3H, s, $C8H_3$), 2.92 (1H, v. br. s, OH), 2.78 (1H, dd, J = 16.4, 8.9 Hz, $C2H_AH_B$), 2.72 (1H, dd, J = 16.4, 4.0 Hz, $C2H_AH_B$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 172.9 (C1=O), 142.6 (C4), 128.7 (2C, 2 × C6H), 128.0 (C7H), 125.8 (2C, 2 × C5H), 70.4 (C3H), 52.0 ($C8H_3$), 43.3 ($C2H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 203.06798; $C_{10}H_{12}O_3Na$ requires 203.06787, Δ 0.55 ppm.

The analytical data are identical to those reported in literature.[53]

Methyl 2-(1,4-dioxaspiro[4.5]decan-8-yl)acetate (431)



Phenol **417** (28.8 mg, 0.100 mmol, 1.0 equiv), CAN (274 mg, 0.500 mmol, 5.0 equiv) and MeOH (3.5 mL) were subjected to **General Procedure R**. Purification by flash column chromatography (Pentane:Et_2O, 90:10) afforded ester **431** (9.7 mg, 45 μmol, 45%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 2930, 2883, 1737, 1640, 1438, 1380, 1359, 1338, 1314, 1292, 1240, 1167, 1135, 1106, 1086, 1035, 1016, 979, 949, 931.

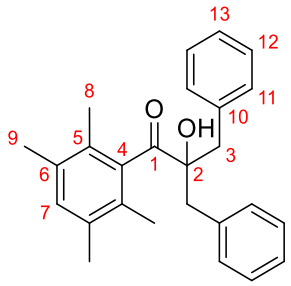
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 3.98 – 3.88 (4H, m, 2 × C3H_2), 3.66 (3H, s, C8H_3), 2.24 (2H, d, J = 7.1 Hz, C2H_2), 1.84 (1H, dddd, J = 18.2, 14.2, 7.0, 3.1 Hz, C7H), 1.78 – 1.69 (4H, m, 2 × C5$H_{ax}$$H_{eq}$ and 2 × C6$H_{ax}$$H_{eq}$), 1.56 (2H, ddd, J = 13.7, 12.9, 4.5 Hz, 2 × C5$H_{ax}$$H_{eq}$), 1.32 (2H, td, J = 12.3, 2.5 Hz, 2 × C6$H_{ax}$$H_{eq}$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 173.5 (C1=O), 108.7 (C4), 64.4 (2C, 2 × C3H_2), 51.6 (C8H_3), 40.9 (C2H_2), 34.4 (2C, 2 × C5H_2), 33.6 (C7H), 30.1 (2C, 2 × C6H_2).

HRMS (ESI^+) Found $[M+H]^+$ = 215.12789; $C_{11}H_{19}O_4$ requires 215.12779, Δ 0.49 ppm.

The analytical data are identical to those reported in literature.[54]

2-Benzyl-2-hydroxy-3-phenyl-1-(2,3,5,6-tetramethylphenyl)propan-1-one (437)



Enone **436** (316 mg, 0.891 mmol, 1.0 equiv), $Pd(OH)_2/C$ (31.6 mg, 10 wt%) and EtOAc (4.5 mL, 0.2 M) were subjected to **General Procedure C** for 4 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded α-hydroxyketone **437** (190 mg, 0.458 mmol, 51%) as a colourless solid.

m.p. = 140 – 142 °C.

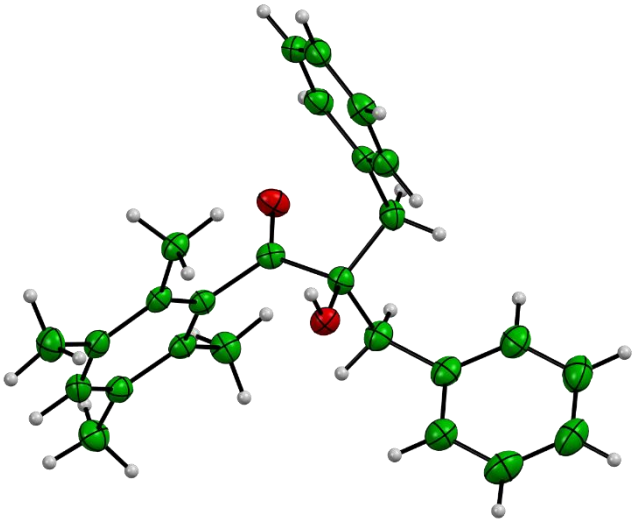
IR (film) ν_{max}/cm^{-1} 3449, 3086, 3063, 3030, 3005, 2928, 2868, 1694, 1604, 1584, 1496, 1466, 1455, 1386, 1374, 1341, 1294, 1233, 1141, 1086, 1032, 1018, 946, 912, 877, 819, 788, 762, 733, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.27 (4H, m, 4 × C11H), 7.27 – 7.23 (4H, m, 4 × C12H), 7.23 – 7.19 (2H, m, 2 × C13H), 7.13 (1H, s, OH), 6.98 (1H, s, C7H), 3.66 (2H, d, J = 14.1 Hz, 2 × C3H_AH$_B$), 2.81 (2H, d, J = 14.1 Hz, 2 × C3H$_A$$H_B$), 2.15 (6H, s, 2 × C9$H_3$), 1.70 (6H, s, 2 × C8$H_3$).

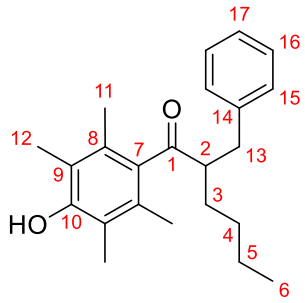
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.9 (C1=O), 140.5 (C4), 135.45 (2C, 2 × C10), 135.39 (2C, 2 × C6), 132.8 (C7H), 131.6 (4C, 4 × C11H), 130.1 (2C, 2 × C5), 128.2 (4C, 4 × C12H), 126.9 (2C, 2 × C13H), 96.1 (C2), 40.4 (2C, 2 × C3H_2), 19.8 (2C, 2 × C9H_3), 16.5 (2C, 2 × C8H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 395.19821; $C_{26}H_{28}O_2Na$ requires 395.19815, Δ 0.15 ppm.

The structure of the product was further confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-Benzyl-1-(4-hydroxy-2,3,5,6-tetramethylphenyl)hexan-1-one (438)



Ketone **339** (84.7 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 90:10 → 85:15) afforded ketone **437** (5.3 mg, 16 μmol, 5.2%) as a colourless solid.

m.p. = 102 – 105 °C.

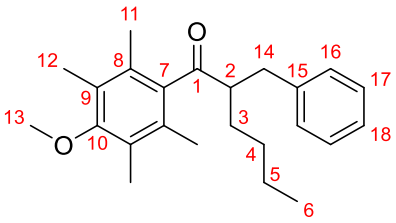
IR (film) ν_{max}/cm^{-1} 3466, 3085, 3062, 3027, 2955, 2928, 2858, 1680, 1603, 1572, 1495, 1455, 1382, 1359, 1295, 1213, 1134, 1108, 1029, 1014, 921.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.21 (2H, m, 2 × C16H), 7.22 – 7.15 (3H, m, 2 × C15H and C17H), 4.73 (1H, s, OH), 3.15 (1H, dd, J = 13.5, 6.5 Hz, C13H_AH$_B$), 3.05 (1H, quint., J = 6.2 Hz, C2H), 2.67 (1H, dd, J = 13.5, 7.2 Hz, C13H$_A$$H_B$), 2.11 (6H, s, 2 × C12$H_3$), 1.96 (6H, br. s, 2 × C11H_3), 1.72 – 1.63 (1H, m, C3H_AH$_B$), 1.41 – 1.28 (3H, m, C3H$_A$$H_B$ and C4H_2), 1.25 – 1.17 (2H, m, C5H_2), 0.82 (3H, t, J = 7.2 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.6 (C1=O), 152.0 (C10), 140.6 (C14), 135.0 (C7), 130.6 (2C, 2 × C8), 129.5 (2C, 2 × C15H), 128.4 (2C, 2 × C16H), 126.2 (C17H), 119.8 (2C, 2 × C9), 56.2 (C2H), 35.7 (C13H_2), 29.7 (C3H_2), 29.5 (C4H_2), 23.0 (C5H_2), 17.3 (2C, 2 × C11H_3), 14.0 (C4H_3), 11.9 (2C, 2 × C12H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 361.21384; $C_{23}H_{30}O_2Na$ requires 361.21380, Δ 0.10 ppm.

2-Benzyl-1-(4-methoxy-2,3,5,6-tetramethylphenyl)hexan-1-one (439)



Ketone **410** (88.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 98:2) afforded ketone **439** (92.7 mg, 0.263 mmol, 88%) as a colourless solid.

m.p. = 75 – 77 °C.

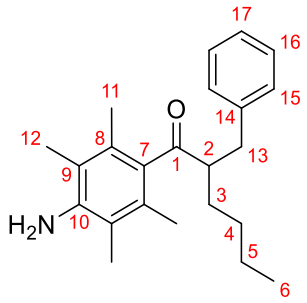
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 2932, 2860, 2828, 1692, 1603, 1568, 1495, 1454, 1382, 1357, 1308, 1261, 1210, 1188, 1131, 1104, 1005, 912.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.30 – 7.22 (2H, m, 2 × C17H), 7.21 – 7.14 (3H, m, 2 × C16H and C18H), 3.65 (3H, s, $C13H_3$), 3.15 (1H, dd, J = 13.4, 6.5 Hz, $C14H_AH_B$), 3.06 (1H, dq, J = 7.1, 5.9 Hz, C2H), 2.69 (1H, dd, J = 13.4, 7.1 Hz, $C14H_AH_B$), 2.15 (6H, s, 2 × $C12H_3$), 1.95 (6H, br. s, 2 × $C11H_3$), 1.76 – 1.65 (1H, m, $C3H_AH_B$), 1.43 – 1.29 (3H, m, $C3H_AH_B$ and $C4H_2$), 1.29 – 1.16 (2H, m, $C5H_2$), 0.82 (3H, t, J = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 212.6 (C1=O), 156.9 (C10), 140.5 (C15), 138.0 (C7), 130.9 (2C, 2 × C8), 129.5 (2C, 2 × C16H), 128.4 (2C, 2 × C17H), 127.6 (2C, 2 × C8), 126.2 (C18H), 60.2 ($C13H_3$), 55.9 (C2H), 35.7 ($C14H_2$), 29.54 ($C3H_2$), 29.52 ($C4H_2$), 22.9 ($C5H_2$), 17.2 (2C, 2 × $C11H_3$), 14.0 ($C6H_3$), 12.4 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 353.24765; $C_{24}H_{33}O_2$ requires 353.24751, Δ 0.41 ppm.

1-(4-Amino-2,3,5,6-tetramethylphenyl)-2-benzylhexan-1-one (440)



Ketone **347** (84.4 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 85:15) afforded ketone **440** (73.0 mg, 0.216 mmol, 72%) as a colourless solid.

m.p. = 75 – 76 °C.

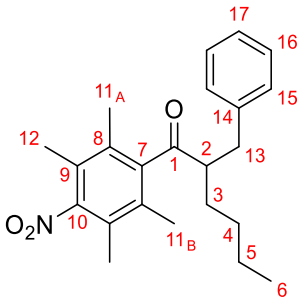
IR (film) ν_{max}/cm^{-1} 3489, 3398, 3085, 3062, 3026, 3001, 2954, 2930, 2870, 2859, 1682, 1626, 1573, 1495, 1454, 1381, 1356, 1319, 1271, 1211, 1180, 1133, 1115, 1030, 1014, 990, 920, 746, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.22 (2H, m, 2 × C16H), 7.22 – 7.18 (2H, m, 2 × C15H), 7.18 – 7.14 (1H, m, C17H), 3.68 (2H, s, NH_2), 3.16 (1H, dd, J = 13.5, 6.4 Hz, C13H_AH$_B$), 3.06 (1H, dq, J = 7.3, 6.0 Hz, C2H), 2.66 (1H, dd, J = 13.5, 7.4 Hz, C13H$_A$$H_B$), 2.05 (6H, s, 2 × C12$H_3$), 1.98 (6H, br. s, 2 × C11H_3), 1.72 – 1.63 (1H, m, C3H_AH$_B$), 1.42 – 1.26 (3H, m, C3H$_A$$H_B$ and C4H_2), 1.26 – 1.14 (2H, m, C5H_2), 0.81 (3H, t, J = 7.2 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.9 (C1=O), 143.1 (C10), 140.7 (C14), 133.3 (C7), 129.9 (2C, 2 × C8), 129.5 (2C, 2 × C15H), 128.3 (2C, 2 × C16H), 126.1 (2C, 2 × C17H), 118.3 (2C, 2 × C9), 56.3 (C2H), 35.8 (C13H_2), 29.8 (C3H_2), 29.5 (C4H_2), 23.0 (C5H_2), 17.7 (2C, 2 × C11H_3), 14.0 (C6H_3), 13.1 (2C, 2 × C12H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 338.24789; $C_{23}H_{32}NO$ requires 338.24784, Δ 0.16 ppm.

2-Benzyl-1-(2,3,5,6-tetramethyl-4-nitrophenyl)hexan-1-one (441)



Ketone **346** (93.4 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 97:3) afforded ketone **441** (22.5 mg, 61.2 μmol, 20%) as a colourless solid.

m.p. = 78 – 80 °C.

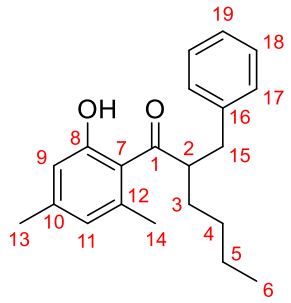
IR (film) ν_{max}/cm^{-1} 3085, 3063, 3027, 2956, 2931, 2871, 2861, 1697, 1604, 1526, 1496, 1455, 1382, 1305, 1269, 1245, 1210, 1181, 1132, 1100, 1022, 989, 914, 811, 744, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.23 (2H, m, 2 × C16H), 7.22 – 7.14 (3H, m, 2 × C15H and C17H), 3.13 (1H, dd, J = 13.5, 7.2 Hz, C13H_AH$_B$), 3.01 (1H, quint., J = 6.6 Hz, C2H), 2.73 (1H, dd, J = 13.5, 6.5 Hz, C13H$_A$$H_B$), 2.09 (9H, br. s, C11$_AH_3$ and 2 × C12H$_3$), 1.82 (3H, v. br. s, C11$_B$H$_3$), 1.74 – 1.64 (1H, m, C3H_AH$_B$), 1.43 – 1.32 (3H, m, C3H$_A$$H_B$ and C4H$_2$), 1.32 – 1.19 (2H, m, C5H$_2$), 0.85 (3H, t, J = 7.2 Hz, C6H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.7 (C1=O), 153.2 (C10), 143.0 (C7), 140.0 (C14), 131.6 (2C, br. s, 2 × C8), 129.5 (2C, 2 × C15H), 128.5 (2C, 2 × C16H), 126.4 (C17H), 125.5 (2C, 2 × C9), 56.1 (C2H), 35.2 (C13H$_2$), 29.58 (C3H$_2$), 29.52 (C4H$_2$), 22.9 (C5H$_2$), 17.1 (2C, br. s, 2 × C11H$_3$), 14.4 (2C, br. s, 2 × C12H$_3$), 14.0 (C6H$_3$).

HRMS (EI$^+$) Found $[M]^+$ = 367.2150; $C_{23}H_{29}NO_3$a requires 367.2142, Δ 2.18 ppm.

2-Benzyl-1-(2-hydroxy-4,6-dimethylphenyl)hexan-1-one (443)



Ketone **338** (76.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10) afforded ketone **443** (85.2 mg, 0.275 mmol, 92%) as a colourless oil.

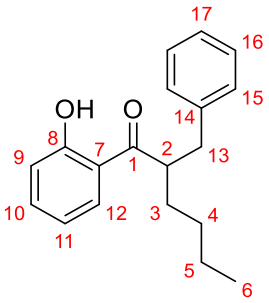
IR (film) ν_{max}/cm^{-1} 3328, 3086, 3062, 3027, 2957, 2928, 2859, 1663, 1615, 1582, 1568, 1496, 1454, 1409, 1377, 1348, 1303, 1275, 1236, 1212, 1194, 1156, 1073, 1055, 1030, 983, 931.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 11.15 (1H, s, OH), 7.18 – 7.12 (2H, m, 2 × C18H), 7.11 – 7.04 (3H, m, 2 × C17H and C19H), 6.53 (1H, s, C11H), 6.39 (1H, s, C9H), 3.62 (1H, qd, J = 7.2, 5.8 Hz, 2 × C2H), 3.05 (1H, dd, J = 13.6, 7.4 Hz, C15H_AH$_B$), 2.68 (1H, dd, J = 13.6, 6.7 Hz, C15H$_A$$H_B$), 2.32 (3H, s, C14$H_3$), 2.17 (3H, s, C13$H_3$), 1.70 – 1.60 (1H, m, C3H_AH$_B$), 1.45 – 1.37 (1H, m, C3H$_A$$H_B$), 1.21 – 1.09 (4H, m, C4H_2 and C5H_2), 0.73 (3H, t, J = 7.0 Hz, C6H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.5 (C1=O), 161.4 (C8), 145.2 (C10), 139.8 (C16), 137.9 (C8), 129.2 (2C, 2 × C17H), 128.5 (2C, 2 × C18H), 126.4 (C19H), 124.7 (C11H), 121.0 (C7), 116.3 (C9), 52.5 (C2H_2), 38.2 (C15H_2), 32.9 (C3H_2), 29.5 (C4H_2), 23.6 (C14H_3), 23.0 (C5H_2), 21.6 (C13H_3), 14.0 (C6H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 311.20062; $C_{21}H_{27}O_2$ requires 311.20056, Δ 0.21 ppm.

2-Benzyl-1-(2-hydroxyphenyl)hexan-1-one (444)



1-(2-Hydroxyphenyl)-3-phenylpropan-1-one **454** (67.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **444** (22.5 mg, 79.7 μmol, 27%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3085, 3062, 3028, 2957, 2927, 2858, 1633, 1610, 1581, 1486, 1445, 1382, 1350, 1282, 1240, 1215, 1199, 1156, 1116, 1075, 1033, 975, 949, 860, 826, 750, 699, 657.

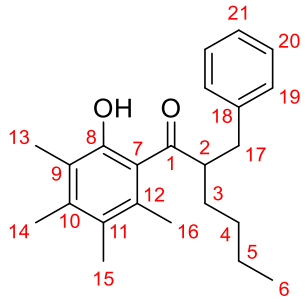
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 12.61 (1H, s, OH), 7.69 (1H, dd, J = 8.1, 1.6 Hz, C12H), 7.44 (1H, ddd, J = 8.6, 7.2, 1.6 Hz, C10H), 7.27 – 7.20 (2H, m, 2 × C16H), 7.19 – 7.12 (3H, m, 2 × C15H and C17H), 6.97 (1H, dd, J = 8.4, 1.2 Hz, C9H), 6.84 (1H, ddd, J = 8.2, 7.2, 1.2 Hz, C11H), 3.75 (1H, tt, J = 7.7, 5.8 Hz, C2H), 3.11 (1H, dd, J = 13.7, 7.7 Hz, C13H_AH$_B$), 2.81 (1H, dd, J = 13.7, 6.4 Hz, C13H$_A$$H_B$), 1.83 (1H, dddd, J = 13.2, 10.5, 7.8, 5.4 Hz, C3H_AH$_B$), 1.58 (1H, dddd, J = 13.3, 10.2, 5.8, 5.2 Hz, C3H$_A$$H_B$), 1.34 – 1.20 (4H, m, $C4H_2$ and $C5H_2$), 0.85 (3H, t, J = 7.0 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.1 (C1=O), 163.1 (C8), 139.6 (C14), 136.5 (C10H), 129.9 (C12H), 129.1 (2C, 2 × C15H), 128.6 (2C, 2 × C16H), 126.4 (C17H), 119.7 (C7), 118.93 (C11H), 118.75 (C9H), 47.6 (C2H), 38.4 ($C13H_2$), 32.4 ($C3H_2$), 29.6 ($C4H_2$), 22.9 ($C5H_2$), 14.0 ($C6H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 305.15082; $C_{20}H_{23}O$ requires 305.15120, Δ –1.26 ppm.

Note: A very broad and weak signal was observed in the IR spectrum between 3400 and 2500 cm^{-1}.

2-Benzyl-1-(2-hydroxy-3,4,5,6-tetramethylphenyl)hexan-1-one (445)



Ketone **341** (84.7 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2) afforded ketone **445** (32.2 mg, 95.1 μmol, 32%) as a yellow solid.

m.p. = 67 – 69 °C.

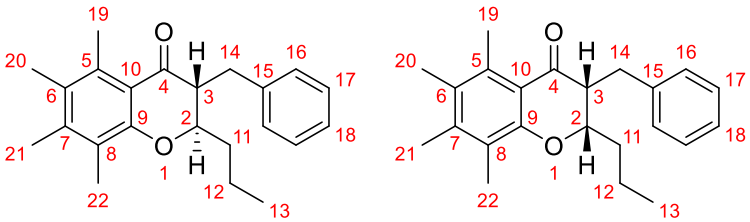
IR (film) ν_{max}/cm^{-1} 3307, 3085, 3062, 3027, 3003, 2956, 2928, 2859, 1622, 1601, 1495, 1454, 1401, 1380, 1334, 1296, 1261, 1211, 1181, 1126, 1112, 1070, 1030, 920.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 9.66 (1H, s, OH), 7.25 – 7.20 (2H, m, 2 × C20H), 7.19 – 7.12 (3H, m, 2 × C19H and C21H), 3.50 (1H, qd, *J* = 7.2, 5.8 Hz, C2H), 3.09 (1H, dd, *J* = 13.6, 7.1 Hz, C17H_AH$_B$), 2.76 (1H, dd, *J* = 13.6, 7.1 Hz, C17H$_A$$H_B$), 2.20 (3H, s, $C14H_3$), 2.16 (3H, s, $C13H_3$), 2.16 (3H, s, $C16H_3$), 2.09 (3H, s, $C15H_3$), 1.66 (1H, dddd, *J* = 13.2, 10.1, 7.5, 5.4 Hz, C3H_AH$_B$), 1.45 (1H, ddt, *J* = 13.6, 10.2, 5.7 Hz, C3H$_A$$H_B$), 1.25 – 1.12 (4H, m, $C4H_2$ and $C5H_2$), 0.79 (3H, t, *J* = 7.0 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 214.0 (C1=O), 153.6 (C8), 141.5 (C10), 139.9 (C18), 131.7 (C12), 129.3 (2C, 2 × C19H), 128.4 (2C, 2 × C20H), 127.2 (C11), 126.3 (C21H), 123.5 (C7), 121.9 (C9), 54.1 (C2H), 38.2 ($C17H_2$), 33.0 ($C3H_2$), 29.5 ($C4H_2$), 22.9 ($C5H_2$), 20.5 ($C16H_3$), 17.1 ($C14H_3$), 15.6 ($C15H_3$), 13.9 ($C6H_3$), 12.2 ($C13H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 361.21368; $C_{23}H_{30}O_2Na$ requires 361.21380, Δ –0.32 ppm.

***anti*-3-Benzyl-5,6,7,8-tetramethyl-2-propylchroman-4-one (*anti*-446), and *syn*-3-Benzyl-5,6,7,8-tetramethyl-2-propylchroman-4-one (*syn*-446)**



In the preparation of ketone **445**, chromanone **446** (47.5 mg, 0.141 mmol, 47%, *anti*:*syn* = 2.7:1) was also isolated as a pale yellow solid.

m.p. = 80 – 83 °C.

IR (film) ν_{max}/cm^{-1} 3085, 3062, 3027, 3004, 2957, 2932, 2872, 1673, 1582, 1495, 1440, 1379, 1353, 1287, 1260, 1154, 1120, 1091, 1031, 973, 942, 915.

^{1}H NMR ($CDCl_3$, 500 MHz, *anti* isomer) δ = 7.33 – 7.27 (2H, m, 2 × C17H), 7.24 – 7.19 (3H, m, 2 × C16H and C18H), 4.26 (1H, ddd, J = 9.8, 4.7, 3.3 Hz, C2H), 3.02 (2H, d, J = 7.1 Hz, $C14H_2$), 2.66 (1H, td, J = 7.1, 4.7 Hz, C3H), 2.58 (3H, s, $C19H_3$), 2.27 (3H, s, $C21H_3$), 2.21 (3H, s, $C22H_3$), 2.20 (3H, s, $C20H_3$), 1.81 – 1.70 (1H, m, $C11H_AH_B$), 1.50 – 1.33 (3H, m, $C11H_AH_B$ and $C12H_2$), 0.85 (3H, t, J = 7.2 Hz, $C13H_3$).

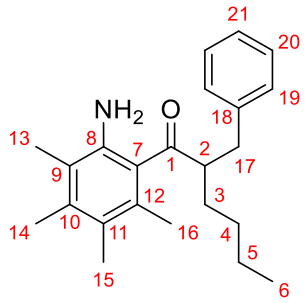
^{1}H NMR ($CDCl_3$, 500 MHz, *syn* isomer) δ = 7.28 – 7.24 (2H, m, 2 × C17H), 7.22 – 7.18 (1H, m, C18H), 7.14 – 7.11 (2H, m, 2 × C16H), 4.41 (1H, dt, J = 10.0, 3.5 Hz, C2H), 3.10 (1H, dd, J = 13.8, 7.8 Hz, $C14H_AH_B$), 3.03 (1H, dd, J = 7.5, 3.5 Hz, C3H), 2.80 (1H, dd, J = 13.8, 7.0 Hz, $C14H_AH_B$), 2.50 (1H, s, $C19H_3$), 2.27 (3H, s, $C21H_3$), 2.20 (3H, s, $C22H_3$), 2.19 (3H, s, $C20H_3$), 1.91 – 1.83 (1H, m, $C11H_AH_B$), 1.59 – 1.51 (2H, m, $C11H_AH_B$ and $C12H_AH_B$), 1.44 – 1.35 (1H, m, $C12H_AH_B$), 0.94 (3H, t, J = 7.2 Hz, $C13H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, *anti* isomer) δ = 197.2 (C4=O), 156.1 (C9), 143.4 (C7), 138.9 (C15), 136.2 (C5), 129.4 (2C, 2 × C16H), 128.79 (C6), 128.59 (2C, 2 × C17H), 126.50 (C18H), 122.6 (C8), 117.54 (C10), 78.1 (C2H), 54.2 (C3H), 35.0 ($C14H_2$), 34.3 ($C11H_2$), 19.07 ($C12H_2$), 17.62 ($C19H_3$), 17.59 ($C21H_3$), 15.84 ($C20H_3$), 13.81 ($C13H_3$), 12.27 ($C22H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, *syn* isomer) δ = 197.5 (C4=O), 156.6 (C9), 143.0 (C7), 139.3 (C15), 135.9 (C5), 129.0 (2C, 2 × C16H), 128.61 (C6), 128.55 (2C, 2 × C17H), 126.38 (C18H), 122.3 (C8), 117.44 (C10), 78.7 (C2H), 53.0 (C3H), 31.5 ($C11H_2$), 30.9 ($C14H_2$), 19.20 ($C12H_2$), 17.55 ($C19H_3$), 17.34 ($C21H_3$), 15.87 ($C20H_3$), 13.92 ($C13H_3$), 12.25 ($C22H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 359.19831; $C_{23}H_{28}O_2Na$ requires 359.19815, Δ 0.44 ppm.

1-(2-Amino-3,4,5,6-tetramethylphenyl)-2-benzylhexan-1-one (447)



Ketone **353** (84.4 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98.5:1.5 → 98:2 → 97.5:2.5) afforded ketone **447** (35.3 mg, 1.05 mmol, 35%) as a yellow solid.

m.p. = 68 – 70 °C.

IR (film) ν_{max}/cm^{-1} 3480, 3390, 3085, 3062, 3026, 2954, 2927, 2858, 1677, 1605, 1581, 1495, 1454, 1441, 1379, 1319, 1265, 1211, 1181, 1109, 1058, 1030, 915, 847, 803, 774, 744, 732, 700.

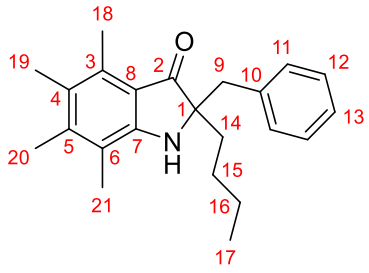
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.28 – 7.23 (2H, m, 2 × C20H), 7.23 – 7.20 (2H, m, 2 × C19H), 7.20 – 7.14 (1H, m, C21H), 3.76 (2H, br. s, NH_2), 3.29 (1H, quint., J = 6.5 Hz, C2H), 3.18 (1H, dd, J = 13.5, 7.2 Hz, C17H_AH$_B$), 2.70 (1H, dd, J = 13.5, 6.7 Hz, C17H$_A$$H_B$), 2.20 (3H, s, $C14H_3$), 2.09 (3H, s, $C15H_3$), 2.05 (3H, s, $C13H_3$), 1.97 (3H, s, $C16H_3$), 1.74 – 1.65 (1H, m, C3H_AH$_B$), 1.46 – 1.36 (1H, m, C3H$_A$$H_B$), 1.36 – 1.28 (2H, m, $C4H_2$), 1.26 – 1.17 (2H, m, $C5H_2$), 0.82 (3H, t, J = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 212.9 (C1=O), 140.6 (C18), 139.8 (C8), 137.1 (C10), 130.2 (C12), 129.6 (2C, 2 × C19H), 128.4 (2C, 2 × C20H), 126.2 (C21H), 125.7 (C7), 125.4 (C11), 119.2 (C9), 55.6 (C2H), 36.4 ($C17H_2$), 31.1 ($C3H_2$), 29.5 ($C4H_2$), 22.9 ($C5H_2$), 18.7 ($C16H_3$), 17.1 ($C14H_3$), 15.6 ($C15H_3$), 14.0 ($C6H_3$), 13.6 ($C13H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 50.8 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 338.2484; $C_{23}H_{32}NO$ requires 338.2484, Δ 0.00 ppm.

2-Benzyl-2-butyl-4,5,6,7-tetramethylindolin-3-one (448)



In the preparation of ketone **447**, indolinone **448** (16.5 mg, 49.2 μmol, 16%) was also isolated as a yellow solid.

m.p. = 108 – 111 °C.

IR (film) ν_{max}/cm^{-1} 3370, 3084, 3062, 3028, 2955, 2928, 2870, 2859, 1662, 1598, 1494, 1454, 1373, 1272, 1240, 1162, 1118, 1083, 1029, 978, 910, 866, 802, 781, 770, 732, 701.

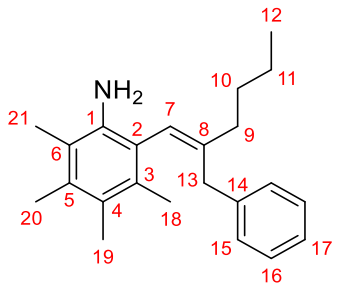
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.29 – 7.25 (2H, m, 2 × C12H), 7.24 – 7.20 (1H, m, C13H), 7.21 – 7.17 (2H, m, 2 × C11H), 4.09 (1H, s, NH), 2.89 (1H, d, J = 13.3 Hz, C9H_AH_B), 2.74 (1H, d, J = 13.3 Hz, C9H_AH_B), 2.58 (3H, s, $C18H_3$), 2.23 (3H, s, $C20H_3$), 2.12 (3H, s, $C19H_3$), 2.08 (3H, s, $C21H_3$), 1.87 (1H, ddd, J = 13.5, 11.3, 5.5 Hz, C14H_AH_B), 1.50 (1H, ddd, J = 13.5, 11.5, 5.0 Hz, C14H_AH_B), 1.24 – 1.10 (2H, m, $C15H_2$), 1.09 – 0.96 (2H, m, $C16H_2$), 0.77 (3H, t, J = 7.3 Hz, $C17H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 205.8 (C1=O), 158.4 (C7), 144.4 (C5), 137.0 (C10), 134.2 (C3), 130.5 (2C, 2 × C11H), 128.3 (2C, 2 × C12H), 126.8 (C13H), 126.4 (C4), 117.0 (C8), 116.1 (C6), 69.6 (C1), 43.7 ($C9H_2$), 36.1 ($C14H_2$), 25.4 ($C15H_2$), 23.2 ($C16H_2$), 17.3 ($C20H_3$), 14.9 ($C19H_3$), 14.3 ($C18H_3$), 14.1 ($C17H_3$), 12.6 ($C21H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 79.9 (C1N).

HRMS (ESI^+) Found $[M+H]^+$ = 336.2328; $C_{23}H_{30}NO$ requires 336.2327, Δ 0.30 ppm.

(*Z*)-2-(2-Benzylhex-1-en-1-yl)-3,4,5,6-tetramethylaniline (449)



In the preparation of ketone **447**, styrene **449** (4.5 mg, 14 μmol, 4.7%) was also isolated as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3465, 3382, 3083, 3061, 3026, 2955, 2926, 2870, 2856, 1734, 1673, 1603, 1494, 1454, 1378, 1321, 1261, 1156, 1074, 1030, 947, 870, 804, 728, 700.

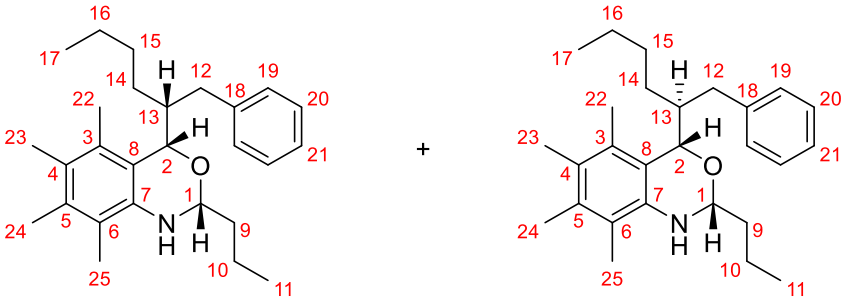
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.23 – 7.18 (2H, m, 2 × C16H), 7.16 – 7.10 (1H, m, C17H), 7.06 – 6.99 (2H, m, 2 × C15H), 6.13 (1H, s, C7H), 3.70 (2H, v. br. s, NH_2), 3.22 (2H, q_{AB}, J_{AB} = 14.4 Hz, Δ_{AB} = 19.2 Hz, $C13H_2$), 2.24 (3H, s, $C20H_3$), 2.19 (3H, s, $C18H_3$), 2.17 (3H, s, $C19H_3$), 2.14 (3H, s, $C21H_3$), 2.13 – 2.07 (2H, m, $C9H_2$), 1.55 – 1.47 (2H, m, $C10H_2$), 1.34 (2H, sext., J = 7.3 Hz, $C11H_2$), 0.91 (3H, t, J = 7.3 Hz, $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 144.7 (C8), 140.1 (C14), 139.8 (C1), 133.7 (C5), 132.4 (C3), 129.1 (2C, 2 × C15H), 128.2 (2C, 2 × C16H), 125.9 (C17H), 125.0 (C4), 122.8 (C7H), 121.6 (C2), 118.2 (C6), 37.3 ($C13H_2$), 35.3 ($C9H_2$), 30.6 ($C10H_2$), 22.8 ($C11H_2$), 17.9 ($C18H_3$), 16.8 ($C20H_3$), 16.3 ($C19H_3$), 14.2 ($C12H_3$), 14.0 ($C21H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 322.2537; $C_{23}H_{32}N$ requires 322.2535, Δ 0.62 ppm.

Note: This compound displays axial chirality, as indicated by the diastereotopic nature of $C13H_2$ which appears as an AB quartet.

***rel*-(2*R*,4*S*)-5,6,7,8-Tetramethyl-4-((*R*)-1-phenylhexan-2-yl)-2-propyl-1,4-dihydro-2*H*-benzo[*d*][1,3]oxazine (450), and *rel*-(2*R*,4*S*)-5,6,7,8-Tetramethyl-4-((*S*)-1-phenylhexan-2-yl)-2-propyl-1,4-dihydro-2*H*-benzo[*d*][1,3]oxazine (450)**



In the preparation of ketone **447**, benzooxazine **450** (7.2 mg, 18 μmol, 6.1%) was also isolated as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3340, 3084, 3061, 3025, 2956, 2927, 2871, 2858, 1718, 1653, 1603, 1583, 1495, 1455, 1378, 1312, 1261, 1154, 1088, 1066, 1029, 1017, 909, 844, 803, 743, 700.

^{1}H NMR ($CDCl_3$, 500 MHz, isomer A) δ = 7.34 – 7.27 (4H, m, 2 × C19H and 2 × C20H), 7.24 – 7.17 (1H, m, C21H), 4.90 (1H, d, J = 1.8 Hz, C2H), 4.20 (1H, dd, J = 6.5, 4.7 Hz, C1H), 3.45 (1H, v. br. s, NH), 2.84 (1H, dd, J = 13.2, 4.6 Hz, C12H_AH$_B$), 2.76 (1H, dd, J = 13.2, 10.6 Hz, C12H$_A$$H_B$), 2.17 (3H, s, C24H$_3$), 2.08 (3H, s, C25H$_3$), 2.06 (3H, s, C23H$_3$), 1.96 – 1.88 (1H, m, C13H), 1.79 – 1.67 (2H, m, C9H$_2$), 1.73 (3H, s, C22H$_3$), 1.61 – 1.52 (2H, m, C10H$_2$), 1.20 – 1.14 (2H, m, C14H_AH$_B$ and C15H_AH$_B$), 1.16 – 1.07 (1H, m, C16H_AH$_B$), 1.04 – 0.97 (1H, m, C16H$_A$$H_B$), 1.02 (3H, t, J = 7.4 Hz, C11H$_3$), 0.99 – 0.90 (2H, m, C14H$_A$$H_B$ and C15H$_A$$H_B$), 0.69 (3H, t, J = 7.1 Hz, C17H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, isomer A) δ = 142.0 (C18), 140.68 (C7), 132.7 (C5), 129.54 (2C, 2 × C19H), 129.41 (C3), 128.24 (2C, 2 × C20H), 128.0 (C4), 125.8 (C21H), 124.02 (C8), 122.0 (C6), 81.95 (C1H), 74.6 (C2H), 44.6 (C13H), 37.9 (C12H$_2$), 37.43 (C9H$_2$), 30.0 (C15H$_2$), 27.7 (C14H$_2$), 22.7 (C16H$_2$), 18.46 (C10H$_2$), 16.58 (C24H$_3$), 16.4 (C22H$_3$), 15.74 (C23H$_3$), 14.2 (C11H$_3$), 14.0 (C17H$_3$), 12.8 (C25H$_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, isomer A) δ = 76.3 (NH).

^{1}H NMR ($CDCl_3$, 500 MHz, isomer B) δ = 7.14 – 7.07 (2H, m, 2 × C20H), 7.07 – 7.01 (1H, m, C21H), 6.82 – 6.78 (2H, m, 2 × C19H), 5.35 (1H, d, J = 2.0 Hz, C2H), 4.32 (1H, dd, J = 6.0, 5.2 Hz, C1H), 3.45 (1H, v. br. s, NH), 2.27 – 2.21 (2H, m, C12H$_2$), 2.19 (3H, s, C24H$_3$), 2.14 (3H, s, C23H$_3$), 2.13 (3H, s, C22H$_3$), 2.08 (3H, s, C25H$_3$), 2.04 – 1.98 (1H, m, C3H), 1.83 – 1.70 (2H, m, C9H$_2$), 1.69 – 1.60 (1H, m, C14H_AH$_B$), 1.66 – 1.54 (2H, m, C10H$_2$), 1.57 – 1.47 (1H, m, C15H_AH$_B$), 1.39 – 1.31 (1H, m, C14H$_A$$H_B$), 1.32 – 1.20 (3H, m, C15H$_A$$H_B$ and C16H$_2$), 1.01 (3H, t, J = 7.4 Hz, C11H$_3$), 0.86 (3H, t, J = 7.2 Hz, C17H$_3$).

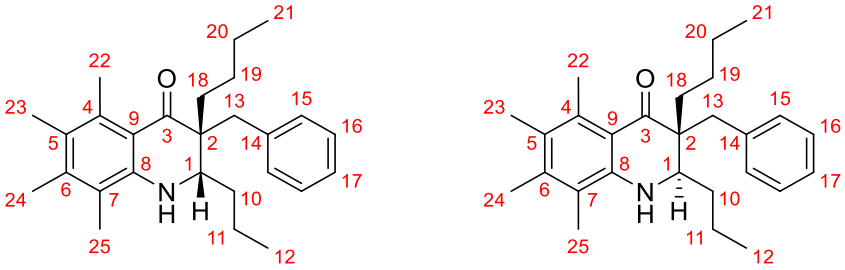
^{13}C NMR ($CDCl_3$, 126 MHz, isomer B) δ = 142.8 (C18), 140.75 (C7), 133.0 (C5), 129.2 (C3H), 129.0 (2C, 2 × C19H), 128.18 (C4), 127.8 (2C, 2 × C20H), 125.1 (C21H), 124.05 (C8), 121.7 (C6), 82.06 (C1H), 75.7 (C2H), 45.2 (C13H), 37.38 ($C9H_2$), 35.5 ($C12H_2$), 31.0 ($C14H_2$), 29.8 ($C15H_2$), 23.3 ($C16H_2$), 18.36 ($C10H_2$), 16.9 ($C23H_3$), 16.60 ($C24H_3$), 15.82 ($C22H_3$), 15.74 ($C11H_3$ and $C17H_3$), 12.8 ($C25H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, isomer B) δ = 76.3 (NH).

HRMS (ESI^+) Found $[M+H]^+$ = 394.31064; $C_{27}H_{40}NO$ requires 394.31044, Δ 0.50 ppm.

Note: The d.r. is 1.1:1, but it is not possible to distinguish between either diastereomers.

***rel*-(2*S*,3*R*)-3-Benzyl-3-butyl-5,6,7,8-tetramethyl-2-propyl-2,3-dihydroquinolin-4(1*H*)-one (451, major), and *rel*-(2*R*,3*R*)-3-Benzyl-3-butyl-5,6,7,8-tetramethyl-2-propyl-2,3-dihydroquinolin-4(1*H*)-one (451, minor)**



In the preparation of ketone **447**, quinolinone **451** (3.6 mg, 9.5 μmol, 3.2%, *syn*:*anti* = 1.5:1) was also isolated as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 3433, 3085, 3061, 3028, 2956, 2928, 2871, 2859, 1666, 1581, 1495, 1455, 1410, 1379, 1349, 1304, 1248, 1180, 1141, 1095, 1076, 1031, 913, 861, 801, 727, 701.

^{1}H NMR ($CDCl_3$, 500 MHz, *syn* isomer) δ = 7.23 – 7.16 (2H, m, 2 × C16H), 7.19 – 7.13 (1H, m, C17H), 7.00 – 6.95 (2H, m, 2 × C15H), 4.20 (1H, br. s), 3.43 (1H, dd, J = 10.5, 2.5 Hz, C1H), 3.22 (1H, d, J = 13.9 Hz, C13H_AH$_B$), 2.64 (1H, d, J = 14.0 Hz, C13H$_A$$H_B$), 2.46 (3H, s, $C22H_3$), 2.27 (3H, s, $C24H_3$), 2.19 (3H, s, $C23H_3$), 2.09 (3H, s, $C25H_3$), 1.79 (1H, td, J = 13.6, 3.7 Hz, C18H_AH$_B$), 1.76 – 1.64 (2H, m, $C10H_2$), 1.61 – 1.53 (1H, m, C11H_AH$_B$), 1.58 – 1.49 (1H, m, C18H$_A$$H_B$), 1.43 – 1.33 (1H, m, C11H$_A$$H_B$), 1.39 – 1.30 (1H, m, C19H_AH$_B$), 1.34 – 1.18 (2H, m, $C20H_2$), 1.09 – 1.00 (1H, m, C19H$_A$$H_B$), 1.02 (3H, t, J = 7.3 Hz, $C12H_3$), 0.83 (3H, t, J = 7.3 Hz, $C21H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, *syn* isomer) δ = 199.7 (C3=O), 146.0 (C8), 140.7 (C6), 138.16 (C14), 136.7 (C4), 130.6 (2C, 2 × C15H), 127.9 (2C, 2 × C16H), 126.22 (C17H), 125.6 (C5), 117.39 (C7), 116.68 (C9), 57.2 (C1H), 51.9 (C2), 35.7 (br. s, $C13H_2$), 31.3 ($C18H_2$), 30.4 ($C10H_2$), 26.2 ($C19H_2$), 23.70 ($C20H_2$), 20.28 ($C11H_2$), 18.07 ($C22H_3$), 17.86 ($C24H_3$), 16.10 ($C23H_3$), 14.28 ($C21H_3$), 14.21 ($C12H_3$), 13.15 ($C25H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, *syn* isomer) δ = 68.9 (NH).

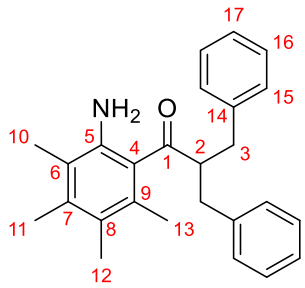
^{1}H NMR ($CDCl_3$, 500 MHz, *anti* isomer) δ = 7.19 – 7.13 (3H, m, 2 × C16H and C17H), 7.00 – 6.95 (2H, m, 2 × C15H), 4.27 (1H, v. br. s, NH), 3.34 (1H, dd, J = 7.4, 5.6 Hz, C1H), 3.20 (1H, d, J = 14.0 Hz, C13H_AH$_B$), 3.10 (1H, d, J = 13.9 Hz, C13H$_A$$H_B$), 2.50 (3H, s, $C22H_3$), 2.26 (3H, s, $C24H_3$), 2.19 (3H, s, $C23H_3$), 2.09 (3H, s, $C25H_3$), 1.66 – 1.58 (1H, m, C18H_AH$_B$), 1.51 – 1.42 (3H, m, $C10H_2$ and C18H$_A$$H_B$), 1.41 – 1.34 (2H, m, C11H_AH$_B$ and C19H_AH$_B$), 1.34 – 1.15 (4H, m, C11H$_A$$H_B$, C19H$_A$$H_B$ and $C20H_2$), 0.92 (3H, t, J = 7.3 Hz, $C21H_3$), 0.90 (3H, t, J = 7.2 Hz, $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz, *anti* isomer) δ = 200.6 (C3=O), 145.5 (C8), 141.0 (C6), 138.33 (C14), 136.5 (C4), 130.3 (2C, 2 × C15H), 128.1 (2C, 2 × C16H), 126.28 (C17H), 125.4 (C5), 117.31 (C7), 116.65 (C9), 58.2 (C1H), 52.5 (C2), 39.0 ($C13H_2$), 30.2 ($C10H_2$), 28.8 (br. s, $C18H_2$), 25.4 ($C19H_2$), 23.58 ($C20H_2$), 20.31 ($C11H_2$), 18.09 ($C22H_3$), 17.87 ($C24H_3$), 16.06 ($C23H_3$), 14.24 ($C21H_3$), 14.0 ($C12H_3$), 13.14 ($C25H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz, *anti* isomer) δ = 66.6 (NH).

HRMS (ESI^+) Found $[M+H]^+$ = 392.2958; $C_{27}H_{38}NO$ requires 392.2953, Δ 1.27 ppm.

1-(2-Amino-3,4,5,6-tetramethylphenyl)-2-benzyl-3-phenylpropan-1-one (452)



Ketone **353** (84.4 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 97:3) afforded ketone **452** (60.2 mg, 0.162 mmol, 54%) as a colourless solid.

m.p. = 139 – 141 °C.

IR (film) ν_{max}/cm^{-1} 3478, 3389, 3084, 3061, 3026, 2922, 2868, 1679, 1604, 1581, 1495, 1453, 1440, 1383, 1357, 1321, 1272, 1204, 1178, 1117, 1082, 1064, 1047, 1030, 1003, 915, 848, 777, 735, 699.

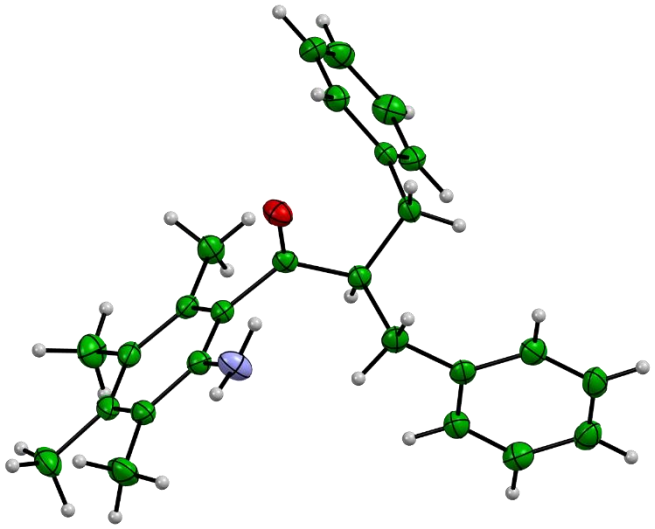
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.25 – 7.19 (4H, m, 4 × C16H), 7.18 – 7.13 (2H, m, 2 × C17H), 7.13 – 7.08 (4H, m, 4 × C15H), 3.63 (1H, quint., J = 7.0 Hz, C2H), 3.58 (2H, br. s, NH_2), 3.15 (2H, dd, J = 13.6, 7.1 Hz, 2 × C3$H_A$$H_B$), 2.57 (2H, dd, J = 13.6, 6.9 Hz, 2 × C3$H_A$$H_B$), 2.18 (3H, s, C11$H_3$), 2.04 (2H, s, C12$H_3$), 2.01 (3H, s, C10$H_3$), 1.78 (3H, s, C13$H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.6 (C1=O), 140.0 (2C, 2 × C14), 139.7 (C5), 137.4 (C7), 130.4 (C9), 129.5 (4C, 4 × C15H), 128.4 (4C, 4 × C16H), 126.3 (2C, 2 × C17H), 125.5 (C8), 125.2 (C4), 119.2 (C6), 57.9 (C2), 36.7 (2C, 2 × C3H_2), 18.4 (C13H_3), 17.1 (C11H_3), 15.6 (C12H_3), 13.5 (C10H_3).

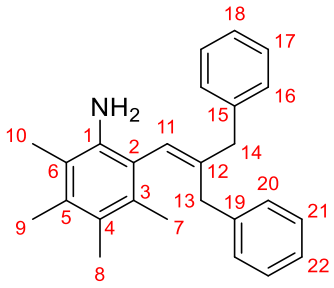
^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 51.2 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 372.23251; $C_{26}H_{30}NO$ requires 372.23219, Δ 0.87 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2-(2-Benzyl-3-phenylprop-1-en-1-yl)-3,4,5,6-tetramethylaniline (453)



In the preparation of ketone **452**, styrene **453** (17.3 mg, 48.7 μmol, 16%) was also isolated as a pale yellow oil after a subsequent purification by preparative TLC (Pentane:Et_2O, 90:10).

m.p. = 113 – 116 °C.

IR (film) ν_{max}/cm^{-1} 3465, 3379, 3083, 3060, 3025, 2918, 1602, 1584, 1493, 1452, 1433, 1379, 1322, 1281, 1155, 1100, 1074, 1030, 1002, 955, 909, 878, 843, 811, 747, 730, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 – 7.30 (2H, m, 2 × C17H), 7.29 – 7.22 (5H, m, 2 × C16H, C18H and 2 × C21H), 7.21 – 7.13 (1H, m, C22H), 7.06 – 6.97 (2H, m, 2 × C20H), 6.26 (1H, s, C11H), 3.59 (2H, br. s, NH_2), 3.41 (2H, q_{AB}, J_{AB} = 14.5 Hz, Δ_{AB} = 13.1 Hz, $C14H_2$), 3.15 (2H, q_{AB}, J_{AB} = 14.3 Hz, Δ_{AB} = 29.2 Hz, $C13H_2$), 2.25 (3H, s, $C9H_3$), 2.22 (3H, s, $C7H_3$), 2.19 (3H, s, $C8H_3$), 2.14 (3H, s, $C10H_3$).

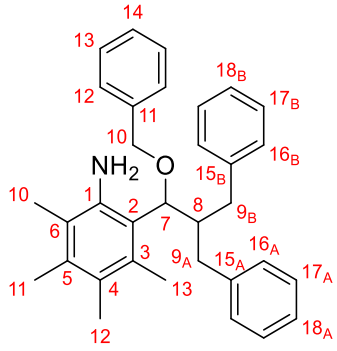
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 144.0 (C12), 140.1 (C15), 139.80 (C1), 139.71 (C19), 133.9 (C5), 132.4 (C3), 129.33 (2C, 2 × C20H), 129.19 (2C, 2 × C16H), 128.6 (2C, 2 × C17H), 128.4 (2C, 2 × C21H), 126.4 (C18H), 126.0 (C22H), 125.06 (C11H), 125.95 (C4), 121.1 (C2), 118.2 (C6), 42.4 ($C14H_2$), 36.7 ($C13H_2$), 17.9 ($C7H_3$), 16.8 ($C9H_3$), 16.2 ($C8H_3$), 14.0 ($C10H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 52.7 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 356.23715; $C_{26}H_{30}N$ requires 356.23728, Δ –0.35 ppm.

Note: This compound displays axial chirality, as indicated by the diastereotopic nature of $C13H_2$ and $C14H_2$, both of which appear as an AB quartet.

2-(2-Benzyl-1-(benzyloxy)-3-phenylpropyl)-3,4,5,6-tetramethylaniline (454)



In the preparation of ketone **452**, aniline **454** (9.5 mg, 21 μmol, 6.8%) was also isolated as a pale yellow oil after a subsequent purification by preparative TLC (Pentane:Et_2O, 90:10).

IR (film) ν_{max}/cm^{-1} 3474, 3372, 3084, 3061, 3026, 3002, 2925, 2859, 1730, 1603, 1582, 1495, 1453, 1386, 1312, 1282, 1258, 1209, 1155, 1096, 1063, 1028, 910, 850, 794, 748, 734, 699.

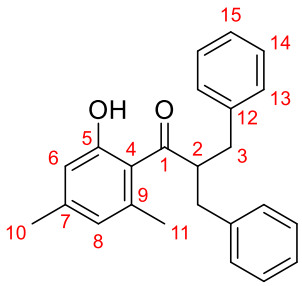
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.41 – 7.35 (4H, m, 2 × C12H and 2 × C13H), 7.35 – 7.31 (1H, m, C14H), 7.26 – 7.21 (2H, m, $C17_AH$), 7.19 – 7.16 (1H, m, $C18_AH$), 7.16 – 7.11 (4H, m, 2 × $C16_AH$ and 2 × $C17_BH$), 7.10 – 7.06 (1H, m, $C18_BH$), 6.93 – 6.88 (2H, m, 2 × $C16_BH$), 4.84 (1H, d, J = 6.2 Hz, C7H), 4.63 (2H, v. br. s, NH_2), 4.53 (1H, d, J = 11.5 Hz, C10H_AH_B), 4.27 (1H, d, J = 11.5 Hz, C10H_AH_B), 3.10 – 3.00 (1H, m, C9$_A$$H_AH_B$), 2.91 – 2.79 (2H, m, C8H and C9$_A$H$_A$$H_B$), 2.49 – 2.37 (2H, m, $C9_BH_2$), 2.21 (3H, s, $C11H_3$), 2.13 (3H, s, $C12H_3$), 2.05 (3H, s, $C10H_3$), 1.86 (3H, s, $C13H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 142.5 (C1), 141.3 ($C15_B$), 141.0 ($C15_A$), 138.7 (C11), 134.5 (C5), 133.0 (C3), 129.8 (2C, 2 × $C16_AH$), 129.1 (2C, 2 × $C16_BH$), 128.5 (2C, 2 × C13H), 128.17 (2C, 2 × $C17_AH$), 128.09 (2C, 2 × C12H), 128.03 (2C, 2 × $C17_BH$), 127.7 (C14H), 125.7 ($C18_AH$), 125.5 ($C18_BH$), 124.4 (C4), 119.2 (C4), 118.2 (C2), 80.8 (C7H), 70.6 ($C10H_2$), 45.7 (C8H), 36.2 ($C9_AH_2$), 36.0 ($C9_BH_2$), 17.3 ($C11H_3$), 16.6 ($C12H_3$), 16.0 ($C13H_3$), 13.5 ($C10H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 52.3 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 464.29510; $C_{33}H_{38}NO$ requires 464.29479, Δ 0.68 ppm.

2-Benzyl-1-(2-hydroxy-4,6-dimethylphenyl)-3-phenylpropan-1-one (457)



Ketone **338** (76.3 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1 → 98:2 → 95:5) afforded ketone **457** (21.7 mg, 62.9 μmol, 21%) as a colourless oil.

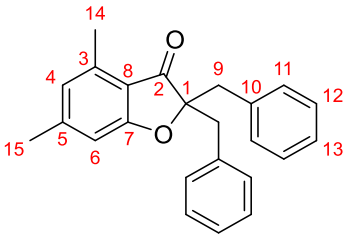
IR (film) ν_{max}/cm^{-1} 3350, 3085, 3062, 3027, 2962, 2922, 2856, 1660, 1615, 1582, 1567, 1496, 1453, 1408, 1349, 1301, 1261, 1238, 1204, 1155, 1080, 1056, 1029, 933.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 11.16 (1H, s, OH), 7.24 – 7.19 (4H, m, 4 × C14H), 7.18 – 7.13 (2H, m, 2 × C13H), 7.13 – 7.07 (4H, m, 4 × C15H), 6.54 (1H, s, C6H), 6.38 (1H, s, C8H), 4.06 (1H, tt, J = 7.8, 6.4 Hz, C2H), 3.12 (2H, dd, J = 13.6, 7.7 Hz, 2 × C3$H_A$$H_B$), 2.76 (2H, dd, J = 13.6, 6.4 Hz, 2 × C3$H_A$$H_B$), 2.24 (3H, s, C11$H_3$), 2.20 (3H, s, C10$H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.4 (C1=O), 161.4 (C5), 145.3 (C7), 139.3 (2C, 2 × C12), 137.8 (C9), 129.1 (4C, 4 × C13H), 128.5 (4C, 4 × C14H), 126.5 (2C, 2 × C15H), 124.6 (C8H), 120.8 (C4), 116.2 (C6H), 54.5 (C2H), 38.6 (2C, 2 × C3H_2), 23.5 (C11H_3), 21.6 (C10H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 345.18500; $C_{24}H_{25}O_2$ requires 345.18491, Δ 0.26 ppm.

2,2-Dibenzyl-4,6-dimethylbenzofuran-3(2*H*)-one (458)



In the preparation of ketone **456**, benzofuranone **458** (57.7 mg, 0.169 mmol, 56%) was also isolated as a colourless solid.

m.p. = 118 – 120 °C.

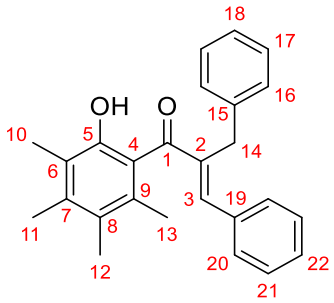
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3030, 2950, 2920, 2854, 1702, 1613, 1598, 1495, 1455, 1407, 1378, 1332, 1303, 1264, 1191, 1146, 1135, 1084, 1070, 1023, 962, 921.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.21 – 7.17 (4H, m, 4 × C11H), 7.17 – 7.12 (4H, m, 4 × C12H), 7.12 – 7.08 (2H, m, 2 × C13H), 6.52 (1H, s, C6H), 6.35 (1H, s, C4H), 3.10 (4H, q_{AB}, J_{AB} = 13.9 Hz, Δ_{AB} = 38.3 Hz, 2 × $C2H_2$), 2.34 (3H, s, $C14H_3$), 2.22 (3H, s, $C15H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.1 (C2=O), 172.6 (C7), 149.0 (C5), 138.7 (C3), 135.0 (2C, 2 × C10), 130.5 (4C, 4 × C11H), 128.0 (4C, 4 × C12H), 126.8 (2C, 2 × C13H), 124.2 (C4H), 117.5 (C8), 110.1 (C6H), 92.1 (C1), 42.0 (2C, 2 × $C9H_2$), 22.4 ($C15H_3$), 17.6 ($C14H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 343.16980; $C_{24}H_{23}O_2$ requires 343.16926, Δ 1.58 ppm.

(*E*)-2-Benzyl-1-(2-hydroxy-3,4,5,6-tetramethylphenyl)-3-phenylprop-2-en-1-one (459)



In the preparation of benzofuranone **460**, enone **459** (5.4 mg, 1.5 μmol, 4.9%) was also isolated as a pale yellow oil.

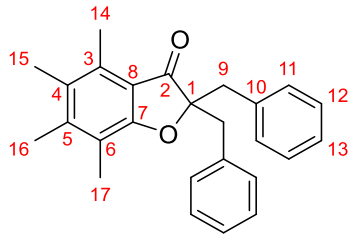
IR (film) ν_{max}/cm^{-1} 3390, 3084, 3061, 3026, 3001, 2924, 2870, 1611, 1495, 1450, 1383, 1309, 1280, 1261, 1205, 1166, 1078, 1048, 1030, 1011, 947, 915.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.65 (1H, s, OH), 7.39 – 7.32 (5H, m, 2 × C16H, 2 × C20H and C22H), 7.31 (1H, s, C3H), 7.29 – 7.25 (4H, m, 2 × C17H and 2 × C21H), 7.23 – 7.17 (1H, m, C18H), 4.10 (2H, s, $C14H_2$), 2.25 (3H, s, $C11H_3$), 2.21 (3H, s, $C10H_3$), 2.13 (3H, s, $C12H_3$), 2.08 (3H, s, $C13H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.3 (C1=O), 152.3 (C5), 143.9 (C3H), 141.9 (C2), 140.1 (C7), 139.1 (C15), 135.6 (C19), 132.3 (C9), 129.4 (2C, 2 × C20H), 129.1 (C22H), 128.80 (2C, 2 × C16H), 128.75 (2C, 2 × C21H), 128.67 (2C, 2 × C17H), 127.3 (C8), 126.3 (C18H), 122.3 (C4), 121.8 (C6), 32.6 ($C14H_2$), 20.2 ($C13H_3$), 17.0 ($C11H_3$), 15.6 ($C12H_3$), 12.3 ($C10H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 371.20078; $C_{26}H_{27}O_2$ requires 371.20056, Δ 0.59 ppm.

2,2-Dibenzyl-4,5,6,7-tetramethylbenzofuran-3(2*H*)-one (460)



Ketone **341** (84.7 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded benzofuranone **460** (106 mg, 0.286 mmol, 95%) as a colourless solid.

m.p. = 143 – 145 °C.

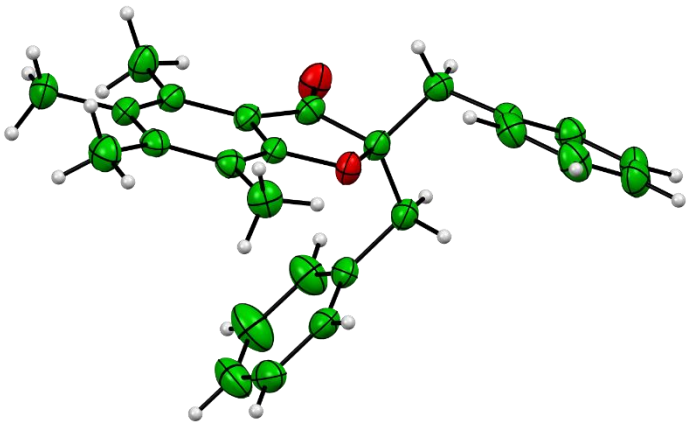
IR (film) ν_{max}/cm^{-1} 3086, 3062, 3030, 3005, 2920, 2873, 1698, 1595, 1495, 1454, 1399, 1381, 1336, 1282, 1231, 1183, 1104, 1080, 1017.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.23 – 7.17 (4H, m, 4 × C11H), 7.17 – 7.12 (4H, m, 4 × C12H), 7.12 – 7.06 (2H, m, 2 × C13H), 3.08 (4H, q_{AB}, J_{AB} = 13.8 Hz, Δ_{AB} = 24.7 Hz, 2 × $C9H_2$), 2.38 (3H, s, $C14H_3$), 2.18 (3H, s, $C17H_3$), 2.13 (3H, s, $C16H_3$), 1.99 (3H, s, $C15H_3$).

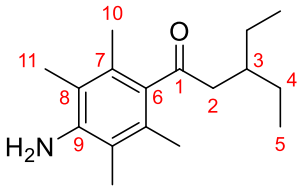
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 204.3 (C2=O), 168.8 (C7), 145.8 (C5), 135.3 (2C, 2 × C10), 133.2 (C3), 130.5 (4C, 4 × C11H), 128.4 (C4), 127.9 (4C, 4 × C12H), 126.6 (2C, 2 × C13H), 117.6 (C6), 116.7 (C8), 91.1 (C1), 41.9 (2C, 2 × $C9H_2$), 17.2 ($C16H_3$), 14.7 ($C15H_3$), 13.9 ($C14H_3$), 11.1 ($C17H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 371.20084; $C_{26}H_{27}O_2$ requires 371.20056, Δ 0.75 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



1-(4-Amino-2,3,5,6-tetramethylphenyl)-3-ethylpentan-1-one (461)[6]



Ketone **349** (115 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), 3-pentanol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 85:15) afforded ketone **461** (119 mg, 0.457 mmol, 76%) as a colourless solid.

m.p. = 65 – 67 °C.

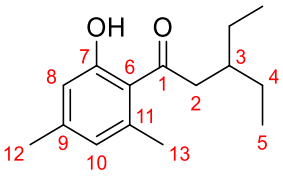
IR (film) ν_{max}/cm^{-1} 3490, 3403, 2960, 2933, 2918, 2875, 2857, 1693, 1629, 1624, 1577, 1461, 1401, 1381, 1364, 1338, 1323, 1292, 1277, 1244, 1155, 1141, 1115, 1011, 1001, 934.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.65 (2H, br. s, NH_2), 2.61 (2H, d, J = 6.2 Hz, $C2H_2$), 2.11 (6H, s, 2 × $C10H_3$), 2.07 (6H, s, 2 × $C11H_3$), 1.98 (1H, sept., J = 6.2 Hz, C3H), 1.49 – 1.33 (4H, m, 2 × $C4H_2$), 0.89 (6H, t, J = 7.4 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 211.9 (C1=O), 142.9 (C9), 134.6 (C6), 128.3 (2C, 2 × C7), 118.4 (2C, 2 × C6), 50.2 ($C2H_2$), 35.5 (C3H), 25.7 (2C, 2 × $C4H_2$), 17.1 (2C, 2 × $C10H_3$), 13.1 (2C, 2 × $C11H_3$), 11.0 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 262.21658; $C_{17}H_{28}NO$ requires 262.21654, Δ 0.16 ppm.

3-Ethyl-1-(2-hydroxy-4,6-dimethylphenyl)pentan-1-one (462)



Ketone **336** (98.5 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (2.39 mg, 3.00 μmol, 0.5 mol%), NaO*t*-Bu (115 mg, 1.20 mmol, 2.0 equiv), 3-pentanol (79.3 mg, 0.900 mmol, 1.5 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10) afforded ketone **462** (14.5 mg, 61.9 μmol, 10%) as a colourless oil.

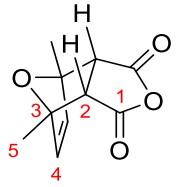
IR (film) ν_{max}/cm^{-1} 3351 (br.), 2961, 2933, 2921, 2876, 2857, 1680, 1630, 1614, 1565, 1491, 1459, 1407, 1381, 1349, 1304, 1267, 1227, 1189, 1161, 1099, 1057, 1032, 1010, 976, 941, 868, 837, 781, 734.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 11.87 (1H, s, OH), 6.65 (1H, s, C8H), 6.54 (1H, s, C10H), 2.83 (2H, d, J = 6.7 Hz, $C2H_2$), 2.55 (3H, s, $C13H_3$), 2.27 (3H, s, $C12H_3$), 2.00 (1H, sept., J = 6.4 Hz, C3H), 1.42 – 1.27 (4H, m, 2 × $C4H_2$), 0.86 (6H, t, J = 7.4 Hz, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.1 (C1=O), 162.1 (C7), 145.3 (C9), 138.5 (C11), 124.6 (C10H), 120.6 (C6), 116.6 (C8H), 48.6 ($C2H_2$), 37.8 (C3H), 26.1 (2C, 2 × $C4H_2$), 24.4 ($C13H_3$), 21.6 ($C12H_3$), 11.1 (2C, 2 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 235.16948; $C_{15}H_{23}O_2$ requires 235.16926, Δ 0.95 ppm.

***endo*-4,7-Dimethyl-4,7-epoxyisobenzofuran-1,3(3a*H*,4*H*,7*H*,7a*H*)-dione (464)[55]**



To a well-stirred solution of maleic anhydride (1.96 g, 20.0 mmol, 1.0 equiv) in Et_2O (2.0 mL, 10 M) was added 2,5-dimethylfuran (1.92 g, 20.0 mmol, 1.0 equiv) at RT for 3.5 h, then 0 °C for 1 h. The reaction mixture was directly filtered, and the residue was rinsed with cold Et_2O (3 × 2 mL) and dried *in vacuo* to give anhydride **464** (2.57 g) as a pale yellow solid.

The filtrate was concentrated and filtered, and the residue was rinsed with cold Et_2O (2 × 1.5 mL) to give anhydride **464** (0.381 g, total 2.95 g, 15.2 mmol, 76%) as a pale yellow solid.

m.p. = 72 – 74 °C.

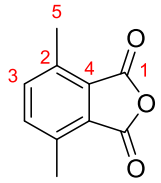
IR (film) ν_{max}/cm^{-1} 2992, 2941, 1854, 1830, 1769, 1709, 1584, 1443, 1391, 1320, 1240, 1213, 1195, 1134, 1095, 1080, 1040, 977, 919, 882, 862, 833, 791, 745, 670, 626.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.35 (2H, s, 2 × C4H), 3.16 (2H, s, 2 × C2H), 1.76 (6H, s, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 168.6 (2C, 2 × C1=O), 141.3 (2C, 2 × C4H), 89.0 (2C, 2 × C3), 54.1 (2C, 2 × C2H), 15.7 (2C, 2 × $C5H_3$).

Note: This compound gradually undergoes retro-Diels–Alder reaction over time, and this process is accelerated in solution such as $CDCl_3$, so it should be freshly made and used immediately.

4,7-Dimethylisobenzofuran-1,3-dione (465), or 4,7-Dimethylphthalic anhydride (465)[55]



A vigorously stirred flask containing H_2SO_4 (4.0 mL, 0.5 M) was cooled to –10 °C, then anhydride **464** (384 mg, 2.00 mmol, 1.0 equiv) was added in small portions over 1 min, and the reaction stirred for 30 min. The reaction mixture was then poured into ice/H_2O (20 mL) and stirred for 5 – 10 min. Once all the ice has thawed, the suspension was filtered and the residue rinsed with H_2O (10 mL). The residue was azeotroped with benzene (3 × 30 mL), then redissolved in benzene and filtered, eluting with benzene. The eluent was concentrated *in vacuo* to afford anhydride **465** (222 mg, 1.26 mmol, 63%) as an off-white solid.

m.p. = 139 – 141 °C.

IR (film) ν_{max}/cm^{-1} 2988, 2965, 2931, 1845, 1828, 1770, 1737, 1696, 1498, 1434, 1388, 1350, 1273, 1240, 1188, 1023, 912, 893, 851, 782, 747, 637.

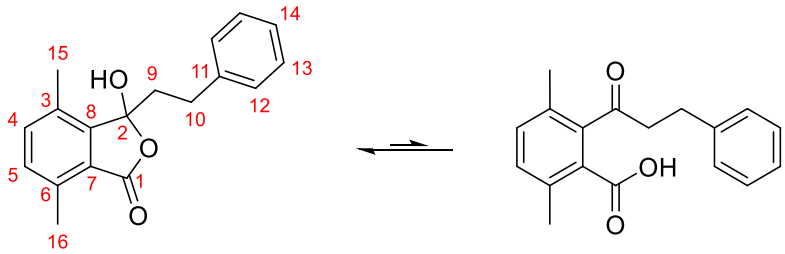
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.51 (2H, s, 2 × C3H), 2.68 (6H, s, 2 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 163.4 (2C, 2 × C1=O), 137.93 (2C, 2 × C4), 137.88 (2C, 2 × C3H), 128.7 (2C, 2 × C2), 17.5 (2C, 2 × $C5H_3$).

Note: The compound undergoes hydrolysis in the carrier liquid used in mass spectrometry.

3-Hydroxy-4,7-dimethyl-3-phenethylisobenzofuran-1(3*H*)-one (467), or

3,6-Dimethyl-2-(3-phenylpropanoyl)benzoic acid (466)[56]



Anhydride **465** (1.26 g, 7.16 mmol, 1.0 equiv), phenethylmagnesium chloride (7.9 mL, 1.0 M in THF, 7.90 mmol, 1.1 equiv) and THF (36 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 96:4 → 92:8 → 85:15) afforded ketone/lactol **467**/**466** (1.09 g, 3.87 mmol, 54%) as a colourless oil. The compound solidifies when evaporated from a solution of benzene to give a colourless solid.

m.p. = 86 – 89 °C (benzene).

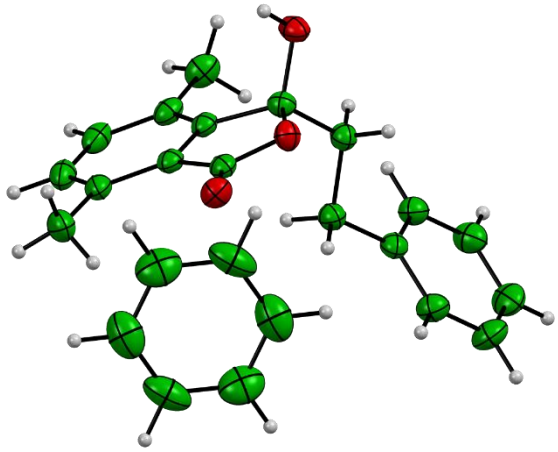
IR (film) ν_{max}/cm^{-1} 3365, 3086, 3062, 3027, 2962, 2929, 2864, 1736, 1603, 1588, 1503, 1454, 1416, 1382, 1335, 1254, 1202, 1167, 1134, 1077, 1029, 1004, 962, 937, 893, 872, 861, 825, 803, 752, 720, 700.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 (1H, d, J = 7.7 Hz, C4H), 7.26 – 7.22 (2H, m, 2 × C13H), 7.21 (1H, d, J = 7.7 Hz, C5H), 7.19 – 7.14 (1H, m, C14H), 7.10 (2H, dd, J = 7.1, 1.3 Hz, 2 × C12H), 3.54 (1H, br. s, OH), 2.77 (1H, ddd, J = 14.9, 12.4, 5.6 Hz, C10H$_A$*H$_B$*), 2.69 – 2.61 (1H, m, C9*H$_A$*H$_B$), 2.60 (3H, s, C16H$_3$), 2.45 (3H, s, C15H$_3$), 2.44 – 2.33 (2H, m, C9H$_A$*H$_B$* and C10H$_A$*H$_B$*).

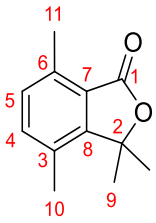
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 168.8, 146.5, 140.7, 137.1, 136.5, 132.7, 131.0, 128.6, 128.4, 126.3, 124.3, 106.3, 39.4, 30.0, 17.3, 17.2.

HRMS (ESI$^+$) Found $[M+H]^+$ = 281.11823; $C_{18}H_{17}O_3$ requires 281.11832, Δ –0.33 ppm.

Note: None of the uncyclised acid was observed in the $CDCl_3$ solution by ^1H NMR. In addition, the compound typically exists as a very viscous oil which does not solidify upon cooling, but could be crystallised by slow evaporation from benzene. The structure of the product, as a co-crystal with benzene, was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



3,3,4,7-Tetramethylisobenzofuran-1(3*H*)-one (468)[57]



Anhydride **465** (1.58 g, 8.97 mmol, 1.0 equiv), MeMgBr (6.1 mL, 3.0 M in THF, 18.3 mmol, 2.05 equiv) and THF (45 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O:DCM, 80:10:10) afforded lactone **468** (1.06 g, 5.59 mmol, 62%) as a colourless solid.

m.p. = 104 – 107 °C.

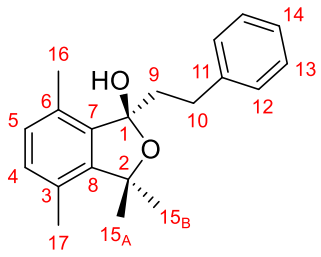
IR (film) ν_{max}/cm^{-1} 3026, 2982, 2934, 2872, 1751, 1588, 1502, 1461, 1441, 1388, 1368, 1327, 1279, 1254, 1211, 1197, 1171, 1051, 968, 942, 894, 827, 804, 713, 647, 616.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.27 (1H, d, J = 7.4 Hz, C4H), 7.14 (1H, d, J = 7.6 Hz, C5H), 2.64 (3H, s, C11H$_3$), 2.41 (3H, s, C10H$_3$), 1.70 (6H, s, 2 × C9H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 170.2 (C1=O), 152.8 (C8), 137.4 (C6), 136.0 (C4H), 131.0 (C5H), 128.7 (C3), 123.3 (C7), 84.7 (C2), 25.7 (2C, 2 × C9H$_3$), 18.0 (C10H$_3$), 17.3 (C11H$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 191.10662; $C_{12}H_{15}O_2$ requires 191.10666, Δ –0.18 ppm.

3,3,4,7-Tetramethyl-1-phenethyl-1,3-dihydroisobenzofuran-1-ol (470)[57]



Lactone **468** (1.06 g, 5.59 mmol, 1.0 equiv), phenethylmagnesium chloride (6.1 mL, 1.0 M in THF, 6.10 mmol, 1.1 equiv) and THF (28 mL, 0.2 M) were subjected to **General Procedure J**. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 90:10 → 85:15) afforded lactol **470** (1.18 g, 3.98 mmol, 71%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3411 (br.), 3084, 3061, 3025, 2976, 2929, 2868, 1758, 1661, 1603, 1585, 1496, 1454, 1383, 1362, 1333, 1278, 1209, 1185, 1157, 1083, 1063, 1010, 975, 940, 891, 874, 812, 783, 746, 699.

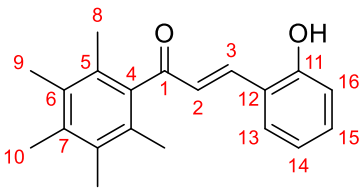
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.23 (2H, m), 7.21 – 7.14 (3H, m), 7.04 (2H, q$_{AB}$, J_{AB} = 7.6 Hz, Δ_{AB} = 15.1 Hz, C4H and C5H), 2.75 (1H, td, J = 11.8, 4.5 Hz, C10H_AH$_B$), 2.62 – 2.57 (1H, m, OH), 2.44 (3H, s, C16H$_3$), 2.50 – 2.33 (3H, m, C9H$_2$ and C10H$_A$$H_B$), 2.37 (3H, s, C17H$_3$), 1.67 (3H, s, C15$_AH_3$), 1.65 (3H, s, C15$_BH_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 145.3 (C8), 142.2 (C11), 138.0 (C7), 131.9 (C4H), 130.9 (C6), 130.6 (C5H), 128.58 (C3), 128.49 (2C, 2 × C13H), 128.46 (2C, 2 × C12H), 125.9 (C14H), 107.9 (C1), 84.7 (C2), 41.4 ($C9H_2$), 31.2 ($C10H_2$), 29.6 ($C15_AH_3$), 27.4 ($C15_BH_3$), 18.2 ($C17H_3$), 17.7 ($C16H_3$).

A stable molecular ion could not be detected by ESI, EI or APCI.

Note: The compound displays sensitivity towards acidic conditions. The $CDCl_3$ used should be first passed through a plug of K_2CO_3 to neutralise any traces of HCl.

(*E*)-3-(2-Hydroxyphenyl)-1-(2,3,4,5,6-pentamethylphenyl)prop-2-en-1-one (471)



Ketone **121** (951 mg, 5.00 mmol, 1.0 equiv), salicaldehyde (672 mg, 5.55 mmol, 1.1 equiv), NaOH (500 mg, 12.5 mmol, 2.5 equiv) and H_2O:EtOH (1:1, 25 mL, 0.2 M) were subjected to a modification of **General Procedure A** at 60 °C for 16 h. The crude material was resuspended in pentane and filtered, then rinsed with cold pentane:Et_2O (9:1, 2 × 4 mL) and cold DCM (4 mL). The residue was dried *in vacuo* to afford enone **471** (877 mg, 2.98 mmol, 60%) as a pale yellow solid.

m.p. = 210 – 214 °C.

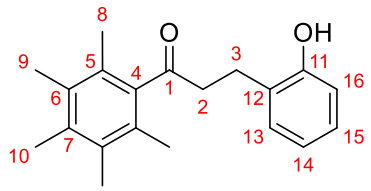
IR (film) ν_{max}/cm^{-1} 3244 (br.), 2984, 2945, 2872, 1613, 1598, 1579, 1498, 1458, 1451, 1410, 1381, 1370, 1318, 1276, 1252, 1228, 1184, 1156, 1133, 1111, 1094, 1070, 1017, 991, 957, 909, 889, 811, 754, 745, 733.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.61 (1H, s, OH), 7.73 (1H, d, J = 16.2 Hz, C3H), 7.37 (1H, d, J = 16.2 Hz, C2H), 7.29 (1H, dd, J = 7.8, 1.7 Hz, C13H), 7.23 (1H, ddd, J = 8.2, 7.3, 1.6 Hz, C15H), 6.98 (1H, dd, J = 8.1, 1.1 Hz, C16H), 6.87 (1H, td, J = 7.5, 1.1 Hz, C14H), 2.29 (3H, s, $C10H_3$), 2.23 (6H, s, 2 × $C9H_3$), 2.15 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 206.9 (C1=O), 157.3 (C11), 146.5 (C3H), 137.4 (C4), 135.7 (C7), 133.0 (2C, 2 × C6), 132.26 (C15H), 132.23 (C13H), 130.3 (C13H), 129.3 (2C, 2 × C5), 121.7 (C12), 120.3 (C14H), 117.0 (C16H), 17.8 (2C, 2 × $C8H_3$), 16.9 ($C10H_3$), 16.2 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 295.16919; $C_{20}H_{23}O_2$ requires 295.16926, Δ –0.23 ppm.

3-(2-Hydroxyphenyl)-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (472)



Enone **471** (877 mg, 2.98 mmol, 1.0 equiv), $Pd(OH)_2/C$ (87.7 mg, 10 wt%) and EtOAc:DCM (3:1, 15 mL, 0.2 M) were subjected to **General Procedure C** for 4 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **472** (882 mg, 2.98 mmol, 100%) as a colourless solid.

m.p. = 137 – 139 °C.

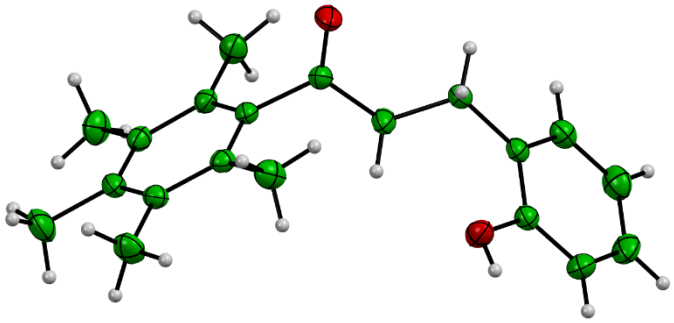
IR (film) ν_{max}/cm^{-1} 3393, 2980, 2948, 2928, 2896, 2863, 1685, 1608, 1593, 1505, 1457, 1443, 1396, 1366, 1349, 1310, 1274, 1253, 1233, 1178, 1154, 1120, 1101, 1070, 1043, 1028, 997, 987, 939, 929, 872, 850, 816, 771, 747, 729.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.53 (1H, s, OH), 7.13 (1H, ddd, J = 8.1, 7.2, 1.7 Hz, C15H), 7.09 (1H, ddd, J = 7.5, 1.8, 0.7 Hz, C13H), 6.93 (1H, ddd, J = 8.1, 1.3, 0.6 Hz, C16H), 6.87 (1H, td, J = 7.4, 1.2 Hz, C14H), 3.14 – 3.06 (2H, m, $C2H_2$), 3.06 – 2.95 (2H, m, $C3H_2$), 2.22 (3H, s, $C10H_3$), 2.15 (6H, s, 2 × $C9H_3$), 1.92 (6H, s, 2 × $C8H_3$).

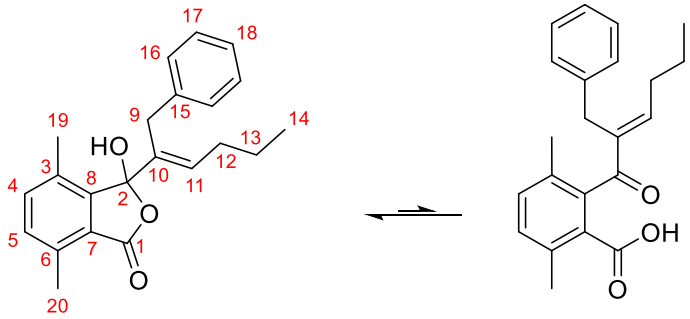
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 215.0 (C1=O), 154.5 (C11), 139.4 (C4), 136.0 (C7), 133.3 (2C, 2 × C6), 130.6 (C13H), 128.1 (C15H), 127.6 (C12), 127.4 (2C, 2 × C5), 120.9 (C14H), 117.6 (C16H), 47.4 ($C2H_2$), 23.3 ($C3H_2$), 16.94 (2C, 2 × $C8H_3$), 16.82 ($C10H_3$), 16.0 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 297.18491; $C_{20}H_{25}O_2$ requires 297.18491, Δ 0.00 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



(*E*)-3-Hydroxy-4,7-dimethyl-3-(1-phenylhex-2-en-2-yl)isobenzofuran-1(3*H*)-one (473), or (*E*)-2-(2-Benzylhex-2-enoyl)-3,6-dimethylbenzoic acid (473)



Ketone/lactol **466**/**467** (84.7 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by preparative TLC (DCM:MeOH, 94:6) afforded enone/allylic lactol **473** (9.5 mg, 28 μmol, 9.4%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3341 (br.), 3085, 3061, 3027, 2959, 2927, 2871, 1737, 1697, 1657, 1602, 1496, 1454, 1415, 1381, 1329, 1290, 1256, 1195, 1170, 1148, 1101, 1075, 1030, 936, 889, 825, 800, 722, 701.

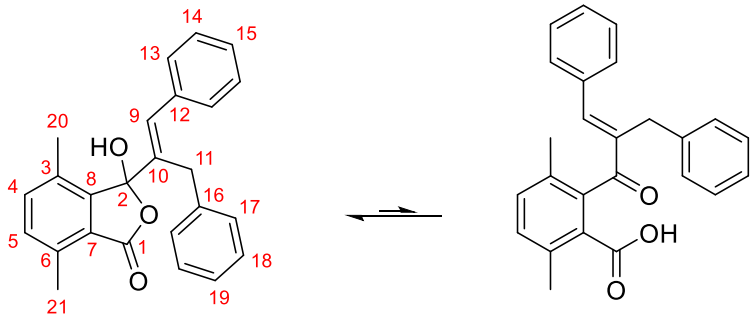
^{1}H NMR (C_6D_6, 500 MHz) δ = 7.11 – 6.99 (4H, m, 2 × C16H and 2 × C17H), 6.98 – 6.92 (1H, m, C18H), 6.71 (2H, s, C3H and C4H), 6.18 (1H, t, J = 7.1 Hz, C11H), 4.34 (1H, v. br. s, OH), 3.45 (2H, br. s, $C9H_2$), 2.50 (3H, s, $C20H_3$), 2.06 (3H, s, $C19H_3$), 1.93 (2H, qd, J = 7.4, 1.5 Hz, $C12H_2$), 1.16 (2H, sext., J = 7.4 Hz, $C13H_2$), 0.72 (3H, t, J = 7.4 Hz, $C14H_3$).

^{13}C NMR (C_6D_6, 126 MHz) δ = 169.6 (v. br. s, C1=O), 145.5 (v. br. s, C8), 140.0 (C15), 136.4 (C6 and C11H), 135.0 (br. s, C4H), 132.11 (C3), 132.05 (C5H and C10), 128.7 (2C, 2 × C16H), 128.3 (2C, 2 × C17H), 126.9 (v. br. s, C7), 126.0 (C18H), 102.0 (v. br. s, C2), 32.8 ($C9H_2$), 30.9 ($C12H_2$), 22.5 ($C13H_2$), 17.9 (br. s, $C20H_3$), 17.4 (br. s, $C19H_3$), 14.0 ($C14H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 337.17993; $C_{22}H_{25}O_3$ requires 337.17982, Δ 0.33 ppm.

Note: C11H does not show up on HSQC, but $C12H_2$ has a somewhat broad HMBC correlations to a carbon signal around 136.4 ppm, and C11H has HMBC correlations to $C9H_2$, $C12H_2$ and $C13H_2$ thus confirming its identity. Combined with the fact that multiple signals, particularly the OH proton signal and the carbon signals for C1, C2, C7 and C8, are significantly broadened, these observations suggest that there is significant chemical exchange within the NMR time frame that constantly modulates the electronics of those key sites.

(*E*)-3-(1,3-Diphenylprop-1-en-2-yl)-3-hydroxy-4,7-dimethylisobenzofuran-1(3*H*)-one (474), or (*E*)-2-(2-Benzyl-3-phenylacryloyl)-3,6-dimethylbenzoic acid (474)



Ketone/lactol **466**/**467** (84.7 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by preparative TLC (DCM:MeOH, 94:6) afforded enone/allylic lactol **473** (10.0 mg, 27.0 mmol, 9.0%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3337, 3083, 3060, 3026, 2958, 2925, 2855, 1738, 1655, 1620, 1600, 1495, 1453, 1409, 1382, 1328, 1257, 1189, 1152, 1075, 1030, 977, 936, 907, 882, 825, 799, 774, 753, 699.

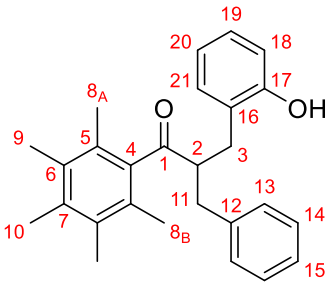
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.37 – 7.30 (4H, m, 2 × C13H and 2 × C14H), 7.30 – 7.27 (1H, m, C15H), 7.26 (1H, s, C9H), 7.17 (1H, d, J = 7.7 Hz, C4H), 7.10 (1H, d, J = 7.7 Hz, C5H), 7.14 – 7.07 (2H, br. m, 2 × C18H), 7.07 – 7.02 (1H, br. m, C20H), 6.99 (2H, br. d, J = 7.3 Hz, 2 × C17H), 3.75 (2H, br. s, $C11H_2$), 3.45 (1H, v. br. s, OH), 2.51 (3H, s, $C21H_3$), 2.35 (3H, s, $C20H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 168.8 (br. s, C1), 145.8 (v. br. s, C8), 138.5 (C16), 136.7 (C6), 136.12 (C12), 135.95 (v. br. s, C4H), 132.5 (C5H), 131.9 (br. s, C3), 128.9 (3C, C10 and 2 × C13H), 128.7 (2C, 2 × C14H), 128.4 (2C, 2 × C17H), 128.3 (2C, 2 × C18H), 128.0 (2C, br. s, C9H and C15H), 126.2 (C19H), 125.1 (v. br. s, C7), 106.7 (v. br. s, C2), 33.4 (br. s, $C11H_2$), 17.5 (2C, br. s, $C20H_3$ and $C21H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 393.14590; $C_{25}H_{22}O_3Na$ requires 393.14612, Δ –0.54 ppm.

Note: Comparing with allylic lactol **472**, a C_6D_6 or $CDCl_3$ solution did not improve the quality of the various spectra. The various broadened signals at key sites suggest that there is significant chemical exchange within the NMR time frame that constantly modulates the electronics of those sites. Unusually, the benzylic aryl carbons were broadened but not the protons in their respective spectra, whereas for the styrene group it was the protons that were broadened but not the carbons.

2-Benzyl-3-(2-hydroxyphenyl)-1-(2,3,4,5,6-pentamethylphenyl)propan-1-one (476)



Ketone **472** (88.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and BnOH (300 μL, 324 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 95:5 → 92.5:7.5) afforded ketone **476** (14.1 mg, 36.5 μmol, 12%) as a colourless oil.

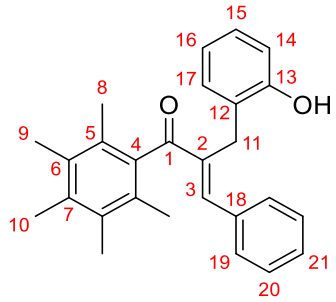
IR (film) ν_{max}/cm^{-1} 3377 (br.), 3085, 3063, 3027, 3003, 2922, 2852, 1676, 1604, 1594, 1584, 1490, 1455, 1380, 1357, 1325, 1302, 1262, 1232, 1200, 1178, 1153, 1127, 1097, 1075, 1039, 1029, 988, 905, 875, 858, 847, 805, 752, 733, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.38 (1H, s, OH), 7.34 – 7.28 (2H, m, 2 × C14H), 7.26 – 7.20 (1H, m, C15H), 7.16 – 7.11 (2H, m, 2 × C13H), 7.07 (1H, ddd, J = 8.0, 7.0, 2.0 Hz, C19H), 6.88 (1H, dd, J = 8.1, 1.2 Hz, C18H), 6.75 (1H, td, J = 7.3, 1.2 Hz, C20H), 6.72 (1H, dd, J = 7.6, 2.0 Hz, C21H), 3.44 (1H, ddt, J = 11.3, 10.1, 3.3 Hz, C2H), 3.15 (1H, d, J = 14.0 Hz, C11H_AH$_B$), 3.14 (1H, t, J = 13.7 Hz, C3H_AH$_B$), 2.54 (1H, dd, J = 14.2, 3.0 Hz, C3H$_A$$H_B$), 2.49 (1H, dd, J = 13.5, 11.2 Hz, C11H$_A$$H_B$), 2.22 (3H, s, C10H$_3$), 2.14 (6H, s, 2 × C9H$_3$), 2.05 (3H, s, C8$_AH_3$), 1.66 (3H, s, C8$_BH_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 216.4 (C1=O), 154.6 (C17), 139.1 (C12), 138.0 (C4), 136.3 (C7), 133.4 (2C, br. s, 2 × C6), 131.0 (C21H), 129.04 (2C, 2 × C13H), 128.89 (2C, v. br. s, 2 × C5), 128.79 (2C, 2 × C14H), 128.1 (C19H), 126.8 (C15H), 126.3 (C16), 120.7 (C20H), 117.7 (C18H), 59.2 (C2H), 37.5 ($C11H_2$), 28.1 ($C3H_2$), 17.7 (2C, v. br. s, $C8_AH_3$ and $C8_BH_3$), 16.9 ($C10H_3$), 16.1 (2C, br. s, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 387.23181; $C_{27}H_{31}O_2$ requires 387.23186, Δ –0.12 ppm.

(*E*)-2-(2-Hydroxybenzyl)-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylprop-2-en-1-one (477)



In the preparation of ketone **476**, enone **477** (65.8 mg, 0.254 mmol, 85%) was also isolated as a colourless solid.

m.p. = 144 – 146 °C.

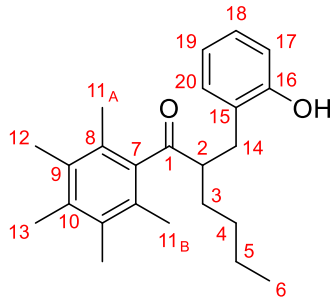
IR (film) ν_{max}/cm^{-1} 3342 (br.), 3064, 3027, 2981, 2925, 2871, 1637, 1616, 1606, 1594, 1488, 1455, 1381, 1360, 1324, 1307, 1269, 1237, 1225, 1205, 1166, 1094, 1072, 1039, 1029, 986, 947, 907, 847, 795, 753, 730, 697, 681, 648.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.09 (1H, s, OH), 7.47 – 7.39 (2H, m, 2 × C20H), 7.39 (1H, s, C3H), 7.42 – 7.35 (3H, m, 2 × C19H and C21H), 7.08 (1H, ddd, J = 8.0, 5.8, 3.2 Hz, C15H), 6.93 (1H, dt, J = 8.2, 1.0 Hz, C14H), 6.72 – 6.65 (2H, m, C16H and C17H), 4.02 (2H, s, $C11H_2$), 2.24 (3H, s, $C10H_3$), 2.17 (6H, s, 2 × $C9H_3$), 1.93 (6H, s, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.5 (C1=O), 154.6 (C13), 147.7 (C3H), 142.3 (C2), 136.5 (C4), 135.9 (C7), 135.5 (C18), 133.0 (2C, 2 × C6), 130.4 (C17H), 129.5 (2C, 2 × C5), 129.3 (C21H), 129.1 (2C, 2 × C19H), 128.9 (2C, 2 × C20H), 128.2 (C15H), 125.8 (C12), 120.6 (C16H), 118.0 (C14H), 25.4 ($C11H_2$), 17.4 (2C, 2 × $C8H_3$), 16.9 ($C10H_3$), 16.1 (2C, 2 × $C9H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 385.21611; $C_{27}H_{29}O_2$ requires 385.21621, Δ –0.26 ppm.

2-(2-Hydroxybenzyl)-1-(2,3,4,5,6-pentamethylphenyl)hexan-1-one (478)



Ketone **472** (88.9 mg, 0.300 mmol, 1.0 equiv), $[Ir(COD)Cl]_2$ (2.01 mg, 3.00 μmol, 1 mol%), DPPBz (2.67 mg, 0.600 μmol, 2 mol%), KOH (33.7 mg, 0.300 mmol, 1.0 equiv) and *n*-butanol (275 μL, 222 mg, 3.00 mmol, 10 equiv) were subjected to **General Procedure D** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 96:4) afforded ketone **478** (92.9 mg, 0.264 mmol, 88%) as a colourless solid.

m.p. = 85 – 88 °C.

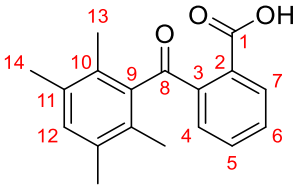
IR (film) ν_{max}/cm^{-1} 3373, 3067, 3037, 3006, 2955, 2930, 2871, 2860, 2732, 1674, 1609, 1594, 1504, 1489, 1457, 1380, 1358, 1304, 1262, 1232, 1179, 1137, 1105, 1070, 1040, 1020, 996, 911, 849, 752, 731, 676, 647, 610.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.58 (1H, s, OH), 7.12 (1H, ddd, J = 7.8, 7.2, 1.7 Hz, C18H), 7.09 (1H, dd, J = 7.5, 1.7 Hz, C20H), 6.91 (1H, dd, J = 8.1, 1.3 Hz, C17H), 6.86 (1H, td, J = 7.4, 1.3 Hz, C19H), 3.17 (1H, dd, J = 13.3, 10.3 Hz, C14H_AH$_B$), 3.13 (1H, m, C2H), 2.74 (1H, dd, J = 13.2, 2.0 Hz, C14H$_A$$H_B$), 2.21 (3H, s, $C13H_3$), 2.13 (6H, br. s, 2 × $C12H_3$), 2.04 (3H, v. br. s, C11$_A$H$_3$), 1.75 – 1.65 (1H, m, C3H_AH$_B$), 1.63 (3H, v. br. s, C11$_B$H$_3$), 1.60 – 1.48 (1H, m, C3H$_A$$H_B$), 1.46 – 1.34 (2H, m, $C4H_2$), 1.34 – 1.19 (2H, m, $C5H_2$), 0.87 (3H, t, J = 7.2 Hz, $C6H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 217.3 (C1=O), 154.7 (C16), 138.4 (C7), 136.1 (C10), 133.2 (2C, 2 × C9), 131.2 (C20H), 128.7 (2C, v. br. s, 2 × C8), 128.1 (C18H), 126.7 (C15), 120.7 (C19H), 117.9 (C17), 57.0 (C2H), 30.9 ($C3H_2$), 30.1 ($C4H_2$), 28.6 ($C14H_2$), 22.7 ($C5H_2$), 17.6 (2C, v. br. s, C11$_A$H$_3$ and C11$_B$H$_3$), 16.9 ($C13H_3$), 16.1 (2C, br. s, 2 × $C12H_3$), 14.0 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 353.24747; $C_{24}H_{33}O_2$ requires 353.24751, Δ –0.11 ppm.

2-(2,3,5,6-Tetramethylbenzoyl)benzoic acid (497)



To a solution of phthalic anhydride (741 mg, 5.00 mmol, 1.0 equiv) and durene (738 mg, 5.50 mmol, 1.1 equiv) in DCM (20 mL, 0.25 M) was added $AlCl_3$ (1.47 g, 11.0 mmol, 2.2 equiv) in a single portion at RT, and the reaction stirred for 10 min. The reaction was poured into ice/water/aq. 1 M HCl (1:1:1, 60 mL) and diluted with DCM (40 mL). The layers were separated, the aqueous layer extracted with DCM (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. The residue was resuspended in DCM (10 mL), filtered, and the residue rinsed with DCM (3 × 5 mL). The residue was dried *in vacuo* to afford carboxylic acid **497** (620 mg) as a colourless solid.

The filtrate was concentrated *in vacuo*, then purified by flash column chromatography (Pentane:Et_2O, 80:20, then DCM:MeOH, 90:10) to afford carboxylic acid **497** (465 mg, total 1.08 g, 3.84 mmol, 77%) as a colourless solid.

m.p. = >180 °C (decomposition).

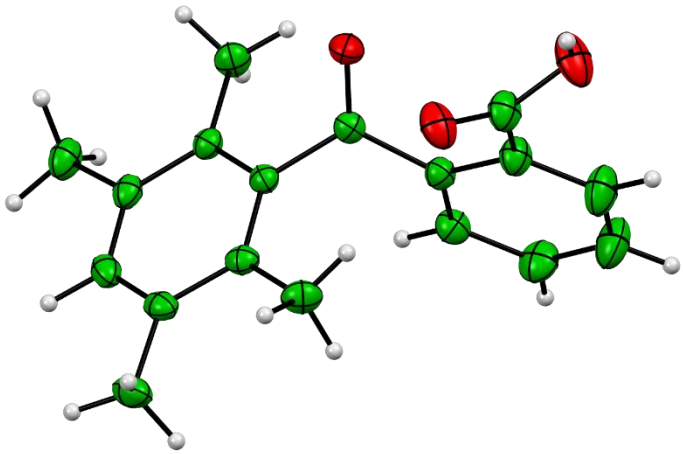
IR (film) ν_{max}/cm^{-1} 3074, 2979, 2948, 2920, 2822, 2668, 2594, 2558, 1703, 1671, 1594, 1575, 1489, 1468, 1448, 1415, 1391, 1378, 1304, 1269, 1242, 1203, 1166, 1141, 1114, 1058, 1040, 1009, 946.

^{1}H NMR (DMSO-d_6, 500 MHz) δ = 13.10 (1H, s, OH), 7.67 (1H, td, J = 7.5, 1.2 Hz, C6H), 7.61 (1H, dd, J = 7.6, 1.3 Hz, C7H), 7.49 (1H, td, J = 7.6, 1.4 Hz, C5H), 7.23 (1H, dd, J = 7.8, 1.1 Hz, C4H), 7.09 (1H, s, C12H), 2.20 (6H, s, 2 × C14H$_3$), 1.95 (6H, s, 2 × C13H$_3$).

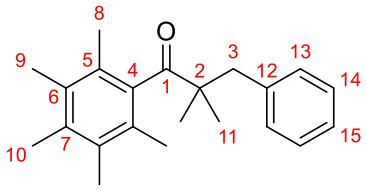
^{13}C NMR (DMSO-d_6, 126 MHz) δ = 199.8 (C8=O), 170.4 (C1=O), 139.1 (C9), 135.9 (C3), 135.0 (C2), 134.0 (2C, 2 × C11), 133.0 (C6H), 132.0 (C12H), 130.4 (C4H), 130.0 (C5H), 129.7 (2C, 2 × C10), 128.2 (C7), 19.1 (2C, 2 × C14H_3), 15.9 (2C, 2 × C13H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 305.11484; $C_{18}H_{18}O_3Na$ requires 305.11482, Δ 0.47 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



2,2-Dimethyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylpropan-1-one (503)



Ketone **145** (280 mg, 1.00 mmol, 1.0 equiv), NaH (100 mg, 60% dispersion in mineral oil, 2.50 mmol, 2.5 equiv), MeI (160 μL, 355 mg, 2.50 mmol, 1.0 equiv) and DMF (5.0 mL, 0.2 M) were subjected to **General Procedure G** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99.5:0.5 → 99:1) afforded ketone **503** (48.1 mg, 0.156 mmol, 16%) as a colourless solid.

m.p. = 90 – 93 °C.

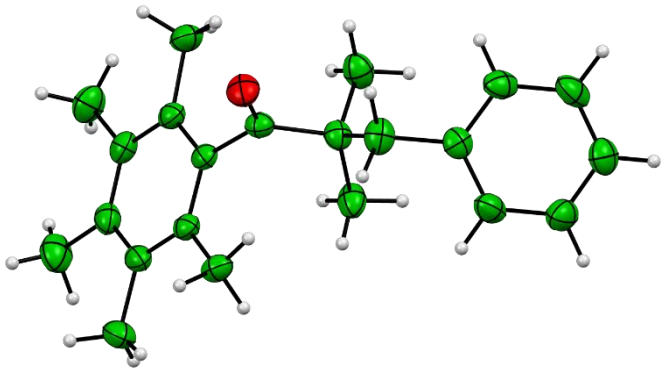
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3027, 2969, 2927, 2872, 1734, 1686, 1603, 1581, 1494, 1467, 1453, 1384, 1360, 1301, 1261, 1205, 1086, 1030, 987, 903.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.30 – 7.25 (2H, m, 2 × C14H), 7.25 – 7.20 (1H, m, C15H), 7.20 – 7.15 (2H, m, 2 × C13H), 2.96 (2H, s, $C3H_2$), 2.24 (3H, s, $C10H_3$), 2.19 (6H, s, 2 × $C9H_3$), 2.08 (6H, s, 2 × $C8H_3$), 1.11 (6H, s, 2 × $C11H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 219.4 (C1=O), 139.7 (C12), 137.8 (C4), 135.0 (C7), 133.2 (2C, 2 × C6), 131.3 (2C, 2 × C13H), 127.9 (2C, 2 × C14H), 127.7 (2C, 2 × C5), 126.4 (C15H), 49.6 (C2), 44.9 ($C3H_2$), 24.9 (2C, 2 × $C11H_3$), 19.1 (2C, 2 × $C8H_3$), 16.8 ($C10H_3$), 16.2 (2C, 2 × $C9H_3$).

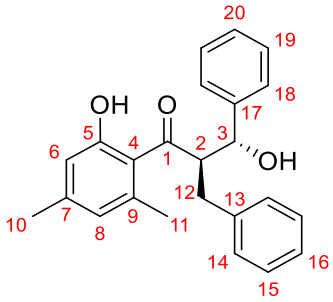
HRMS (ESI^+) Found $[M+H]^+$ = 309.22137; $C_{22}H_{29}O$ requires 309.22129, Δ 0.27 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



***rel*-(2*R*,3*R*)-2-Benzyl-3-hydroxy-1-(2-hydroxy-4,6-dimethylphenyl)-3-phenylpropan-1-one (506), or**

***anti*-2-Benzyl-3-hydroxy-1-(2-hydroxy-4,6-dimethylphenyl)-3-phenylpropan-1-one (506)**



Ketone **338** (254 mg, 1.00 mmol, 1.0 equiv), benzaldehyde (116 mg, 1.10 mmol, 1.1 equiv), NaOH (90.0 mg, 2.25 mmol, 2.25 equiv) and H_2O:EtOH (1:1, 6.7 mL, 0.15 M) were subjected to **General Procedure A** for 16 h. Filtration and drying *in vacuo* afforded β-hydroxyketone **506** (202 mg, 0.561 mmol, 56%) as a colourless solid.

m.p. = 115 – 117 °C.

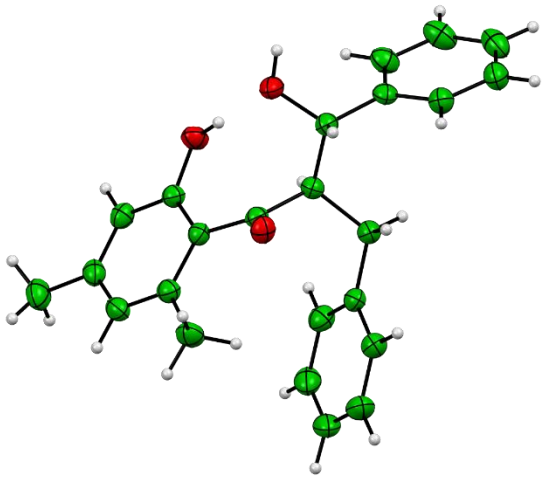
IR (film) ν_{max}/cm^{-1} 3193, 3087, 3063, 3030, 2954, 2923, 2856, 1663, 1618, 1562, 1495, 1454, 1411, 1361, 1321, 1274, 1246, 1219, 1180, 1153, 1083, 1055, 1031, 1008, 931, 911.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 10.67 (1H, s, C5OH), 7.43 – 7.37 (2H, m, 2 × C18H), 7.38 – 7.31 (2H, m, 2 × C19H), 7.32 – 7.25 (1H, m, C20H), 7.12 – 7.02 (3H, m, 2 × C15H and C16H), 6.97 (2H, m, 2 × C14H), 6.53 (1H, s, C6H), 6.33 (1H, s, C8H), 5.05 (1H, dd, J = 8.1, 1.9 Hz, C3H), 4.24 (1H, ddd, J = 9.4, 8.1, 5.6 Hz, C2H), 3.34 (1H, br. s, C3HO*H*), 2.93 (1H, dd, J = 13.8, 9.5 Hz, C12H_AH$_B$), 2.67 (1H, dd, J = 13.8, 5.6 Hz, C12H$_A$$H_B$), 2.19 (3H, s, C10$H_3$), 2.08 (3H, s, C11$H_3$).

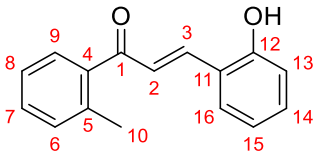
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.7 (C1=O), 159.4 (C5), 144.9 (C10), 141.8 (C17), 138.6 (C9), 137.9 (C13), 128.82 (2C, 2 × C19H), 128.80 (2C, 2 × C14H), 128.47 (C20H), 128.40 (2C, 2 × C15H), 126.8 (2C, 2 × C18H), 126.5 (C20H), 124.4 (C8H), 123.3 (C4), 116.4 (C6), 77.7 (C3H), 58.2 (C2H), 37.1 ($C12H_2$), 22.2 ($C11H_3$), 21.6 ($C10H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 383.16196; $C_{24}H_{24}O_3Na$ requires 383.16177, Δ 0.50 ppm.

The relative stereochemistry of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



(*E*)-3-(2-Hydroxyphenyl)-1-(2-methylphenyl)prop-2-en-1-one (512)



2′-Methylacetophenone (671 mg, 5.00 mmol, 1.0 equiv), salicaldehyde (672 mg, 5.55 mmol, 1.1 equiv), NaOH (500 mg, 12.5 mmol, 2.5 equiv) and H_2O:EtOH (1:1, 25 mL, 0.2 M) were subjected to a modification of **General Procedure A** at 60 °C for 16 h. The crude material was resuspended in pentane and filtered, then rinsed with cold pentane:Et_2O (9:1, 2 × 4 mL) and cold DCM (4 mL). The residue was dried *in vacuo* to afford enone **512** (857 mg, 3.60 mmol, 72%) as a yellow solid.

m.p. = 142 – 144 °C.

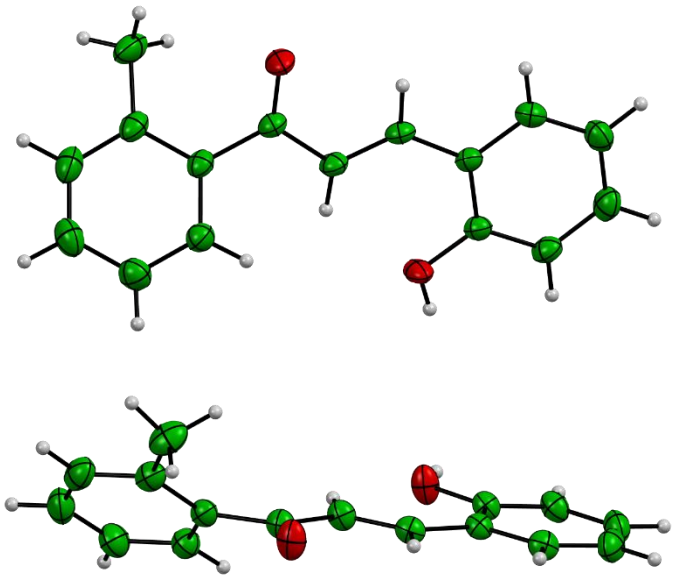
IR (film) ν_{max}/cm^{-1} 3275 (br.), 3066, 2970, 2860, 1646, 1599, 1580, 1499, 1487, 1459, 1360, 1333, 1312, 1274, 1251, 1218, 1191, 1158, 1130, 1112, 1095, 1071, 1023, 991, 910, 880, 866, 842, 819, 804, 752.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.74 (1H, d, J = 16.2 Hz, C3H), 7.56 (1H, d, J = 16.2 Hz, C2H), 7.62 – 7.52 (1H, br. m, OH), 7.51 (1H, d, J = 8.2 Hz, C9H), 7.44 (1H, dd, J = 7.8, 1.6 Hz, C16H), 7.40 (1H, td, J = 7.5, 1.4 Hz, C7H), 7.33 – 7.26 (1H, m, C8H), 7.30 (1H, d, J = 7.9 Hz, C6H), 7.27 (1H, td, J = 7.7, 1.5 Hz, C14H), 6.96 (1H, dd, J = 8.4, 1.2 Hz, C13H), 6.92 (1H, td, J = 7.5, 1.2 Hz, C15H), 2.47 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 199.7 (C1=O), 156.5 (C12), 144.2 (C3H), 139.0 (C4), 137.0 (C5), 132.2 (C14H), 131.4 (C6H), 130.64 (C7H), 130.61 (C16H), 128.4 (C9H), 127.7 (C2H), 125.6 (C8H), 121.9 (C11), 120.8 (C15H), 116.9 (C13H), 20.4 ($C10H_3$).

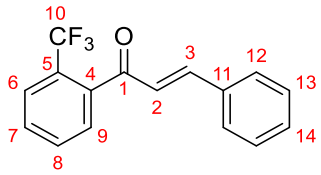
HRMS (ESI^+) Found $[M+H]^+$ = 239.10666; $C_{16}H_{15}O_2$ requires 239.10666, Δ 0.01 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



Note: The compound irreversibly turns dark blue as it melts.

(*E*)-3-Phenyl-1-(2-(trifluoromethyl)phenyl)prop-2-en-1-one (S1)



1-(2′-(Trifluoromethyl)phenyl)ethan-1-one (282 mg, 1.50 mmol, 1.0 equiv), benzaldehyde (175 mg, 1.65 mmol, 1.1 equiv), NaOH (75.0 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 10 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **S1** (412 mg, 1.45 mmol, 97%) as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 1650, 1599, 1576, 1496, 1314, 1271, 1211, 1169, 1132, 1070, 1045, 1033, 1018.

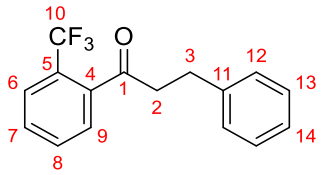
^{1}H{^{19}F} NMR ($CDCl_3$, 400 MHz) δ = 7.78 (1H, dd, J = 7.6, 1.5 Hz, C6H), 7.68 – 7.58 (2H, m, C7H and C8H), 7.56 – 7.51 (2H, m, 2 × C13H), 7.47 (1H, dd, J = 7.3, 1.6 Hz, C9H), 7.45 – 7.36 (3H, m, 2 × C12H and C14H), 7.30 (1H, d, J = 16.3 Hz, C3H), 7.05 (1H, d, J = 16.3 Hz, C2H).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 195.3 (C1=O), 148.0 (C3H), 139.0 (q, $^3J_{CF}$ = 2.0 Hz, C4), 134.2 (C11), 131.8 (C8H), 131.2 (C14H), 130.0 (C7H), 129.2 (2C, 2 × C12H), 128.7 (2C, 2 × C13H), 128.2 (C9H), 128.0 (q, $^2J_{CF}$ = 32.3 Hz, C5), 126.9 (br. s, C2H), 126.8 (q, $^3J_{CF}$ = 4.8 Hz, C6H), 123.7 (q, $^1J_{CF}$ = 274.0 Hz, C10F_3).

^{19}F NMR ($CDCl_3$, 377 MHz) δ = –58.0 (3F, s, C10F_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 299.0654; $C_{16}H_{11}F_3ONa$ requires 299.0654, Δ –0.20 ppm. The analytical data are identical to those reported in literature.[58]

3-Phenyl-1-(2-(trifluoromethyl)phenyl)propan-1-one (S2)



Enone **S2** (386 mg, 1.40 mmol, 1.0 equiv), $Pd(OH)_2/C$ (38.6 mg, 10 wt%) and EtOAc (7.0 mL, 0.2 M) were subjected to **General Procedure C** for 1.5 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S2** (358 mg, 1.29 mmol, 92%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3030, 2919, 2851, 1707, 1604, 1582, 1497, 1452, 1314, 1275, 1171, 1131, 1067, 1034, 981.

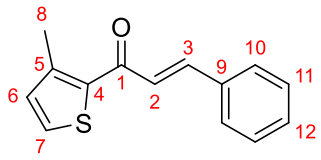
^{1}H{^{19}F} NMR ($CDCl_3$, 400 MHz) δ = 7.74 – 7.69 (1H, m, C6H), 7.61 – 7.51 (2H, m, C7H and C8H), 7.34 – 7.27 (3H, m, C9H and 2 × C13H), 7.26 – 7.18 (3H, m, 2 × C12H and C14H), 3.21 – 3.13 (2H, m, $C2H_2$), 3.11 – 3.03 (2H, m, $C3H_2$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.6 (C1=O), 140.7 (C11), 140.4 (q, $^3J_{CF}$ = 2.1 Hz, C4), 131.9 (C8H), 130.1 (C7H), 128.7 (2C, 2 × C13H), 128.5 (2C, 2 × C12H), 126.99 (q, $^2J_{CF}$ = 32.3 Hz, C5), 126.95 (C9H), 126.8 (q, $^3J_{CF}$ = 5.0 Hz, C6H), 126.4 (C14H), 123.7 (q, $^1J_{CF}$ = 273.5 Hz, $C10F_3$), 45.0 ($C2H_2$), 30.0 ($C3H_2$).

^{19}F NMR ($CDCl_3$, 377 MHz) δ = –58.1 (3F, s, $C10F_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 301.0810; $C_{16}H_{13}F_3ONa$ requires 301.0811, Δ –0.26 ppm.

(*E*)-1-(3-Methylthiophen-2-yl)-3-phenylprop-2-en-1-one (S3)



1-(3-Methylthiophen-2-yl)ethan-1-one (210 mg, 1.50 mmol, 1.0 equiv), benzaldehyde (175 mg, 1.65 mmol, 1.1 equiv), NaOH (75.0 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 10 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **S3** (659 mg, 2.89 mmol, 96%) as a pale yellow solid.

m.p. = 37 – 39 °C. [Lit.: 43 – 45 °C.]

IR (film) ν_{max}/cm^{-1} 1651, 1598, 1575, 1521, 1495, 1449, 1402, 1328, 1203, 1040, 997, 975, 937.

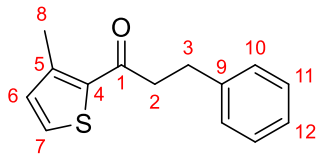
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.80 (1H, d, J = 15.4 Hz, C3H), 7.66 – 7.59 (2H, m, 2 × C10H), 7.46 (1H, d, J = 4.9 Hz, C7H), 7.43 – 7.38 (3H, m, 2 × C11H and C12H), 7.35 (1H, d, J = 15.4 Hz, C2H), 7.00 (1H, d, J = 4.9 Hz, C6H), 2.66 (3H, s, C8H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 183.1 (C1=O), 146.1 (C5), 143.6 (C3H), 136.4 (C4), 134.9 (C9), 133.0 (C6H), 130.5 (C12H), 129.8 (C7H), 129.0 (2C, 2 × C11H), 128.5 (2C, 2 × C10H), 124.3 (C2H), 17.2 (C8H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 251.0501; $C_{14}H_{12}OSNa$ requires 251.0501, Δ 0.13 ppm.

The analytical data are identical to those reported in literature.[59]

1-(3-Methylthiophen-2-yl)-3-phenylpropan-1-one (S4)



Enone **S3** (650 mg, 2.80 mmol, 1.0 equiv), $Pd(OH)_2/C$ (65 mg, 10 wt%) and EtOAc (14 mL, 0.2 M) were subjected to **General Procedure C** for 4 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S4** (231 mg, 1.00 mmol, 36%) as a colourless oil. Enone **S3** (250 mg, 1.08 mmol, 38%) was also recovered from the reaction.

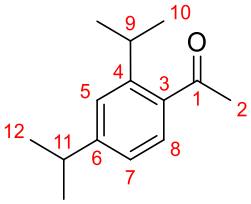
IR (film) ν_{max}/cm^{-1} 3062, 3027, 2921, 2851, 1665, 1522, 1495, 1453, 1404, 1379, 1355, 1289, 1191, 1031, 977.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.39 (1H, d, J = 4.9 Hz, C7H), 7.34 – 7.28 (2H, m, 2 × C11H), 7.28 – 7.24 (2H, m, 2 × C10H), 7.24 – 7.18 (1H, m, C12H), 6.95 (1H, d, J = 4.9 Hz, C6H), 3.21 – 3.13 (2H, m, $C2H_2$), 3.11 – 3.03 (2H, m, $C3H_2$), 2.58 (3H, s, $C8H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 192.9 (C1=O), 145.4 (C5), 141.2 (C9), 135.6 (C4), 132.8 (C6H), 129.6 (C7H), 128.63 (2C, 2 × C11H), 128.57 (2C, 2 × C10H), 126.2 (C12H), 43.6 ($C2H_2$), 30.5 ($C3H_2$), 17.1 ($C8H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 253.0658; $C_{14}H_{14}OSNa$ requires 253.0658, Δ –0.03 ppm.

1-(2,4-Diisopropylphenyl)ethan-1-one (S5)



1,3-Diisopropylbenzene (1.62 g, 10.0 mmol, 1.0 equiv), acetyl bromide (740 μL, 1.23 g, 10.0 mmol, 1.0 equiv), $AlCl_3$ (1.47 g, 11.0 mmol, 1.1 equiv) and DCM (50 mL) were subjected to a modification of **General Procedure B** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S5** (1.95 g, 9.54 mmol, 95%) as a colourless oil.

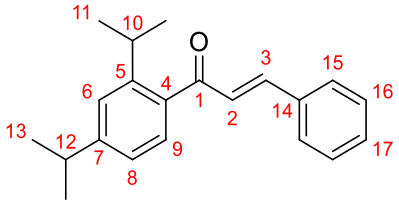
IR (film) ν_{max}/cm^{-1} 2962, 2927, 2907, 2870, 1683, 1607, 1563, 1493, 1463, 1413, 1383, 1356, 1327, 1285, 1246, 1190, 1166, 1094, 1062, 1014, 962, 923, 894, 824, 759.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.48 (1H, d, J = 8.0 Hz, C8H), 7.26 (1H, s, C5H), 7.09 (1H, dd, J = 8.0, 1.8 Hz, C7H), 3.57 (1H, sept., J = 6.9 Hz, C9H), 2.93 (1H, sept., J = 6.9 Hz, C11H), 2.56 (3H, s, C2H_3), 1.26 (6H, d, J = 6.9 Hz, 2 × C12H_3), 1.24 (6H, d, J = 6.9 Hz, 2 × C10H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.1 (C1=O), 152.5 (C6), 148.6 (C4), 136.2 (C3), 128.6 (C8H), 124.9 (C5H), 123.3 (C7H), 34.4 (C11H), 30.6 (C2H_3), 29.3 (C9H), 24.3 (2C, 2 × C10H_3), 23.9 (2C, 2 × C12H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 205.15900; $C_{14}H_{21}O$ requires 205.15869, Δ 1.49 ppm.

(*E*)-1-(2,4-Diisopropylphenyl)-3-phenylprop-2-en-1-one (S6)



Ketone **S5** (511 mg, 2.50 mmol, 1.0 equiv), benzaldehyde (292 mg, 2.75 mmol, 1.1 equiv), NaOH (100 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 16 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **S6** (730 mg, 2.50 mmol, 100%) as a viscous yellow oil.

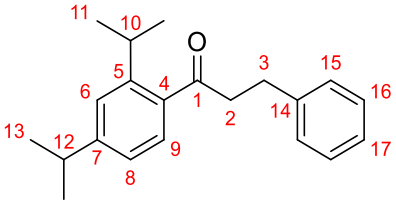
IR (film) ν_{max}/cm^{-1} 3060, 3026, 2961, 2928, 2870, 1667, 1643, 1604, 1575, 1495, 1461, 1449, 1415, 1383, 1362, 1329, 1300, 1283, 1213, 1187, 1160, 1117, 1103, 1089, 1058, 1029, 1014, 981, 926, 892, 873, 851, 829, 777, 752, 703, 683, 652.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.61 – 7.51 (2H, m, 2 × C15H), 7.44 (1H, d, J = 16.1 Hz, C3H), 7.44 – 7.36 (3H, m, 2 × C16H and C17H), 7.32 (1H, d, J = 7.9 Hz, C9H), 7.28 (1H, d, J = 1.7 Hz, C6H), 7.12 (1H, dd, J = 7.9, 1.8 Hz, C8H), 7.10 (1H, d, J = 16.1 Hz, C2H), 3.30 (1H, sept., J = 6.6 Hz, C10H), 2.96 (1H, sept., J = 6.8 Hz, C12H), 1.30 (6H, d, J = 6.9 Hz, 2 × C13H_3), 1.25 (6H, d, J = 6.9 Hz, 2 × C11H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 197.7 (C1=O), 151.5 (C7), 147.7 (C5), 145.9 (C3H), 136.6 (C4), 134.8 (C14), 130.7 (C17H), 129.1 (2C, 2 × C16H), 128.5 (2C, 2 × C15H), 127.91 (C9H), 127.87 (C2H), 124.6 (C6H), 123.4 (C8H), 34.5 (C12H), 30.0 (C10H), 24.4 (2C, 2 × C11H_3), 24.0 (2C, 2 × C13H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 293.18991; $C_{21}H_{25}O$ requires 293.18999, Δ –0.28 ppm.

1-(2,4-Diisopropylphenyl)-3-phenylpropan-1-one (S7)



Enone **S6** (730 mg, 2.50 mmol, 1.0 equiv), $Pd(OH)_2/C$ (73 mg, 10 wt%) and EtOAc (12.5 mL, 0.2 M) were subjected to **General Procedure C** for 3 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S7** (555 mg, 2.43 mmol, 92%) as a colourless oil.

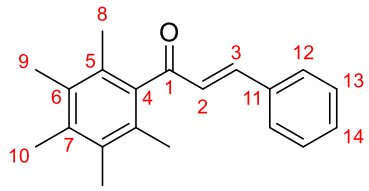
IR (film) ν_{max}/cm^{-1} 3106, 3086, 3063, 3027, 2961, 2928, 2870, 1684, 1606, 1562, 1496, 1455, 1414, 1383, 1362, 1331, 1290, 1253, 1232, 1210, 1185, 1162, 1088, 1076, 1056, 1029, 977, 922, 894, 825, 787, 775, 746, 699, 651.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.37 (1H, d, J = 8.0 Hz, C9H), 7.33 – 7.26 (2H, m, 2 × C16H), 7.27 – 7.21 (3H, m, C6H and 2 × C15H), 7.23 – 7.16 (1H, m, C17H), 7.07 (1H, dd, J = 8.0, 1.8 Hz, C8H), 3.38 (1H, sept., J = 6.9 Hz, C10H), 3.19 (2H, t, J = 7.6 Hz, $C2H_2$), 3.05 (2H, t, J = 7.6 Hz, $C3H_2$), 2.92 (1H, sept., J = 6.9 Hz, C12H), 1.26 (6H, d, J = 6.9 Hz, 2 × $C13H_3$), 1.22 (6H, d, J = 6.9 Hz, 2 × $C11H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 204.9 (C1=O), 152.2 (C7), 148.2 (C5), 141.4 (C14), 136.5 (C4), 128.62 (2C, 2 × C15H), 128.56 (2C, 2 × C16H), 127.7 (C9H), 126.2 (C17H), 124.9 (C6H), 123.4 (C8H), 44.3 ($C2H_2$), 34.4 (C12H), 30.5 ($C3H_2$), 29.4 (C10H), 24.3 (2C, 2 × $C11H_3$), 23.9 (2C, 2 × $C13H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 295.20572; $C_{21}H_{27}O$ requires 295.20564, Δ 0.26 ppm.

(*E*)-1-(2,3,4,5,6-Pentamethylphenyl)-3-phenylprop-2-en-1-one (S8)[5]



Ketone **121** (5.71 g, 30.0 mmol, 1.0 equiv), benzaldehyde (3.35 mL, 3.50 g, 33.0 mmol, 1.1 equiv), NaOH (1.50 m, 37.5 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 200 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Filtration and drying *in vacuo* afforded enone **S8** (8.13 g, 29.0 mmol, 97%) as a pale yellow solid.

m.p. = 136 – 138 °C.

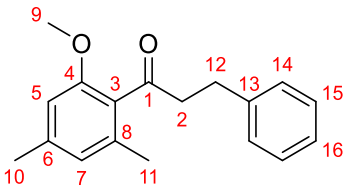
IR (film) ν_{max}/cm^{-1} 3059, 3034, 2981, 2924, 1640, 1621, 1602, 1575, 1495, 1448, 1382, 1315, 1271, 1179, 1123, 1070, 1017, 978, 954, 880.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.56 – 7.49 (2H, m, 2 × C12H), 7.43 – 7.34 (3H, m, 2 × C13H and C14H), 7.20 (1H, d, J = 16.2 Hz, C3H), 6.97 (1H, d, J = 16.2 Hz, C2H), 2.29 (3H, s, C10H_3), 2.23 (6H, s, 2 × C9H_3), 2.12 (6H, s, 2 × C8H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.0 (C1=O), 146.8 (C3H), 138.0 (C4), 135.6 (C7), 134.7 (C11), 133.0 (2C, 2 × C6), 130.8 (C14H), 129.12 (3C, 2 × C5 and C2H), 129.05 (2C, 2 × C12H), 128.6 (2C, 2 × C13H), 17.6 (2C, 2 × C8H_3), 16.9 (C10H_3), 16.2 (2C, 2 × C9H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 279.17432; $C_{20}H_{23}O$ requires 279.17434, Δ –0.09 ppm.

1-(2-Methoxy-4,6-dimethylphenyl)-3-phenylpropan-1-one (S9)



Phenol **338** (191 mg, 0.750 mmol, 1.0 equiv), NaH (35.8 mg, 60% dispersion in mineral oil, 0.788 mmol, 1.05 equiv), iodomethane (46 μL, 106 mg, 0.750 mmol, 1.0 equiv) and DMF (3.8 mL, 0.2 M) were subjected to **General Procedure G** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S9** (168 mg, 0.675 mmol, 90%) as a colourless oil.

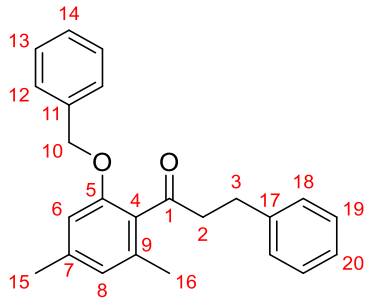
IR (film) ν_{max}/cm^{-1} 3085, 3062, 3026, 3002, 2960, 2925, 2858, 1692, 1610, 1576, 1496, 1454, 1409, 1378, 1356, 1311, 1286, 1260, 1243, 1222, 1206, 1187, 1155, 1096, 1030, 984, 921.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.31 – 7.25 (2H, m, 2 × C15H), 7.24 – 7.21 (2H, m, 2 × C14H), 7.21 – 7.15 (1H, m, C16H), 6.61 (1H, s, C7H), 6.56 (1H, s, C5H), 3.76 (3H, s, $C9H_3$), 3.14 – 3.06 (2H, m, $C2H_2$), 3.06 – 2.98 (2H, m, $C3H_2$), 2.31 (3H, s, $C10H_3$), 2.11 (3H, s, $C11H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 207.2 (C1=O), 156.6 (C4), 141.5 (C13), 140.4 (C6), 135.9 (C8), 128.58 (2C, 2 × C14H), 128.48 (2C, 2 × C15H), 128.38 (C3), 126.0 (C16H), 123.9 (C6H), 109.3 (C5H), 55.6 ($C9H_3$), 46.2 ($C2H_2$), 30.0 ($C14H_2$), 21.8 ($C10H_3$), 19.1 ($C11H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 269.15359; $C_{18}H_{21}O_2$ requires 269.15361, Δ –0.04 ppm.

1-(2-(Benzyloxy)-4,6-dimethylphenyl)-3-phenylpropan-1-one (S10)



Phenol **338** (191 mg, 0.750 mmol, 1.0 equiv), NaH (35.8 mg, 60% dispersion in mineral oil, 0.788 mmol, 1.05 equiv), BnBr (89 μL, 128 mg, 0.750 mmol, 1.0 equiv) and DMF (3.8 mL, 0.2 M) were subjected to **General Procedure G** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S10** (247 mg, 0.716 mmol, 96%) as a colourless solid.

m.p. = 78 – 80 °C.

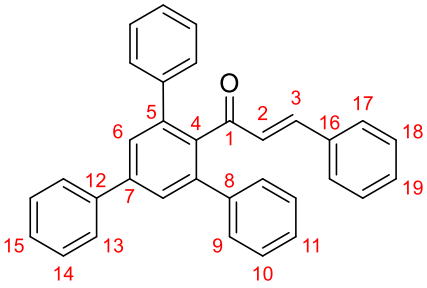
IR (film) ν_{max}/cm^{-1} 3086, 3063, 3028, 2956, 2922, 2867, 1692, 1610, 1574, 1497, 1453, 1378, 1357, 1310, 1283, 1260, 1204, 1155, 1087, 1029, 987.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.40 – 7.30 (5H, m, 2 × C12H, 2 × C13H and C14H), 7.25 – 7.18 (2H, m, 2 × C19H), 7.18 – 7.12 (1H, m, C20H), 7.11 – 7.04 (2H, m, 2 × C18H), 6.63 (2H, s, C6H and C8H), 5.04 (2H, s, $C10H_2$), 3.14 – 3.06 (2H, m, $C2H_2$), 2.99 – 2.91 (2H, m, $C3H_2$), 2.30 (3H, s, $C15H_3$), 2.13 (3H, s, $C16H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 207.1 (C1=O), 155.9 (C5), 141.5 (C17), 140.4 (C7), 136.7 (C11), 136.1 (C9), 128.78 (C5), 128.74 (2C, 2 × C13H), 128.51 (2C, 2 × C18H), 128.44 (2C, 2 × C19H), 128.2 (C14H), 127.6 (2C, 2 × C12H), 126.0 (C20H), 124.3 (C8H), 110.6 (C6H), 70.6 ($C10H_2$), 46.3 ($C2H_2$), 30.1 ($C3H_2$), 21.8 ($C15H_3$), 19.2 ($C16H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 345.18512; $C_{24}H_{25}O_2$ requires 345.18491, Δ 0.62 ppm.

(*E*)-3-Phenyl-1-(5′-phenyl-[1,1′:3',1′′-terphenyl]-2′-yl)prop-2-en-1-one (S11), or (*E*)-3-Phenyl-1-(2,4,6-triphenylphenyl)prop-2-en-1-one (S11)



1,3,5-Triphenylbenzene (460 mg, 1.50 mmol, 1.0 equiv), cinnamoyl chloride (275 mg, 1.65 mmol, 1.1 equiv), $AlCl_3$ (220 mg, 1.88 mmol, 1.25 equiv) and DCM (7.5 mL, 0.2 M) were subjected to **General Procedure B** for 2 h. Purification by flash column chromatography (Pentane:EtOAc, 95:5) afforded enone **S11** (483 mg, 1.11 mmol, 74%) as a yellow solid.

m.p. = 213 – 215 °C. [Lit.: 210 °C.][60]

IR (film) ν_{max}/cm^{-1} 3081, 3058, 3031, 1675, 1648, 1626, 1597, 1575, 1558, 1494, 1448, 1427, 1395, 1328, 1307, 1296, 1267, 1206, 1181, 1158, 1105, 1075, 1046, 1030, 1018, 999, 977, 908, 888.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.72 (2H, m, 2 × C13H), 7.52 – 7.46 (2H, m, 2 × C6H), 7.45 – 7.38 (5H, m, 4 × C9H and C15H), 7.37 – 7.32 (4H, m, 4 × C10H), 7.34 – 7.28 (3H, m, 2 × C11H and C19H), 7.30 – 7.23 (4H, m, 2 × C17H and 2 × C18H), 7.13 (1H, d, J = 16.2 Hz, C3H), 6.49 (1H, d, J = 16.2 Hz, C2H).

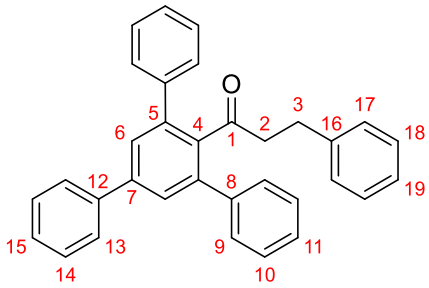
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 198.2 (C1=O), 145.0 (C3H), 142.0 (C7), 141.4 (2C, 2 × C5), 140.7 (2C, 2 × C8), 140.1 (C12), 137.8 (C4), 134.7 (C16), 130.5 (C19H), 129.3 (4C, 4 × C9H), 129.09 (2C, 2 × C14H), 129.04 (C2H), 128.9 (2C, 2 × C18H), 128.5 (4C, 4 × C10H), 128.30 (2C, 2 × C17H), 128.15 (2C, 2 × C6H), 128.11 (C15H), 127.7 (2C, 2 × C11H), 127.4 (2C, 2 × C13H).

HRMS (ESI^+) Found $[M+H]^+$ = 437.19012; $C_{33}H_{25}O$ requires 437.18999, Δ 0.30 ppm.

Note: The compound has rather poor solubility in EtOAc.

3-Phenyl-1-(5′-phenyl-[1,1′:3′,1′′-terphenyl]-2′-yl)propan-1-one (S12), or

3-Phenyl-1-(2,4,6-triphenylphenyl)propan-1-one (S12)



Enone **S11** (300 mg, 0.687 mmol, 1.0 equiv), $Pd(OH)_2/C$ (30 mg, 10 wt%) and EtOAc:DCM (10:1, 14 mL, 0.05 M) were subjected to a modification **General Procedure C** for 4 h. Purification by flash column chromatography (Pentane:Et_2O, 96:4) afforded ketone **S12** (288 mg, 0.656 mmol, 96%) as a pale yellow solid.

m.p. = 47 – 49 °C.

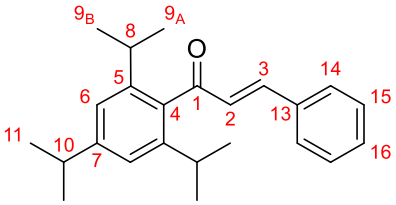
IR (film) ν_{max}/cm^{-1} 3105, 3083, 3059, 3029, 2927, 1698, 1595, 1575, 1557, 1495, 1453, 1427, 1396, 1356, 1289, 1256, 1199, 1157, 1076, 1030, 978, 909, 888, 760, 699.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.72 – 7.64 (2H, m, 2 × C13H), 7.61 (2H, s, 2 × C6H), 7.50 – 7.44 (2H, m, 2 × C14H), 7.44 – 7.40 (10H, m, 4 × C9H, 4 × C10H and 2 × C11H), 7.40 – 7.35 (1H, m, C15H), 7.17 – 7.11 (2H, m, 2 × C18H), 7.11 – 7.07 (1H, m, C19H), 6.78 – 6.72 (2H, m, 2 × C17H), 2.50 – 2.39 (4H, m, $C2H_2$ and $C3H_2$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 207.4 (C1=O), 141.7 (C7), 141.0 (C16), 140.4 (2C, 2 × C8), 140.04 (C12), 139.99 (2C, 2 × C5), 139.89 (C4), 129.4 (4C, 4 × C9H), 129.1 (2C, 2 × C14H), 128.6 (4C, 4 × C10H), 128.37 (2C, 2 × C18H), 128.28 (2C, 2 × C17H), 128.07 (C15H), 128.04 (2C, 2 × C6H), 127.90 (2C, 2 × C11H), 127.4 (2C, 2 × C13H), 125.9 (C19H), 47.4 ($C2H_2$), 29.8 ($C3H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 439.20575; $C_{33}H_{27}O$ requires 439.20564, Δ 0.24 ppm.

(*E*)-3-Phenyl-1-(2,4,6-triisopropylphenyl)prop-2-en-1-one (S13)



1-(2,4,6-Triisopropylphenyl)ethan-1-one (370 mg, 1.50 mmol, 1.0 equiv), benzaldehyde (175 mg, 1.65 mmol, 1.1 equiv), NaOH (75.0 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 10 mL, 0.15 M) were subjected to **General Procedure A** for 72 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **S13** (341 mg, 0.989 mmol, 66%) as a yellow oil.

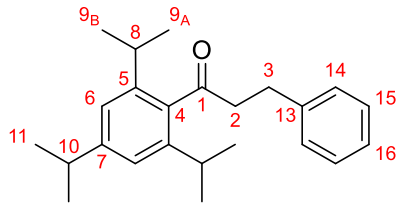
IR (film) ν_{max}/cm^{-1} 2960, 2928, 2869, 1647, 1623, 1604, 1574, 1462, 1448, 1427, 1297, 1282, 1253, 1063, 1016, 981.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.62 – 7.57 (2H, m, 2 × C14H), 7.50 – 7.43 (3H, m, 2 × C15H and C16H), 7.31 (1H, d, J = 16.2 Hz, C3H), 7.14 (2H, s, 2 × C6H), 7.08 (2H, d, J = 16.2 Hz, C2H), 3.02 (1H, sept., J = 6.8 Hz, C10H), 2.88 (2H, sept., J = 6.8 Hz, 2 × C8H), 1.37 (6H, d, J = 6.9 Hz, 2 × $C11H_3$), 1.27 (6H, br. s, 4 × $C9_AH_3$), 1.26 (6H, br. s, 4 × $C9_BH_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 202.1 (C1=O), 149.8 (C7), 146.8 (C3H), 145.0 (2C, 2 × C5), 135.5 (C4), 134.6 (C13), 130.8 (C16H), 129.8 (C2H), 129.1 (2C, 2 × C15H), 128.6 (2C, 2 × C14H), 121.2 (2C, 2 × C6H), 34.5 (C10H), 31.2 (2C, 2 × C8H), 24.9 (2C, br. s, 2 × $C9_AH_3$), 24.2 (2C, 2 × $C11H_3$), 24.0 (2C, br. s, 2 × $C9_BH_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 335.23691; $C_{24}H_{31}O$ requires 335.23694, Δ –0.10 ppm.

3-Phenyl-1-(2,4,6-triisopropylphenyl)propan-1-one (S14)



Enone **S13** (341 mg, 1.00 mmol, 1.0 equiv), $Pd(OH)_2/C$ (34.1 mg, 10 wt%) and EtOAc (5.0 mL, 0.2 M) were subjected to **General Procedure C** for 2 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S14** (298 mg, 0.886 mmol, 89%) as a viscous pale yellow liquid.

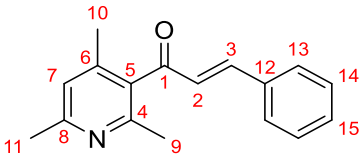
IR (film) ν_{max}/cm^{-1} 3062, 3028, 2961, 2928, 2869, 1699, 1606, 1570, 1496, 1459, 1363, 1223, 1098, 976.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.33 – 7.23 (4H, m, 2 × C14H and 2 × C15H), 7.23 – 7.17 (1H, m, C16H), 6.98 (2H, s, 2 × C6H), 3.13 – 2.98 (4H, m, $C2H_2$ and $C3H_2$), 2.88 (1H, sept., J = 6.9 Hz, C10H), 2.51 (2H, sept., J = 6.8 Hz, 2 × C8H), 1.24 (6H, d, J = 6.9 Hz, 2 × $C11H_3$), 1.17 (12H, br. d, J = 6.8 Hz, 2 × $C9_AH_3$ and 2 × $C9_BH_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.2 (C1=O), 149.6 (C7), 143.6 (2C, 2 × C5), 141.1 (C13), 138.0 (C4), 128.7 (2C, 2 × C14H), 128.6 (2C, 2 × C15H), 126.2 (C16H), 121.1 (2C, 2 × C6H), 48.0 ($C2H_2$), 34.4 (C10H), 31.0 (2C, 2 × C8H), 29.6 ($C3H_2$), 24.5 (4C, v. br. s, 2 × $C9_AH_3$ and 2 × $C9_BH_3$), 24.1 (2C, 2 × $C11H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 359.2345; $C_{24}H_{32}ONa$ requires 359.2345, Δ –0.20 ppm.

(*E*)-3-Phenyl-1-(2,4,6-trimethylpyridin-3-yl)prop-2-en-1-one (S15)[5]



1-(2′,4′,6′-Trimethylpyridin-3-yl)ethan-1-one (224 mg, 1.50 mmol, 1.0 equiv), benzaldehyde (175 mg, 1.65 mmol, 1.1 equiv), NaOH (75.0 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 10 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 50:50) afforded enone **S15** (337 mg, 1.34 mmol, 89%) as a pale yellow solid.

m.p. = 92 – 94 °C.

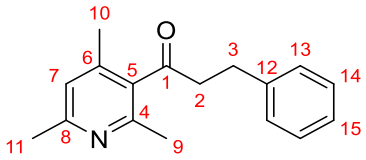
IR (film) ν_{max}/cm^{-1} 3061, 3029, 2958, 2921, 1643, 1592, 1449, 1275, 1187, 1070, 982.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.55 – 7.47 (2H, m, 2 × C13H), 7.45 – 7.36 (3H, m, 2 × C14H and C15H), 7.17 (1H, d, J = 16.3 Hz, C3H), 6.95 (1H, d, J = 16.3 Hz, C2H), 6.91 (1H, s, C7H), 2.54 (3H, s, $C9H_3$), 2.42 (3H, s, $C11H_3$), 2.19 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 199.5 (C1=O), 158.1 (C4), 153.5 (C8), 147.5 (C3H), 144.5 (C6), 134.2 (C12), 132.6 (C5), 131.3 (C15H), 129.2 (2C, 2 × C13H), 128.7 (2C, 2 × C14H), 128.2 (C2H), 122.4 (C7H), 24.5 ($C9H_3$), 22.9 ($C11H_3$), 19.1 ($C10H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 274.1203; $C_{17}H_{17}NONa$ requires 274.1202, Δ 0.35 ppm.

3-Phenyl-1-(2,4,6-trimethylpyridin-3-yl)propan-1-one (S16)[5]



Enone **S15** (326 mg, 1.30 mmol, 1.0 equiv), $Pd(OH)_2/C$ (32.6 mg, 10 wt%) and EtOAc (6.5 mL, 0.2 M) were subjected to **General Procedure C** for 3.5 h. Purification by flash column chromatography (Pentane:Et_2O, 50:50) afforded ketone **S16** (310 mg, 1.22 mmol, 94%) as a colourless oil.

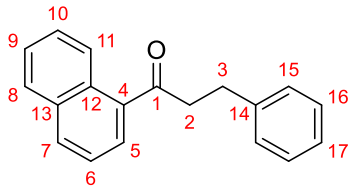
IR (film) ν_{max}/cm^{-1} 3063, 3028, 2959, 2923, 1699, 1592, 1559, 1496, 1453, 1166, 1029, 975.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.32 – 7.25 (2H, m, 2 × C14H), 7.24 – 7.17 (3H, m, 2 × C13H and C15H), 6.81 (1H, s, C7H), 3.10 – 2.99 (4H, m, $C2H_2$ and $C3H_2$), 2.47 (3H, s, $C9H_3$), 2.32 (3H, s, $C11H_3$), 2.08 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 207.9 (C1=O), 157.9 (C4), 152.0 (C8), 142.9 (C6), 140.6 (C12), 134.7 (C5), 128.7 (2C, 2 × C14H), 128.6 (2C, 2 × C13H), 126.4 (C15H), 122.4 (C7H), 46.5 ($C2H_2$), 29.6 ($C3H_2$), 24.3 ($C9H_3$), 22.5 ($C11H_3$), 18.8 ($C10H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 276.1360; $C_{17}H_{19}NONa$ requires 276.1359, Δ 0.37 ppm.

1-(Naphthalen-1-yl)-3-phenylpropan-1-one (S17)[61]



To a 10 – 20 mL microwave vial was added 1-acetylnaphthalene (850 mg, 5.00 mmol, 1.0 equiv), LiO*t*-Bu (800 mg, 10.0 mmol, 2.0 equiv), BnOH (780 mL, 811 mg, 7.50 mmol, 1.5 equiv) and toluene (20 mL, 0.25 M) sequentially. The vial was sealed with a microwave vial cap and purged with an Ar balloon briefly. The vial (complete with the Ar balloon) was then heated to 110 °C in a preheated oil bath for 12 h. The reaction mixture was cooled to RT, filtered through a SiO_2 plug, eluting with Et_2O, and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S17** (450 mg, 1.73 mmol, 35%) as a colourless oil).

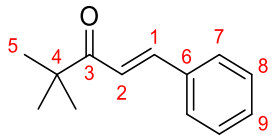
IR (film) ν_{max}/cm^{-1} 3085, 3060, 3027, 2950, 2928, 2863, 1681, 1620, 1593, 1574, 1508, 1496, 1454, 1398, 1356, 1288, 1234, 1213, 1172, 1099, 1074, 1030, 945, 866, 802, 779, 750, 699, 652.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.56 (1H, ddt, *J* = 8.6, 1.4, 0.8 Hz, C11H), 7.98 (1H, ddt, *J* = 8.2, 1.2, 0.6 Hz, C7H), 7.88 (1H, ddt, *J* = 8.1, 1.5, 0.6 Hz, C8H), 7.83 (1H, dd, *J* = 7.2, 1.2 Hz, C5H), 7.59 (1H, ddd, *J* = 8.5, 6.8, 1.5 Hz, C10H), 7.54 (1H, ddd, *J* = 8.1, 6.9, 1.3 Hz, C9H), 7.48 (1H, dd, *J* = 8.2, 7.2 Hz, C6H), 7.35 – 7.28 (2H, m, 2 × C16H), 7.30 – 7.24 (2H, m, 2 × C15H), 7.26 – 7.19 (1H, m, C17H), 3.43 – 3.36 (2H, m, $C2H_2$), 3.19 – 3.12 (2H, m, $C3H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.7 (C1=O), 141.2 (C14), 136.1 (C4), 134.1 (C13), 132.7 (C7H), 130.3 (C12), 128.68 (2C, 2 × C16H), 128.60 (2C, 2 × C15H), 128.54 (C8H), 128.0 (C10H), 127.5 (C5H), 126.6 (C9H), 126.3 (C17H), 125.9 (C11H), 124.5 (C6H), 44.0 ($C2H_2$), 30.7 ($C3H_2$).

HRMS (ESI^+) Found $[M+H]^+$ = 261.12758; $C_{19}H_{17}O$ requires 261.12739, Δ 0.72 ppm.

(*E*)-4,4-Dimethyl-1-phenylpent-1-en-3-one (S18)



Pinacolone (150 mg, 1.50 mmol, 1.0 equiv), benzaldehyde (175 mg, 1.65 mmol, 1.1 equiv), NaOH (75.0 mg, 1.88 mmol, 1.25 equiv) and EtOH:H_2O (1:1, 10 mL, 0.15 M) were subjected to **General Procedure A** for 24 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded enone **S18** (164 mg, 0.870 mmol, 58%) as a colourless solid.

m.p. = 34 – 36 °C.

IR (film) ν_{max}/cm^{-1} 2968, 2869, 1683, 1610, 1576, 1495, 1477, 1449, 1395, 1366, 1330, 1202, 1076, 1010, 980.

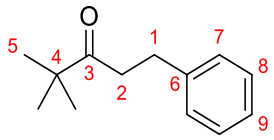
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.69 (1H, d, J = 15.6 Hz, C1H), 7.61 – 7.51 (2H, m, 2 × C7H), 7.43 – 7.35 (3H, m, 2 × C8H and C9H), 7.13 (1H, d, J = 15.6 Hz, C2H), 1.24 (9H, s, 3 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 204.4 (C3=O), 143.0 (C1H), 135.1 (C6), 130.3 (C9H), 129.0 (2C, 2 × C8H), 128.4 (2C, 2 × C7H), 120.9 (C2H), 43.4 (C4), 26.5 (3C, 3 × $C5H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 189.12746; $C_{13}H_{17}O$ requires 189.12739, Δ 0.34 ppm.

The analytical data are identical to those reported in literature.[62]

4,4-Dimethyl-1-phenylpentan-3-one (S19)



Enone **S18** (160 mg, 0.850 mmol, 1.0 equiv), $Pd(OH)_2/C$ (16.0 mg, 10 wt%) and EtOAc (4.0 mL, 0.2 M) were subjected to **General Procedure C** for 1 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S19** (121 mg, 0.636 mmol, 75%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3064, 3028, 2969, 2931, 2870, 1704, 1604, 1496, 1478, 1454, 1366, 1085, 1069, 1030, 983.

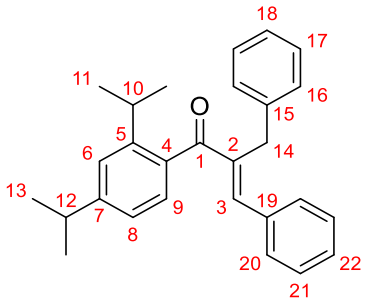
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.33 – 7.23 (2H, m, 2 × C8H), 7.23 – 7.15 (3H, m, 2 × C7H and C9H), 2.92 – 2.84 (2H, m, $C1H_2$), 2.84 – 2.76 (2H, m, $C2H_2$), 1.12 (9H, s, 3 × $C5H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 215.0 (C3=O), 141.6 (C6), 128.45 (2C, 2 × C8H), 128.41 (2C, 2 × C7H), 126.0 (C9H), 44.1 (C4), 38.5 ($C2H_2$), 30.1 ($C1H_2$), 26.3 (3C, 3 × $C5H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 213.12520; $C_{13}H_{18}ONa$ requires 213.12499, Δ 0.99 ppm.

The analytical data are identical to those reported in literature.[63]

(*E*)-2-Benzyl-1-(2,4-diisopropylphenyl)-3-phenylprop-2-en-1-one (S20)



In the preparation of ketone **74**, enone **S20** (13.0 mg, 33.9 μmol, 11%) was also isolated as a colourless oil.

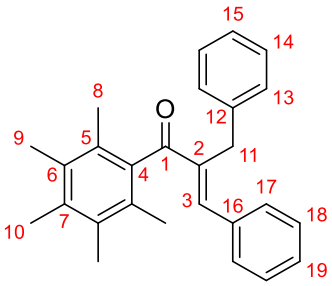
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3026, 2960, 2926, 2870, 1650, 1619, 1605, 1575, 1562, 1494, 1452, 1416, 1382, 1363, 1319, 1296, 1254, 1223, 1186, 1160, 1127, 1105, 1071, 1054, 1030, 1002, 964, 923, 893, 824, 776, 762, 737, 713, 697.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.37 (1H, s, C3H), 7.39 – 7.33 (4H, m, 2 × C20H and 2 × C21H), 7.36 – 7.31 (1H, m, C22H), 7.34 – 7.26 (2H, m, 2 × C17H), 7.31 – 7.24 (2H, m, 2 × C16H), 7.23 (1H, d, J = 1.7 Hz, C6H), 7.25 – 7.17 (1H, m, C18H), 7.15 (1H, d, J = 7.8 Hz, C9H), 7.07 (1H, dd, J = 7.9, 1.7 Hz, C8H), 4.12 (2H, s, $C14H_2$), 3.02 (1H, sept., J = 6.9 Hz, C10H), 2.94 (1H, sept., J = 6.9 Hz, C12H), 1.28 (6H, d, J = 6.9 Hz, 2 × $C13H_3$), 1.20 (6H, d, J = 6.9 Hz, 2 × $C11H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.3 (C1=O), 150.8 (C12), 147.3 (C5), 145.6 (C3H), 141.6 (C2), 139.5 (C15), 136.3 (C4), 135.5 (C19), 129.5 (2C, 2 × C20H), 129.2 (C22H), 128.73 (2C, 2 × C21H), 128.70 (2C, 2 × C17H), 128.4 (2C, 2 × C16H), 127.8 (C9H), 126.2 (C18H), 124.2 (C6H), 123.2 (C8H), 34.4 (C12H), 32.2 ($C14H_2$), 30.3 (C10H), 24.3 (2C, 2 × $C11H_3$), 24.1 (2C, 2 × $C13H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 383.23697; $C_{28}H_{31}O$ requires 383.23694, Δ 0.07 ppm.

(*E*)-2-Benzyl-1-(2,3,4,5,6-pentamethylphenyl)-3-phenylprop-2-en-1-one (S21)



In the preparation of ketone **79**, enone **S21** (24.0 mg, 65.1 μmol, 22%) was also isolated as a pale yellow solid.

m.p. = 123 – 126 °C.

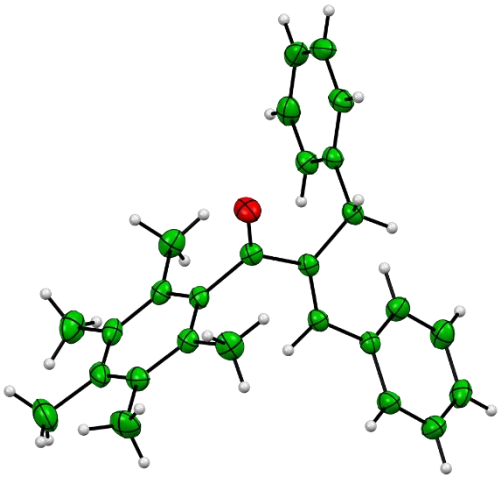
IR (film) ν_{max}/cm^{-1} 3084, 3060, 3027, 2925, 2857, 1726, 1653, 1620, 1494, 1451, 1381, 1306, 1266, 1204, 1165, 1075, 1029, 905.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.43 (1H, s, C3H), 7.40 – 7.27 (9H, m, 2 × C13H, 2 × C14H, 2 × C17H, 2 × C18H and C19H), 7.26 – 7.14 (1H, m, C15H), 4.13 (2H, s, $C11H_2$), 2.28 (3H, s, $C10H_3$), 2.21 (6H, s, 2 × $C9H_3$), 2.04 (6H, s, 2 × $C8H_3$).

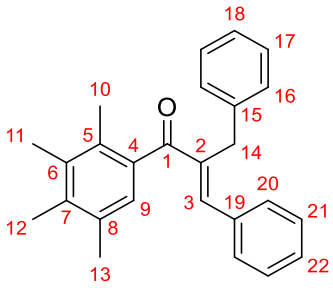
^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.9 (C1=O), 146.1 (C3H), 140.6 (C2), 139.4 (C12), 137.6 (C4), 135.52 (C7), 135.35 (C16), 132.9 (2C, 2 × C6), 129.62 (2C, 2 × C17H), 129.50 (2C, 2 × C5), 129.3 (C19H), 128.7 (2C, 2 × C18H), 128.57 (2C, 2 × C13H), 128.55 (2C, 2 × C14H), 126.2 (C15H), 31.7 ($C11H_2$), 17.6 (2C, 2 × $C8H_3$), 16.9 ($C10H_3$), 16.1 (2C, 2 × $C9H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 369.2215; $C_{27}H_{29}O$ requires 369.2213, Δ 0.47 ppm.

The structure of the product was confirmed by single crystal X-ray diffraction. An ORTEP representation of the molecule is shown below.



(*E*)-2-Benzyl-3-phenyl-1-(2,3,4,5-tetramethylphenyl)prop-2-en-1-one (S22)



In the preparation of ketone **83**, enone **S22** (16.0 mg, 45.1 μmol, 15%) was also isolated as a pale yellow oil.

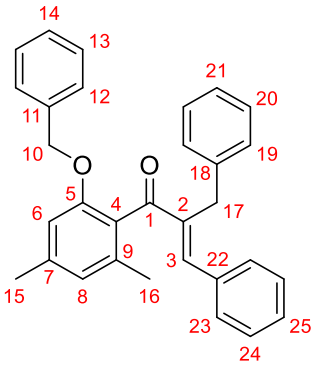
IR (film) ν_{max}/cm^{-1} 3084, 3060, 3026, 3004, 2923, 2866, 1650, 1619, 1601, 1574, 1494, 1449, 1383, 1303, 1234, 1204, 1164, 1077, 1030, 1002, 947, 927, 866.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.40 (1H, s, C3H), 7.39 – 7.32 (5H, m, 2 × C20H, 2 × C21H and C22H), 7.32 – 7.26 (4H, m, 2 × C16H and 2 × C17H), 7.24 – 7.18 (1H, m, C18H), 6.91 (1H, s, C9H), 4.12 (2H, s, $C14H_2$), 2.28 (3H, s, $C13H_3$), 2.25 (3H, s, $C12H_3$), 2.25 (3H, s, $C11H_3$), 2.17 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 201.7 (C1=O), 145.8 (C3H), 141.0 (C2), 139.6 (C15), 137.5 (C4), 136.7 (C7), 136.0 (C6), 135.5 (C19), 133.3 (C8), 131.6 (C5), 129.5 (2C, 2 × C20H), 129.1 (C22H), 128.68 (2C, 2 × C21H), 128.65 (2C, 2 × C17H), 128.4 (2C, 2 × C16H), 126.4 (C9H), 126.2 (C18H), 32.2 ($C14H_2$), 20.9 ($C13H_3$), 17.5 ($C10H_3$), 16.4 ($C12H_3$), 16.1 ($C11H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 377.18765; $C_{26}H_{26}ONa$ requires 377.18759, Δ 0.17 ppm.

(*E*)-2-Benzyl-1-(2-(benzyloxy)-4,6-dimethylphenyl)-3-phenylprop-2-en-1-one (S23)



In the preparation of ketone **87**, enone **S23** (51.1 mg, 88.8 μmol, 30%) was also isolated as a yellow oil.

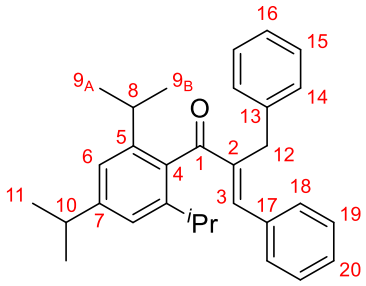
IR (film) ν_{max}/cm^{-1} 3084, 3062, 3028, 2920, 2854, 1652, 1612, 1575, 1495, 1452, 1377, 1312, 1280, 1260, 1226, 1166, 1090, 1075, 1030, 1002, 975, 956, 931.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.52 (1H, s, C3H), 7.33 – 7.30 (5H, m, 2 × C13H, C14H and 2 × C23H), 7.30 – 7.26 (2H, m, 2 × C12H), 7.26 – 7.23 (3H, m, 2 × C24H and C25H), 7.23 – 7.18 (2H, m, 2 × C19H), 7.13 – 7.08 (3H, m, 2 × C20H and C21H), 6.69 (1H, s, C8H), 6.65 (1H, s, C6H), 5.04 (2H, s, $C10H_2$), 4.08 (2H, s, $C17H_2$), 2.34 (3H, s, $C15H_3$), 2.14 (3H, s, $C16H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.1 (C1=O), 155.8 (C5), 145.3 (C3H), 140.4 (C2), 139.77 (C7), 139.66 (C18), 137.0 (C11), 136.6 (C9), 135.6 (C22), 129.7 (2C, 2 × C23H), 129.2 (C14H), 128.62 (2C, 2 × C13H), 128.59 (2C, 2 × C24H), 128.45 (2C, 2 × C20H), 128.33 (2C, 2 × C19H), 127.9 (C25H), 127.5 (2C, 2 × C12H), 126.9 (C4), 125.8 (C21H), 123.9 (C8H), 110.7 (C6H), 70.4 ($C10H_2$), 31.9 ($C17H_2$), 21.8 ($C15H_3$), 19.1 ($C16H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 455.19791; $C_{31}H_{28}O_2Na$ requires 455.19815, Δ –0.54 ppm.

(*E*)-2-Benzyl-3-phenyl-1-(2,4,6-triisopropylphenyl)prop-2-en-1-one (S24)



In the preparation of ketone **89**, enone **S24** (76.3 mg, 0.180 mmol, 57%) was also isolated as a pale yellow solid.

m.p. = 144 – 146 °C.

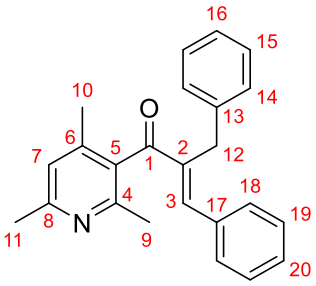
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3028, 2960, 2927, 2869, 1652, 1620, 1605, 1573, 1494, 1453, 1429, 1383, 1362, 1318, 1297, 1248, 1224, 1184, 1135, 1104, 1071, 1029, 963, 929.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.42 (1H, s, C3H), 7.42 – 7.34 (5H, m, 2 × C18H, 2 × C19H and C20H), 7.34 – 7.25 (4H, m, 2 × C14H and 2 × C15H), 7.26 – 7.17 (1H, m, C16H), 7.03 (2H, s, 2 × C6H), 4.14 (2H, s, $C12H_2$), 2.93 (1H, sept., J = 6.9 Hz, C10H), 2.63 (2H, sept., J = 6.7 Hz, 2 × C8H), 1.30 (6H, d, J = 6.9 Hz, 2 × $C11H_3$), 1.19 (6H, d, J = 6.8 Hz, 2 × $C9_AH_3$), 1.11 (6H, d, J = 6.8 Hz, 2 × $C9_BH_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 203.0 (C1=O), 149.6 (C10), 145.9 (C3H), 145.3 (2C, 2 × 5C), 142.1 (C2), 139.3 (C13), 135.4 (C17), 134.9 (C14), 129.4 (2C, 2 × C18H), 129.3 (C20H), 128.8 (2C, 2 × C19H), 128.6 (2C, 2 × C14H), 128.5 (2C, 2 × C15H), 126.2 (C16H), 121.1 (2C, 2 × C6H), 34.4 (C10H), 31.6 ($C12H_2$), 31.0 (2C, 2 × C8H), 24.8 (2C, 2 × $C11H_3$), 24.2 (2C, 2 × $C9_BH_3$), 23.9 (2C, 2 × $C9_AH_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 425.2835; $C_{31}H_{37}O$ requires 425.2839, Δ –0.97 ppm.

(*E*)-2-Benzyl-3-phenyl-1-(2,4,6-trimethylpyridin-3-yl)prop-2-en-1-one (S25)



In the preparation of ketone **91**, enone **S25** (10.0 mg, 29.3 μmol, 9.8%) was also isolated as a yellow oil.

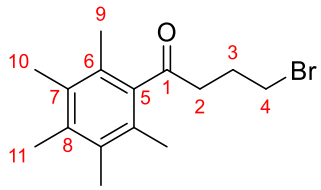
IR (film) ν_{max}/cm^{-1} 3060, 3027, 2981, 2956, 2921, 2854, 1650, 1619, 1592, 1559, 1494, 1450, 1386, 1376, 1316, 1297, 1260, 1231, 1180, 1103, 1073, 1030, 964, 937.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.41 – 7.33 (6H, m, C3H, 2 × C18H, 2 × C19H and C20H), 7.33 – 7.28 (2H, m, 2 × C15H), 7.28 – 7.24 (2H, m, 2 × C14H), 7.24 – 7.19 (1H, m, C16H), 6.88 (1H, s, C7H), 4.12 (2H, s, $C12H_2$), 2.53 (3H, s, $C9H_3$), 2.34 (3H, s, $C11H_3$), 2.11 (3H, s, $C10H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 200.7 (C1=O), 157.8 (C4), 153.6 (C8), 146.2 (C3H), 144.7 (C6), 140.3 (C2), 139.0 (C13), 135.0 (C17), 132.5 (C5), 129.8 (C20H), 129.7 (2C, 2 × C18H), 128.9 (2C, 2 × C19H), 128.7 (2C, 2 × C15H), 128.4 (2C, 2 × C14H), 126.4 (C16H), 122.4 (C7H), 31.7 ($C2H_2$), 24.4 ($C9H_3$), 22.8 ($C11H_3$), 19.1 ($C10H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 364.1671; $C_{24}H_{23}NONa$ requires 364.1672, Δ –0.36 ppm.

4-Bromo-1-(2,3,4,5,6-pentamethylphenyl)butan-1-one (S26)[5]



Pentamethylbenzene (666 mg, 4.50 mmol, 1.0 equiv), 4-bromobutanoyl chloride (573 μL, 924 mg, 4.95 mmol, 1.1 equiv), $AlCl_3$ (750 mg, 5.63 mmol, 1.25 equiv) and DCM (22.5 mL, 0.2 M) were subjected to **General Procedure D** for 3 h. Purification by flash column chromatography (Pentane:Et_2O, 99:1) afforded ketone **S26** (1.15 g, 3.89 mmol, 86%) as a colourless solid.

m.p. = 74 – 75 °C.

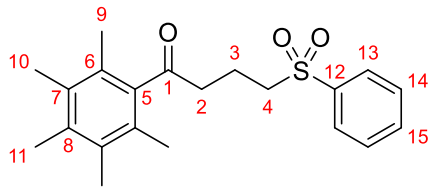
IR (film) ν_{max}/cm^{-1} 2925, 1697, 1575, 1438, 1403, 1315, 1243, 1110.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 3.58 (2H, t, J = 6.4 Hz, $C4H_2$), 2.88 (2H, t, J = 6.9 Hz, $C2H_2$), 2.29 (2H, quint., J = 6.7 Hz, $C3H_2$), 2.24 (3H, s, $C11H_3$), 2.19 (6H, s, 2 × $C10H_3$), 2.11 (6H, s, 2 × $C9H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.8 (C1=O), 140.3 (C5), 135.7 (C8), 133.3 (2C, 2 × C7), 127.4 (2C, 2 × C6), 43.5 ($C2H_2$), 33.5 ($C4H_2$), 26.4 ($C3H_2$), 17.3 (2C, 2 × $C9H_3$), 16.8 ($C11H_3$), 16.1 (2C, 2 × $C10H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 297.0850; $C_{15}H_{22}{}^{79}BrO$ requires 297.0849, Δ 0.56 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)-4-(phenylsulfonyl)butan-1-one (S27)



To a solution of α-bromoketone **S26** (149 mg, 0.500 mmol, 1.0 equiv) in anhydrous DMF (1.0 mL, 0.5 M) was added sodium phenylsulfinate (82.1 mg, 0.500 mmol, 1.0 equiv) at RT and stirred for 24 h, during which time the sulfinate salt slowly dissolved over 3 – 4 h. The reaction was diluted with H_2O (10 mL), brine (10 mL) and Et_2O (10 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 5 mL) and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography (Pentane:Et_2O, 70:30) afforded sulfone **S27** (146 mg, 0.408 mmol, 82%) as a colourless solid.

m.p. = 152 – 154 °C.

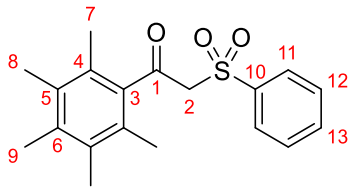
IR (film) ν_{max}/cm^{-1} 3060, 2927, 1697, 1585, 1447, 1406, 1306, 1223, 1197, 1149, 1114, 1087, 1071, 999.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.99 – 7.90 (2H, m, 2 × C13H), 7.74 – 7.63 (1H, m, C15H), 7.65 – 7.54 (2H, m, 2 × C14H), 3.32 – 3.23 (2H, m, C4H_2), 2.84 (2H, t, J = 6.9 Hz, C2H_2), 2.22 (3H, s, C11H_3), 2.17 (6H, s, 2 × C10H_3), 2.19 – 2.06 (2H, m, C3H_2), 2.05 (6H, s, 2 × C9H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 210.3 (C1=O), 139.9 (C12), 139.1 (C5), 135.9 (C8), 133.9 (C15H), 133.3 (2C, 2 × C7), 129.5 (2C, 2 × C14H), 128.2 (2C, 2 × C13H), 127.3 (2C, 2 × C6), 55.3 (C4H_2), 43.3 (C2H_2), 17.30 (2C, 2 × C9H_3), 17.16 (C3H_2), 16.8 (C11H_3), 16.1 (2C, 2 × C10H_3).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 381.1498; $C_{21}H_{26}O_3SNa$ requires 381.1495, Δ 0.77 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)-2-(phenylsulfonyl)ethan-1-one (S28)



To a solution of 2-bromo-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (135 mg, 0.500 mmol, 1.0 equiv) in anhydrous DMF (1.0 mL, 0.5 M) was added sodium phenylsulfinate (82.1 mg, 0.500 mmol, 1.0 equiv) at RT and stirred for 24 h, during which time the sulfinate salt slowly dissolved over 3 – 4 h. The reaction was diluted with H_2O (10 mL), brine (10 mL) and Et_2O (10 mL). The layers were separated, the aqueous layer extracted with Et_2O (3 × 5 mL) and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by column chromatography (Pentane:Et_2O, 70:30) afforded sulfone **S28** (120 mg, 0.363 mmol, 73%) as a colourless solid.

m.p. = 155 – 157 °C.

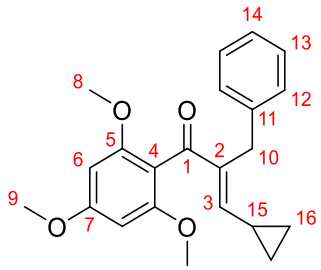
IR (film) ν_{max}/cm^{-1} 3061. 2911, 1704, 1584, 1447, 1384, 1322, 1309, 1246, 1156, 1142, 1083.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 8.06 – 7.97 (2H, m, 2 × C11H), 7.72 – 7.62 (1H, m, C13H), 7.62 – 7.52 (2H, m, Ph), 4.47 (2H, s, $C2H_2$), 2.21 (3H, s, $C9H_3$), 2.14 (6H, s, 2 × $C8H_3$), 2.03 (6H, s, 2 × $C7H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 198.3 (C1=O), 139.6 (C10), 138.1 (C3), 137.1 (C6), 134.1 (C13H), 133.6 (2C, 2 × C5), 129.2 (2C, 2 × C12H), 128.8 (2C, 2 × C11H), 128.1 (2C, 2 × C4), 67.6 ($C2H_2$), 17.4 (2C, 2 × $C7H_3$), 16.9 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 331.1363; $C_{19}H_{23}O_3S$ requires 331.1362, Δ 0.24 ppm.

(*E*)-2-Benzyl-3-cyclopropyl-1-(2,4,6-trimethoxyphenyl)prop-2-en-1-one (S29)



In the preparation of ketone **112**, enone **S29** (18.8 mg, 52.6 μmol, 18%) was also isolated as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3004, 2957, 2925, 2850, 1650, 1629, 1605, 1588, 1495, 1455, 1414, 1336, 1269, 1226, 1205, 1155, 1128, 962.

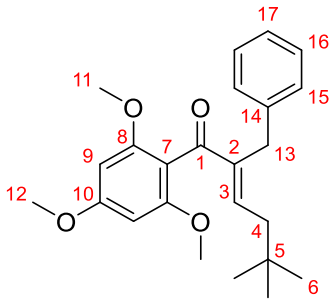
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.32 – 7.22 (4H, m, 2 × C12H and 2 × C13H), 7.18 – 7.11 (1H, m, C14H), 6.08 (2H, s, 2 × C6H), 5.87 (1H, d, J = 10.5 Hz, C3H), 3.95 (2H, s, $C10H_2$), 3.82 (3H, s, $C9H_3$), 3.67 (6H, s, 2 × $C8H_3$), 1.80 (1H, dtt, J = 10.5, 7.9, 4.5 Hz, C15H), 0.92 (2H, dq_{AB}, J = 8.0 Hz, J_{AB} = 4.4 Hz, Δ_{AB} = 5.1 Hz, 2 × C16H_{cis}H$_{trans}$), 0.50 (2H, dq_{AB}, J = 4.3 Hz, J_{AB} = 4.3 Hz, Δ_{AB} = 5.0 Hz, 2 × C16H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 195.5 (C1=O), 161.8 (C7), 158.4 (2C, 2 × C5), 153.9 (C3H), 140.6 (C11), 139.7 (C2), 128.6 (2C, 2 × C13H), 128.1 (2C, 2 × C13H), 125.6 (C14H), 111.7 (C4), 90.8 (2C, 2 × C6H), 55.9 (2C, 2 × $C8H_3$), 55.5 ($C9H_3$), 31.1 ($C10H_2$), 12.6 (C15H), 9.3 (2C, 2 × $C16H_2$).

HRMS (ESI^+) Found $[M+Na]^+$ = 375.1565; $C_{22}H_{24}O_4Na$ requires 375.1567, Δ –0.42 ppm.

Note: *cis* and *trans* with respect to C15H.

(*E*)-2-Benzyl-5,5-dimethyl-1-(2,4,6-trimethoxyphenyl)hex-2-en-1-one (S30)



In the preparation of ketone **13**, enone **S30** (28.3 mg, 74.0 μmol, 25%) was also isolated as a colourless solid.

m.p. = 136 – 138 °C.

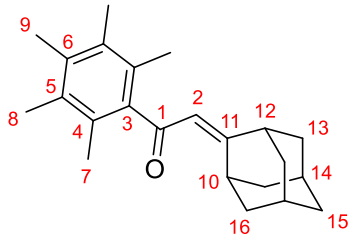
IR (film) ν_{max}/cm^{-1} 3026, 3002, 2955, 1656, 1637, 1605, 1588, 1496, 1455, 1414, 1227, 1205, 1155, 1129, 1036, 961.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.31 – 7.20 (4H, m, 2 × C15 and 2 × C16H), 7.20 – 7.10 (1H, m, C17H), 6.62 (1H, t, J = 7.7 Hz, C3H), 6.11 (2H, s, 2 × C9H), 3.84 (2H, s, $C13H_2$), 3.83 (3H, s, $C12H_3$), 3.69 (6H, s, 2 × $C11H_3$), 2.14 (2H, d, J = 7.7 Hz, $C4H_2$), 0.81 (9H, s, 3 × $C6H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 196.7 (C1=O), 161.9 (C10), 158.3 (2C, 2 × C8), 146.6 (C3H), 142.5 (C2), 140.5 (C14), 128.7 (2C, 2 × C15H), 128.1 (2C, 2 × C16H), 125.6 (C17H), 111.6 (C7), 90.6 (2C, 2 × C9H), 55.8 (2C, 2 × $C11H_3$), 55.5 ($C12H_3$), 43.0 ($C13H_2$), 31.9 ($C4H_2$), 30.7 (C5), 29.4 (3C, 3 × $C6H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 405.2033; $C_{24}H_{30}O_4Na$ requires 405.2036, Δ –0.72 ppm.

2-(Adamantan-2-ylidene)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (S31)



In the preparation of ketone **148** at 85 °C, enone **S31** (52.4 mg, 0.163 mmol, 27%) was also isolated as a pale yellow solid.

m.p. = 98 – 101 °C.

IR (film) ν_{max}/cm^{-1} 2906, 2851, 1721, 1702, 1671, 1611, 1449, 1417, 1384, 1348, 1314, 1302, 1262, 1221, 1208, 1169, 1128, 1099, 1070, 1010, 996, 946.

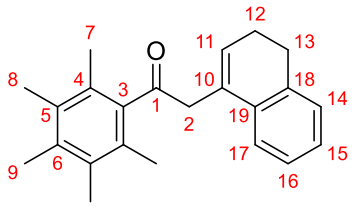
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.15 (1H, s, C2H), 3.72 (1H, quint., J = 3.1 Hz, C10H), 2.40 (1H, quint., J = 3.6 Hz, C12H), 2.23 (3H, s, C9H$_3$), 2.19 (6H, s, 2 × C8H$_3$), 2.15 (6H, s, 2 × C7H$_3$), 2.02 – 1.96 (2H, m, 2 × C13H_{anti}H$_{syn}$), 1.99 – 1.94 (2H, m, 2 × C14H), 1.93 – 1.87 (2H, m, 2 × C16H_{anti}H$_{syn}$), 1.91 – 1.86 (2H, m, C13H$_{anti}$$H_{syn}$), 1.87 – 1.84 (2H, m, C15H$_2$), 1.83 – 1.77 (2H, m, 2 × C16H$_{anti}$$H_{syn}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.3 (C1=O), 171.3 (C11), 141.8 (C3), 135.0 (C6), 133.0 (2C, 2 × C5), 127.9 (2C, 2 × C4), 120.4 (C2H), 41.9 (C12H), 40.5 (2C, 2 × C13H$_2$), 39.5 (2C, 2 × C16H$_2$), 36.9 (C15H$_2$), 33.2 (C10H), 28.0 (2C, 2 × C14H), 17.3 (2C, 2 × C7H$_3$), 16.8 (C9H$_3$), 16.1 (2C, 2 × C8H$_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 323.23709; $C_{23}H_{31}O$ requires 323.23694, Δ 0.46 ppm.

Note: *syn* and *anti* with respect to C2H.

2-(3,4-Dihydronaphthalen-1-yl)-1-(2,3,4,5,6-pentamethylphenyl)ethan-1-one (S32)



In the preparation of ketone **121** at 85 °C, skipped enone **S32** (52.4 mg, 0.163 mmol, 27%) was also isolated as a pale yellow solid.

m.p. = 105 – 107 °C.

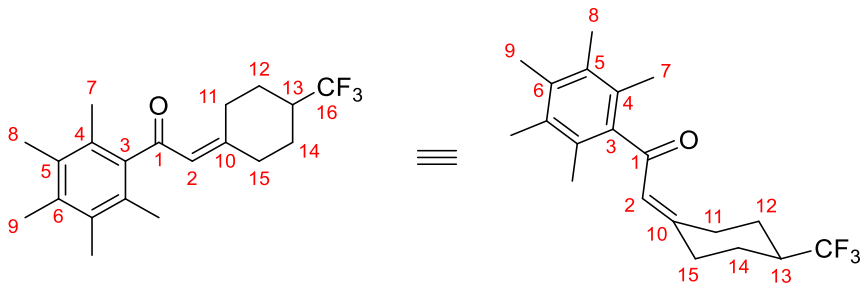
IR (film) ν_{max}/cm^{-1} 3057, 3021, 2983, 2927, 2892, 2823, 1703, 1573, 1489, 1448, 1406, 1319, 1278, 1257, 1234, 1168, 1106, 1068, 1019, 994, 946, 930, 910.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.31 – 7.27 (1H, m, C17H), 7.22 – 7.17 (1H, m, C16H), 7.17 – 7.14 (2H, m, C14H and C15H), 5.96 (1H, t, J = 4.5 Hz, C11H), 3.85 (2H, q, J = 1.0 Hz, $C2H_2$), 2.80 (2H, t, J = 8.0 Hz, $C13H_2$), 2.35 – 2.27 (2H, m, $C12H_2$), 2.26 (3H, s, $C9H_3$), 2.20 (6H, s, 2 × $C8H_3$), 2.14 (6H, s, 2 × $C7H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.2 (C1=O), 140.5 (C3), 136.5 (C18), 135.5 (C6), 134.8 (C19), 133.1 (2C, 2 × C5), 130.01 (C10), 129.94 (C11), 127.7 (3C, 2 × C4 and C14H), 127.1 (C15H), 126.5 (C16H), 123.3 (C17H), 49.8 ($C2H_2$), 28.3 ($C13H_2$), 23.5 ($C12H_2$), 17.7 (2C, 2 × $C7H_3$), 16.8 ($C9H_3$), 16.1 (2C, 2 × $C8H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 319.20578; $C_{23}H_{27}O$ requires 319.20564, Δ 0.43 ppm.

1-(2,3,4,5,6-Pentamethylphenyl)-2-(4-(trifluoromethyl)cyclohexylidene)ethan-1-one (S33)



In the preparation of ketone *cis*-**168**, enone **S33** (40.2 mg, 0.119 mmol, 20%) was also isolated as a pale yellow oil.

IR (film) ν_{max}/cm^{-1} 2981, 2889, 1672, 1615, 1451, 1391, 1337, 1323, 1300, 1275, 1252, 1216, 1198, 1179, 1154, 1116, 1074, 1010, 953.

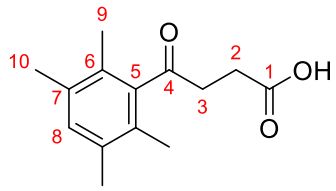
^{1}H{^{19}F} NMR ($CDCl_3$, 500 MHz) δ = 6.21 (1H, t, J = 1.7 Hz, C2H), 3.74 (1H, dtd, J = 14.4, 4.0, 1.8 Hz, C15H$_{ax}$*H$_{eq}$*), 2.35 (1H, dt, J = 13.9, 4.6 Hz, C11H$_{ax}$*H$_{eq}$*), 2.29 – 2.21 (1H, m, C11*H$_{ax}$*H$_{eq}$), 2.28 (1H, dtd, J = 12.2, 8.4, 4.1 Hz, C13H), 2.24 (3H, s, C9H$_3$), 2.18 (6H, s, 2 × C8H$_3$), 2.16 – 2.09 (1H, m, C12H$_{ax}$*H$_{eq}$*), 2.12 (6H, s, 2 × C2H$_3$), 2.10 – 2.03 (1H, m, C14H$_{ax}$*H$_{eq}$*), 1.93 (1H, td, J = 13.7, 4.5 Hz, C15*H$_{ax}$*H$_{eq}$), 1.52 (1H, tdd, J = 13.0, 12.0, 4.5 Hz, C12*H$_{ax}$*H$_{eq}$), 1.43 (1H, tdd, J = 13.2, 12.1, 4.1 Hz, C14*H$_{ax}$*H$_{eq}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ 201.9 (C1=O), 157.8 (C3), 141.2 (C3), 135.5 (C6), 133.2 (2C, 2 × C5), 127.9 (2C, 2 × C4), 127.4 (q, $^{1}J_{CF}$ = 278.6 Hz, C16F$_3$), 125.5 (C2H), 41.5 (q, $^{2}J_{CF}$ = 26.9 Hz, C13H), 35.9 (C11H$_2$), 27.5 (C15H$_2$), 26.7 (q, $^{3}J_{CF}$ = 2.6 Hz, C12H$_2$), 25.9 (q, $^{3}J_{CF}$ = 2.6 Hz, C14H$_2$), 17.3 (2C, 2 × C7H$_3$), 16.9 (C9H$_3$), 16.1 (2C, 2 × C8H$_3$).

^{19}F NMR ($CDCl_3$, 471 MHz) δ = –73.4 (3F, d, $^{3}J_{HF}$ = 8.6 Hz, C16F$_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 361.17484; $C_{20}H_{25}F_3ONa$ requires 361.17497, Δ –0.36 ppm.

4-Oxo-4-(2,3,5,6-tetramethylphenyl)butanoic acid (S34)



To a solution of succinic anhydride (495 mg, 5.00 mmol, 1.0 equiv) and durene (738 mg, 5.50 mmol, 1.1 equiv) in DCM (20 mL, 0.25 M) was added $AlCl_3$ (1.47 g, 11.0 mmol, 2.2 equiv) in a single portion at RT, and the reaction stirred for 10 min. The reaction was poured into ice/water/aq. 1 M HCl (1:1:1, 60 mL) and diluted with DCM (40 mL). The layers were separated, the aqueous layer extracted with DCM (3 × 30 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 75:25) afforded carboxylic acid **S34** (708 mg, 3.04 mmol, 76%) as a colourless solid.

m.p. = 165 – 167 °C. [Lit.: 160 – 161.][64]

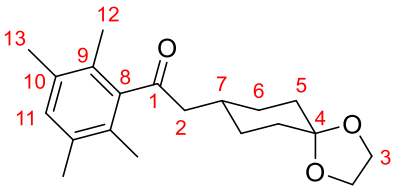
IR (film) ν_{max}/cm^{-1} 3034, 2940, 2919, 2760, 2662, 2569, 1716, 1696, 1469, 1437, 1392, 1355, 1339, 1251, 1235, 1218, 1168, 1116, 1012, 984, 963, 944, 921.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 10.66 (1H, v. br. s, OH), 6.97 (1H, s, C8H), 3.02 (2H, t, J = 6.4 Hz, C3H_2), 2.79 (2H, t, J = 6.4 Hz, C2H_2), 2.21 (6H, s, 2 × C10H_3), 2.08 (6H, s, 2 × C9H_3).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.3 (C4=O), 178.0 (C1=O), 141.9 (C5), 134.6 (2C, 2 × C7), 131.9 (C8H), 128.3 (2C, 2 × C6), 39.8 (C3H_2), 27.5 (C2H_2), 19.6 (2C, 2 × C10H_3), 16.0 (2C, 2 × C9H_3).

HRMS (ESI^+) Found $[M+Na]^+$ = 257.11484; $C_{14}H_{18}O_3Na$ requires 257.11482, Δ 0.09 ppm.

2-(1,4-Dioxaspiro[4.5]decan-8-yl)-1-(2,3,5,6-tetramethylphenyl)ethan-1-one (S35)



Acetyldurene (264 mg, 1.50 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (23.9 mg, 30.0 μmol, 2 mol%), KOH (337 mg, 6.00 mmol, 4.0 equiv), 4-hydroxycyclohexanone glycol acetal (261 mg, 1.65 mmol, 1.1 equiv) and toluene (375 μL, 4 M) were subjected to a modification of **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 96:4) afforded ketone **S35** (392 mg, 1.19 mmol, 79%) as a colourless solid.

m.p. = 148 – 150 °C.

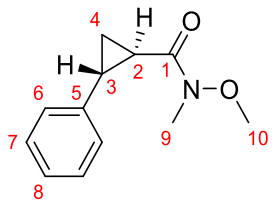
IR (film) ν_{max}/cm^{-1} 2939, 2867, 1698, 1470, 1442, 1396, 1379, 1357, 1337, 1313, 1301, 1281, 1260, 1231, 1196, 1172, 1144, 1112, 1102, 1077, 1031, 1007, 977, 947, 930.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.94 (1H, s, C11H), 4.00 – 3.91 (4H, m, 2 × C3H_2), 2.62 (2H, d, J = 6.5 Hz, C2H_2), 2.19 (6H, s, 2 × C13H_3), 2.12 (1H, ddq, J = 11.5, 6.5, 3.6 Hz, C7H), 2.05 (6H, s, 2 × C12H_3), 1.90 (2H, dq, J = 12.7, 4.1 Hz, C6$H_{ax}$$H_{eq}$), 1.77 (2H, ddt, J = 13.9, 3.4, 3.2 Hz, C7$H_{ax}$$H_{eq}$), 1.65 (2H, td, J = 13.2, 4.2 Hz, C7$H_{ax}$$H_{eq}$), 1.32 (2H, qd, J = 13.1, 3.7 Hz, C6$H_{ax}$$H_{eq}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 210.8 (C1=O), 142.9 (C8), 134.5 (2C, 2 × C10), 131.6 (C11H), 128.0 (2C, 2 × C9), 108.9 (C4), 64.4 (2C, 2 × C3H_2), 51.8 (C2H_2), 34.6 (2C, 2 × C5H_2), 31.1 (C7H), 30.3 (2C, 2 × C6H_2), 19.6 (2C, 2 × C13H_3), 15.9 (2C, 2 × C12H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 317.21118; $C_{20}H_{29}O_3$ requires 317.21112, Δ 0.19 ppm.

***rel*-(1*R*,2*R*)-*N*-Methoxy-*N*-methyl-2-phenylcyclopropane-1-carboxamide (S36)**



trans-2-Phenylcyclopropanecarboxylic acid (811 mg, 5.00 mmol, 1.0 equiv), CDI (1.09 g, 6.75 mmol, 1.35 equiv), *N*,*O*-dimethylhydroxylamine·HCl (683 mg, 7.00 mmol, 1.4 equiv), Et_3N (980 µL, 708 mg, 7.00 mmol, 1.4 equiv) and DCM (12.5 mL, 0.4 M) were subjected to **General Procedure I**. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded Weinreb amide **S36** (847 mg, 4.13 mmol, 83%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3086, 3062, 3029, 3005, 2966, 2937, 2900, 2818, 1650, 1605, 1582, 1498, 1459, 1439, 1420, 1393, 1367, 1312, 1173, 1152, 1119, 1097, 1048, 1022, 1004, 994, 938, 906, 876, 846, 779, 749, 698, 608.

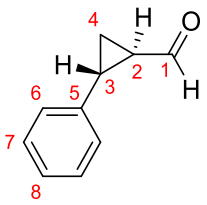
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.32 – 7.25 (2H, m, 2 × C7H), 7.23 – 7.16 (1H, m, C8H), 7.17 – 7.10 (2H, m, 2 × C6H), 3.70 (3H, s, C10H_3), 3.24 (3H, s, C9H_3), 2.51 (1H, ddd, J = 9.0, 6.4, 4.2 Hz, C3H), 2.42 (1H, br. s, C2H), 1.64 (1H, ddd, J = 9.4, 5.4, 4.2 Hz, C4$H_{cis}$$H_{trans}$), 1.31 (1H, ddd, J = 8.4, 6.4, 4.2 Hz, C4$H_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 173.2 (v. br. s, C1=O), 140.9 (C5), 128.6 (2C, 2 × C7H), 126.41 (C8H), 126.36 (2C, 2 × C6H), 61.8 (C10H_3), 32.7 (br. s, C9H_3), 26.0 (C3H), 21.7 (br. s, C2H), 16.6 (C4H_2).

HRMS (ESI$^+$) Found $[M+H]^+$ = 206.11760; $C_{12}H_{16}NO_2$ requires 206.11756, Δ 0.21 ppm.

Note: *cis* and *trans* with respect to C2H. The analytical data are identical to those reported in literature.[65]

***rel*-(1*R*,2*R*)-2-Phenylcyclopropane-1-carbaldehyde (S37)**



Weinreb amide **S36** (845 mg, 4.12 mmol, 1.0 equiv), DIBAL-H (6.2 mL, 1.0 M in DCM, 6.20 mmol, 1.5 equiv) and DCM (21 mL, 0.2 M) were subjected to a modification of **General Procedure H** at –78 °C. Purification by flash column chromatography (Pentane:Et_2O, 80:20) afforded aldehyde **S37** (491 mg, 3.36 mmol, 82%) as a colourless oil.

IR (film) ν_{max}/cm^{-1} 3086, 3063, 3031, 3007, 2832, 2731, 1699, 1605, 1583, 1499, 1458, 1434, 1399, 1385, 1329, 1221, 1181, 1162, 1099, 1080, 1055, 1029, 1002, 964, 940, 922, 896, 859, 830, 758, 740, 696.

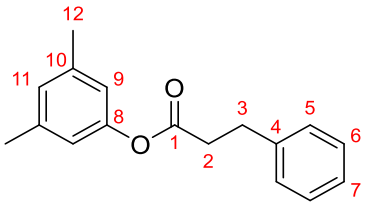
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 9.33 (1H, d, J = 4.6 Hz, C1H), 7.34 – 7.27 (2H, m, 2 × C7H), 7.27 – 7.20 (1H, m, C8H), 7.15 – 7.09 (2H, m, 2 × C6H), 2.64 (1H, ddd, J = 9.2, 6.7, 4.1 Hz, C3H), 2.18 (1H, dddd, J = 8.4, 5.2, 4.6, 4.0 Hz, C2H), 1.74 (1H, dt, J = 9.2, 5.1 Hz, C4H$_{cis}$*H$_{trans}$*), 1.54 (1H, ddd, J = 8.3, 6.7, 4.9 Hz, C4*H$_{cis}$*H$_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 199.8 (C1=O), 139.1 (C5), 128.7 (2C, 2 × C7H), 127.0 (C8H), 126.4 (2C, 2 × C6H), 33.9 (C2H), 26.7 (C3H), 16.6 ($C2H_2$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 147.0804; $C_{10}H_{11}O$ requires 147.0804, Δ 0.28 ppm.

Note: *cis* and *trans* with respect to C2H. The analytical data are identical to those reported in literature.[66]

3,5-Dimethylphenyl 3-phenylpropanoate (S38)



Crude ester **335** (2.66 g, assumed 10.0 mmol, 1.0 equiv), $Pd(OH)_2/C$ (266 mg, 10 wt%) and EtOAc (100 mL, c.a. 0.2 M) were subjected to **General Procedure C** for 24 h. The filtrate was evaporated to give a sticky yellow solid (2.61 g) that was directly used in the next reaction without further purification.

An analytically pure sample was prepared by flash column chromatography (Pentane:Et_2O, 95:5) to give ester **S38** as a colourless solid.

m.p. =35 – 37 °C.

IR (film) ν_{max}/cm^{-1} 3086, 3062, 3028, 2919, 2864, 1756, 1618, 1590, 1497, 1470, 1454, 1417, 1369, 1289, 1220, 1185, 1139, 1126, 1077, 1030, 1000, 949, 907.

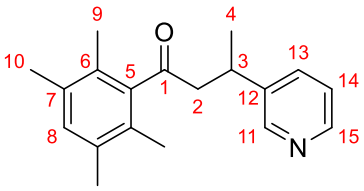
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 7.37 – 7.31 (2H, m, 2 × C6H), 7.30 – 7.23 (3H, m, 2 × C5H and C7H), 6.86 (1H, s, C11H), 6.64 (2H, s, 2 × C9H), 3.08 (2H, t, J = 7.7 Hz, $C3H_2$), 2.92 – 2.84 (2H, m, $C2H_2$), 2.31 (6H, q, J = 0.7 Hz, 2 × $C12H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 171.8 (C1=O), 150.7 (C10), 140.3 (C4), 139.4 (2C, 2 × C10), 128.70 (2C, 2 × C6H), 128.55 (2C, 2 × C5H), 127.7 (C11H), 126.5 (C7H), 119.2 (2C, 2 × C9H), 36.2 ($C2H_2$), 31.1 ($C3H_2$), 21.4 (2C, 2 × $C12H_3$).

HRMS (ESI^+) Found $[M+Na]^+$ = 277.11987; $C_{17}H_{18}O_2Na$ requires 277.11990, Δ –0.10 ppm.

Note: On careful analysis of the signals in the ^{1}H NMR spectrum, fine long-range coupling can be resolved for the signals at δ 6.86 (1H, tsept., J = 1.4, 0.7 Hz, C11H), 6.64 (2H, ddsept., J = 1.3, 0.7, 0.3 Hz, 2 × C9H) and 2.31 (6H, q, J = 0.7 Hz, 2 × $C12H_3$).

3-(Pyridin-3-yl)-1-(2,3,5,6-tetramethylphenyl)butan-1-one (S39)



Acetyldurene (106 mg, 0.600 mmol, 1.0 equiv), $[Cp^*IrCl_2]_2$ (4.78 mg, 12.0 μmol, 2 mol%), KO*t*-Bu (202 mg, 1.80 mmol, 3.0 equiv), 1-(pyridin-3-yl)ethan-1-ol (148 mg, 1.20 mmol, 1.1 equiv) and toluene (150 μL, 4 M) were subjected to **General Procedure E** at 85 °C. Purification by flash column chromatography (Pentane:Et_2O, 75:25) afforded ketone **S39** (123 mg, 0.439 mmol, 73%) as a colourless solid.

m.p. = 93 – 95 °C.

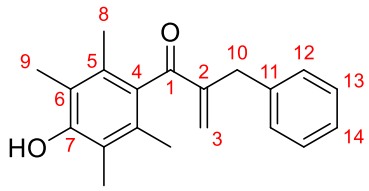
IR (film) ν_{max}/cm^{-1} 3027, 2965, 2927, 2874, 1701, 1590, 1575, 1470, 1425, 1400, 1376, 1345, 1301, 1271, 1228, 1120, 1024, 982, 922, 900, 874, 808, 748, 716.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 8.55 (1H, dd, *J* = 2.5, 0.8 Hz, C11H), 8.46 (1H, dd, *J* = 4.8, 1.6 Hz, C15H), 7.58 (1H, dt, *J* = 7.9, 2.0 Hz, C13H), 7.22 (1H, ddd, *J* = 7.9, 4.8, 0.8 Hz, C14H), 6.93 (1H, s, C8H), 3.57 (1H, sext., *J* = 6.9 Hz, C3H), 3.06 – 2.93 (2H, m, $C2H_2$), 2.17 (6H, s, 2 × $C10H_3$), 1.93 (6H, br. s, 2 × $C9H_3$), 1.41 (3H, d, *J* = 7.0 Hz, $C4H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 209.4 (C1=O), 149.2 (C11H), 147.9 (C15H), 142.3 (C5), 141.8 (C12), 134.8 (C13H), 134.6 (2C, 2 × C7), 131.8 (C8H), 128.0 (2C, 2 × C6), 123.5 (C14H), 53.2 ($C2H_2$), 32.1 (C3H), 22.1 ($C4H_3$), 19.6 (2C, 2 × $C10H_3$), 15.9 (2C, 2 × $C9H_3$).

HRMS (ESI$^+$) Found $[M+H]^+$ = 282.18518; $C_{19}H_{24}NO$ requires 282.18524, Δ –0.21 ppm.

2-Benzyl-1-(4-hydroxy-2,3,5,6-tetramethylphenyl)prop-2-en-1-one (S40)



To a well-stirred flask containing a solution of phenol **337** (282 mg, 1.00 mmol, 1.0 equiv) in EtOH:H_2O (1:1, 5 mL, 0.2 M) was added K_2CO_3 (276 mg, 2.00 mmol, 2.0 equiv) and paraformaldehyde (901 mg, 30.0 mmol, 30 equiv), and the solution stirred at 50 °C for 24 h. The reaction mixture was cooled down to RT and filtered. The residue was washed with H_2O (10 mL) and cold EtOH:H_2O (1:1, 5 mL), then dried *in vacuo* to give enone **S40** (190 mg) as a yellow solid.

The filtrate was extracted with EtOAc (3 × 20 mL), and the combined organics dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 85:15) afforded enone **S40** (67 mg, total 257 mg, 0.872 mmol, 87%) as a yellow solid.

m.p. = 96 – 98 °C.

IR (film) ν_{max}/cm^{-1} 3385, 3086, 3062, 3028, 2924, 1644, 1602, 1576, 1494, 1454, 1397, 1345, 1293, 1215, 1174, 1104, 1030, 1015, 992, 950, 914.

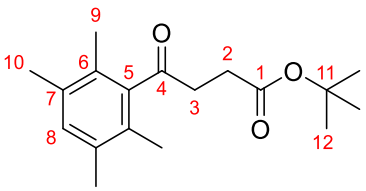
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.35 – 7.29 (2H, m, 2 × C13H), 7.29 – 7.25 (2H, m, 2 × C12H), 7.25 – 7.18 (1H, m, C14H), 5.74 (1H, q, J = 1.3 Hz, C3H$_{syn}$*H$_{anti}$*), 5.70 (1H, s, C3*H$_{syn}$*H$_{anti}$), 4.81 (1H, s, OH), 3.77 (2H, s, C10H_2), 2.11 (6H, s, 2 × C8H_3), 1.93 (6H, s, 2 × C9H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 203.2 (C1=O), 151.9 (C7), 149.8 (C2), 139.2 (C11), 132.7 (C4), 130.8 (2C, 2 × C5), 130.6 (C3H_2), 129.5 (2C, 2 × C12H), 128.6 (2C, 2 × C13H), 126.4 (C14H), 119.6 (2C, 2 × C6), 36.2 (C10H_2), 16.9 (2C, 2 × C8H_3), 11.8 (2C, 2 × C9H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 295.16925; $C_{20}H_{23}O_2$ requires 295.16926, Δ –0.02 ppm.

Note: *syn* and *anti* with respect to C1.

***tert*-Butyl 4-oxo-4-(2,3,5,6-tetramethylphenyl)butanoate (S41)**



To a solution of carboxylic acid **S34** (469 mg, 2.00 mmol, 1.0 equiv), *t*-BuOH (420 μL, 326 mg, 4.40 mmol, 2.2 equiv) and DMAP (80.6 mg, 0.660 mmol, 0.33 equiv) in DCM (8.0 mL, 0.25 M) was added DCC (536 mg, 2.60 mmol, 1.3 equiv) at RT, and stirred for 16 h. The reaction mixture was directly filtered under suction through a pad of Celite®, eluting with DCM, and the eluent washed with H_2O (2 × 20 mL), dried (Na_2SO_4) and concentrated *in vacuo*. Purification by flash column chromatography (Pentane:Et_2O, 90:10) afforded ester **S41** (454 mg, 1.49 mmol, 75%) as a colourless solid.

m.p. = 56 – 58 °C.

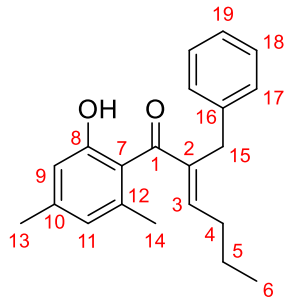
IR (film) ν_{max}/cm^{-1} 3004, 2977, 2931, 2870, 1731, 1704, 1471, 1458, 1392, 1366, 1350, 1322, 1230, 1153, 1113, 1016, 968, 948.

^{1}H NMR ($CDCl_3$, 400 MHz) δ = 6.88 (1H, s, C8H), 2.90 (2H, t, J = 6.6 Hz, $C3H_2$), 2.55 (2H, t, J = 6.6 Hz, $C2H_2$), 2.13 (6H, s, 2 × $C10H_3$), 2.01 (6H, s, 2 × $C9H_3$), 1.41 (9H, s, 3 × $C12H_3$).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 209.8 (C4=O), 172.1 (C1=O), 142.2 (C5), 134.5 (2C, 2 × C7), 131.7 (C8H), 128.3 (2C, 2 × C6), 80.8 (C11), 40.3 ($C3H_2$), 29.1 ($C2H_2$), 28.2 (3C, $C12H_3$), 19.6 (2C, 2 × $C10H_3$), 16.0 (2C, 2 × $C9H_3$).

HRMS (ESI$^+$) Found $[M+Na]^+$ = 313.17740; $C_{18}H_{26}O_3Na$ requires 313.17742, Δ –0.05 ppm.

(*E*)-2-Benzyl-1-(2-hydroxy-4,6-dimethylphenyl)hex-2-en-1-one (S42)



In the preparation of ketone **442**, enone **S42** (7.4 mg, 24 μmol, 8.0%) was also isolated as a pale yellow oil.

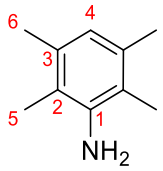
IR (film) ν_{max}/cm^{-1} 3325, 3085, 3062, 3027, 2959, 2925, 2871, 2855, 1705, 1625, 1583, 1495, 1454, 1378, 1310, 1271, 1208, 1190, 1168, 1143, 1053, 1031, 950, 920.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.93 (1H, v. br. s, OH), 7.33 – 7.19 (4H, m, 2 × C17H and 2 × C18H), 7.21 – 7.14 (1H, m, C19H), 6.59 (1H, s, C9H), 6.49 (1H, s, C11H), 6.32 (1H, t, *J* = 7.4 Hz, C3H), 3.84 (2H, s, $C15H_2$), 2.33 (2H, q, *J* = 7.4 Hz, $C4H_2$), 2.26 (3H, s, $C14H_3$), 1.99 (3H, s, $C13H_3$), 1.43 (2H, sext., *J* = 7.4 Hz, $C5H_2$), 0.91 (3H, t, *J* = 7.4 Hz, $C5H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 202.0 (C1=O), 157.5 (C8), 146.9 (C3H), 142.9 (C10), 142.1 (C2), 139.6 (C16), 137.9 (C12), 128.9 (2C, 2 × C17H), 128.6 (2C, 2 × C18H), 126.3 (C19H), 123.8 (C11H), 121.6 (C7), 115.1 (C9H), 32.0 ($C15H_2$), 31.7 ($C4H_2$), 21.9 ($C5H_2$), 21.7 ($C13H_3$), 21.6 ($C14H_3$), 14.2 ($C6H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 309.18526; $C_{21}H_{25}O_2$ requires 309.18491, Δ 1.13 ppm.

2,3,5,6-Tetramethylaniline (S43), or Aminodurene (S43)



Nitrodurene **340** (179 mg, 1.00 mmol, 1.0 equiv), activated zinc dust (863 mg, 13.2 mmol, 13.2 equiv), $CaCl_2 \cdot 2H_2O$ (147 mg, 1.00 mmol, 1.0 equiv) and EtOH:H_2O (4:1, 3.5 mL, 0.3 M) were subjected to **General Procedure P** to afford aniline **S43** (149 mg, 1.00 mmol, 100%) as a colourless solid that gradually turns pale pink on exposure to air.

m.p. = 68 – 70 °C.

IR (film) ν_{max}/cm^{-1} 3433, 3354, 3008, 2965, 2920, 2864, 1625, 1568, 1493, 1469, 1440, 1413, 1401, 1311, 1260, 1160, 1100, 1018, 998, 908, 837, 814, 730, 683.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 6.51 (1H, s, C4H), 3.58 (2H, s, NH_2), 2.23 (6H, s, 2 × $C6H_3$), 2.08 (6H, s, 2 × $C5H_3$).

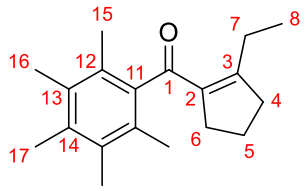
^{13}C NMR ($CDCl_3$, 126 MHz) δ = 142.8 (C1), 133.8 (2C, 2 × C3), 122.1 (C4H), 118.1 (2C, 2 × C2), 20.4 (2C, 2 × $C6H_3$), 13.1 (2C, 2 × $C5H_3$).

^{15}N NMR ($CDCl_3$, 50.7 MHz) δ = 51.6 (NH_2).

HRMS (ESI^+) Found $[M+H]^+$ = 150.12769; $C_{10}H_{16}N$ requires 150.12773, Δ –0.27 ppm.

The spectroscopic data are identical to those reported in literature.[67]

(2-Ethylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (S44)



In the preparation of ketone **232** using **General Procedure F** at 105 °C, enone **S44** (16.8 mg, 62.1 μmol, 10%) was also isolated as a colourless solid.

m.p. = 66 – 69 °C.

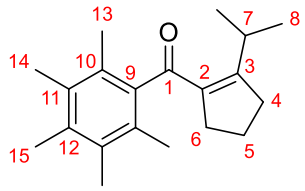
IR (film) ν_{max}/cm^{-1} 2933, 2876, 1734, 1702, 1661, 1635, 1609, 1459, 1431, 1382, 1351, 1308, 1272, 1235, 1170, 1134, 1112, 1068, 1014, 995, 941, 862, 839, 764, 743, 714.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.64 (2H, br. tquint., J = 7.4, 1.9 Hz, C6H_2), 2.57 (2H, br. ddtt, J = 8.1, 7.5, 2.0, 1.0 Hz, C4H_2), 2.23 (3H, s, C17H_3), 2.17 (6H, s, 2 × C16H_3), 2.09 (2H, br. q, J = 7.3 Hz, C7H_2), 2.05 (6H, s, 2 × C15H_3), 1.81 (2H, quint., J = 7.6 Hz, C5H_2), 0.86 (3H, t, J = 7.6 Hz, 2 × C8H_3).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.7 (C1=O), 162.1 (C3), 140.9 (C11), 136.8 (C2), 135.0 (C14), 132.9 (2C, 2 × C13), 128.0 (2C, 2 × C12), 38.8 (C4H_2), 33.9 (C6H_2), 23.1 (C7H_2), 21.3 (C5H_2), 17.3 (2C, 2 × C15H_3), 16.8 (C17H_3), 16.1 (2C, 2 × C16H_3), 12.3 (C8H_3).

HRMS (ESI$^+$) Found $[M+H]^+$ = 271.20575; $C_{19}H_{27}O$ requires 271.20564, Δ 0.40 ppm.

(2-Isopropylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (S45)



In the preparation of ketone **233** using **General Procedure F** at 105 °C, enone **S45** (31.9 mg, 0.112 mmol, 19%) was also isolated as a pale yellow solid.

m.p. = 77 – 80 °C.

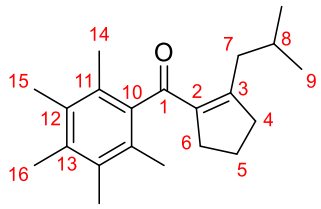
IR (film) ν_{max}/cm^{-1} 2956, 2930, 2870, 1737, 1702, 1659, 1634, 1603, 1463, 1432, 1382, 1350, 1328, 1306, 1267, 1241, 1201, 1172, 1159, 1091, 1068, 1031, 1006, 926, 880, 831, 764, 743, 714.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.98 (1H, br. sept., J = 7.5 Hz, C7H), 2.59 (2H, tt, J = 7.6, 1.9 Hz, $C6H_2$), 2.54 (2H, tt, J = 7.6, 2.0 Hz, $C4H_2$), 2.23 (3H, s, $C15H_3$), 2.17 (6H, s, 2 × $C14H_3$), 2.06 (6H, s, 2 × $C13H_3$), 1.78 (2H, quint., J = 7.6 Hz, $C5H_2$), 0.88 (6H, d, J = 6.8 Hz, 2 × $C8H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.8 (C1=O), 166.0 (C3), 141.1 (C9), 136.0 (br. s, C2), 134.9 (C12), 132.9 (2C, 2 × C11), 128.0 (2C, 2 × C10), 33.9 ($C6H_2$), 33.6 ($C4H_2$), 27.8 (C7H), 21.5 ($C5H_2$), 21.0 (2C, 2 × $C8H_3$), 17.3 (2C, 2 × $C13H_3$), 16.8 ($C15H_3$), 16.1 (2C, 2 × $C14H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 285.22122; $C_{20}H_{29}O$ requires 285.22129, Δ –0.25 ppm.

(2-Isobutylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (S46)



In the preparation of ketone **234** using **General Procedure F** at 105 °C, enone **S46** (23.5 mg, 78.8 μmol, 13%) was also isolated as a colourless oil.

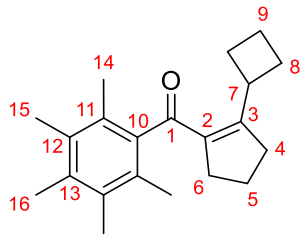
IR (film) ν_{max}/cm^{-1} 2954, 2926, 2868, 1734, 1701, 1661, 1636, 1600, 1463, 1431, 1383, 1366, 1350, 1329, 1308, 1269, 1233, 1188, 1167, 1107, 1069, 1017, 930, 868, 832, 743, 716, 700, 634.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.59 (2H, br. t, J = 7.5 Hz, C6H$_2$), 2.53 (2H, ttt, J = 7.5, 2.0, 1.0 Hz, C4H$_2$), 2.23 (3H, s, C16H$_3$), 2.17 (6H, s, 2 × C15H$_3$), 2.05 (6H, s, 2 × C14H$_3$), 1.79 (2H, quint., J = 7.6 Hz. C5H$_2$), 1.74 (1H, sept., J = 6.8 Hz, C8H), 0.71 (6H, d, J = 6.6 Hz, 2 × C9H$_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.9 (C1=O), 160.3 (C3), 141.0 (C10), 138.3 (br. s, C2), 134.9 (C13), 132.9 (2C, 2 × C12), 128.1 (2C, 2 × C11), 39.4 (C4H$_2$), 38.7 (C7H$_2$), 34.0 (C6H$_2$), 27.5 (C8H), 22.8 (2C, 2 × C9H$_3$), 21.6 (C5H$_2$), 17.3 (2C, 2 × C14H$_3$), 16.8 (C16H$_3$), 16.1 (2C, 2 × C15H$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 299.23691; $C_{21}H_{31}O$ requires 299.23694, Δ –0.11 ppm.

(2-Cyclobutylcyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (S47)



In the preparation of ketone **236** using **General Procedure F** at 105 °C, enone **S47** (18.7 mg, 63.1 μmol, 11%) was also isolated as a pale yellow solid.

m.p. = 57 – 59 °C.

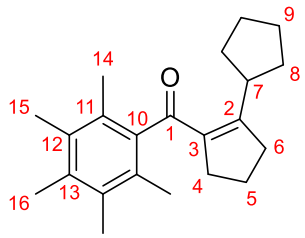
IR (film) ν_{max}/cm^{-1} 2935, 2865, 1737, 1702, 1658, 1633, 1596, 1444, 1432, 1381, 1352, 1307, 1268, 1241, 1193, 1170, 1069, 1020, 932, 894, 868, 825, 764, 742, 716, 700, 636.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 3.45 (1H, br. quint., J = 8.2 Hz, C7H), 2.73 (2H, ttd, J = 7.9, 2.1, 0.9 Hz, C4H$_2$), 2.60 (2H, tt, J = 7.9, 2.3 Hz, C6H$_2$), 2.24 (3H, s, C16H$_3$), 2.18 (6H, s, 2 × C15H$_3$), 2.02 (6H, s, 2 × C14H$_3$), 1.94 (2H, quint.d, J = 9.2, 2.3 Hz, 2 × C8H_AH$_B$), 1.89 – 1.76 (2H, m, 2 × C8H$_A$$H_B$), 1.81 (3H, quint., J = 7.6 Hz, C5H$_2$), 1.76 – 1.66 (2H, m, C9H$_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.6 (C1=O), 162.5 (C3), 141.0 (C10), 136.5 (br. s, C2), 135.0 (C13), 132.9 (2C, 2 × C12), 128.1 (2C, 2 × C11), 36.0 (C4H$_2$), 35.0 (C7H), 34.2 (C6H$_2$), 27.4 (2C, 2 × C8H$_2$), 21.4 (C5H$_2$), 18.8 (C9H$_2$), 17.3 (2C, 2 × C14H$_3$), 16.9 (C16H$_3$), 16.1 (2C, 2 × C15H$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 297.22128; $C_{21}H_{29}O$ requires 297.22129, Δ –0.03 ppm.

[1,1′-Bi(cyclopentan)]-1-en-2-yl(2,3,4,5,6-pentamethylphenyl)methanone (S48)



In the preparation of ketone **237** using **General Procedure F** at 105 °C, enone **S48** (8.6 mg, 27.8 μmol) was also isolated as a pale yellow solid. A second fraction (98.3 mg) containing a 10:1 mixture of ketone **121** and enone **S48** was also obtained. The combined yield is 72.1 μmol, 12%.

m.p. = 67 – 70 °C.

IR (film) ν_{max}/cm^{-1} 2948, 2867, 1737, 1702, 1658, 1635, 1600, 1451, 1432, 1382, 1351, 1308, 1266, 1243, 1188, 1170, 1099, 1069, 1018, 936, 887, 828, 764, 742, 707, 636.

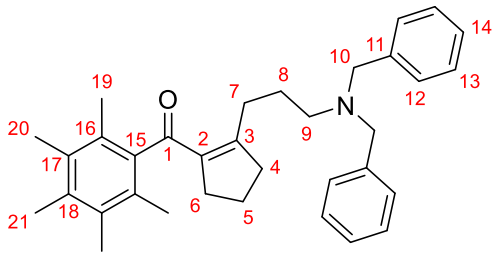
^{1}H NMR ($CDCl_3$, 500 MHz) δ = 2.98 (1H, br. s, C7H), 2.59 (2H, tt, J = 7.3, 1.8 Hz, C4H$_2$), 2.54 (2H, tt, J = 7.4, 2.0 Hz, C6H$_2$), 2.23 (3H, s, C16H$_3$), 2.17 (6H, s, 2 × C15H$_3$), 2.05 (6H, s, 2 × C14H$_3$), 1.78 (2H, quint., J = 7.6 Hz, C5H$_2$), 1.65 – 1.53 (2H, m, 2 × C9H_{cis}H$_{trans}$), 1.56 – 1.46 (2H, m, C8H_{cis}H$_{trans}$), 1.44 – 1.34 (2H, m, C9H$_{cis}$$H_{trans}$), 1.34 – 1.26 (2H, m, C8H$_{cis}$$H_{trans}$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.9 (C1), 164.0 (C2), 141.1 (C10), 137.3 (C3), 134.9 (C13), 132.8 (2C, 2 × C12), 128.1 (2C, 2 × C11), 39.4 (C7H), 34.7 (C6H$_2$), 34.0 (C4H$_2$), 31.6 (2C, 2 × C8H$_2$), 26.1 (2C, 2 × C9H$_2$), 21.7 (C5H$_2$), 17.3 (2C, 2 × C14H$_3$), 16.8 (C16H$_3$), 16.1 (2C, 2 × C15H$_3$).

HRMS (ESI$^+$) Found [M+H]$^+$ = 311.23688; $C_{22}H_{31}O$ requires 311.23694, Δ –0.21 ppm.

Note: *cis* and *trans* with respect to C7H.

(2-(3-(Dibenzylamino)propyl)cyclopent-1-en-1-yl)(2,3,4,5,6-pentamethylphenyl)methanone (S49)



In the preparation of ketone **244** using **General Procedure F** at 105 °C, the column was flushed with Et_2O, and the eluent concentrated *in vacuo*. The residue was purified by preparative HPLC (Pentane:Et_2O, 70:30) to afford enone **S49** (19.5 mg, 40.6 μmol, 6.8%) as a colourless oil.

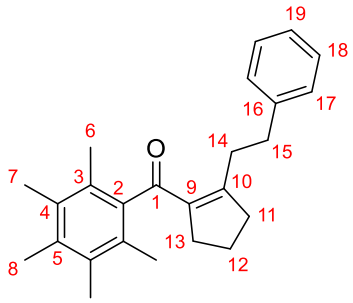
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3026, 2936, 2867, 2831, 2795, 1728, 1660, 1634, 1608, 1494, 1453, 1380, 1353, 1309, 1270, 1240, 1190, 1171, 1126, 1072, 1028, 973, 911, 863, 841, 744, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.33 – 7.25 (8H, m, 4 × C12H and 4 × C13H), 7.27 – 7.19 (2H, m, 2 × C14H), 3.45 (4H, s, 2 × C10H_2), 2.61 (2H, t, J = 7.4 Hz, C6H_2), 2.46 (2H, ttt, J = 7.6, 2.0, 0.9 Hz, C4H_2), 2.15 (3H, s, C21H_3), 2.13 (2H, t, J = 7.6 Hz, C9H_2), 2.10 (6H, s, 2 × C20H_3), 2.00 (6H, s, 2 × C19H_3), 1.97 (2H, br. m, C7H_2), 1.75 (2H, quint., J = 7.6 Hz, C5H_2), 1.44 (2H, dtd, J = 10.2, 7.8, 5.5 Hz, C8H_2).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.6 (C1=O), 160.5 (C3), 140.8 (C15), 139.9 (2C, 2 × C11), 137.6 (br. s, C2), 135.0 (C18), 132.9 (2C, 2 × C17), 128.8 (4C, 4 × C12H), 128.3 (4C, 4 × C13H), 128.1 (2C, 2 × C16), 126.9 (2C, 2 × C14H), 58.4 (2C, 2 × C10H_2), 53.7 (C9H_2), 39.3 (C4H_2), 33.8 (C6H_2), 27.8 (C7H_2), 25.6 (C8H_2), 21.3 (C5H_2), 17.3 (2C, 2 × C19H_3), 16.8 (C21H_3), 16.1 (C20H_3).

HRMS (ESI^+) Found $[M+H]^+$ = 480.32635; $C_{34}H_{42}NO$ requires 480.32609, Δ 0.55 ppm.

(2,3,4,5,6-Pentamethylphenyl)(2-phenethylcyclopent-1-en-1-yl)methanone (S50)



In the preparation of ketone **241** using **General Procedure F** at 105 °C, enone **S50** (27.2 mg, 78.5 μmol, 13%) was also isolated as a pale yellow solid.

m.p. = 81 – 84 °C.

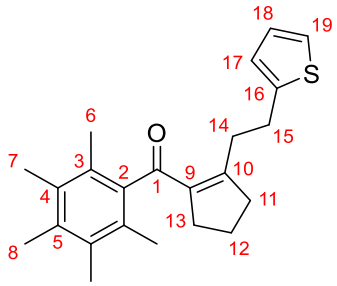
IR (film) ν_{max}/cm^{-1} 3084, 3061, 3026, 2925, 2856, 1736, 1659, 1635, 1604, 1495, 1454, 1431, 1381, 1353, 1309, 1270, 1236, 1190, 1172, 1102, 1070, 1029, 940, 906, 866, 839, 826, 749, 699.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.23 – 7.16 (2H, m, 2 × C18H), 7.18 – 7.10 (1H, m, C19H), 6.84 (2H, d, J = 7.3 Hz, 2 × C17H), 2.71 (2H, br. t, J = 7.6 Hz, $C13H_2$), 2.61 (2H, ddtt, J = 7.9, 6.9, 1.9, 0.9 Hz, $C11H_2$), 2.56 – 2.43 (2H, m, $C15H_2$), 2.29 (2H, br. m, $C14H_2$), 2.26 (3H, s, $C8H_3$), 2.18 (6H, s, 2 × $C7H_3$), 2.06 (6H, s, 2 × $C6H_3$), 1.84 (2H, quint., J = 7.6 Hz, $C12H_2$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.5 (C1=O), 159.5 (C10), 141.6 (C16), 140.9 (C2), 138.1 (br. s, C9), 135.3 (C5), 133.1 (2C, 2 × C4), 128.33 (2C, 2 × C18H), 128.25 (2C, 2 × C17H), 128.23 (2C, 2 × C3), 126.0 (C19H), 39.7 ($C11H_2$), 34.3 ($C15H_2$), 33.8 ($C13H_2$), 32.3 ($C14H_2$), 21.3 ($C12H_2$), 17.4 (2C, 2 × $C6H_3$), 16.8 ($C8H_3$), 16.1 (2C, 2 × $C7H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 347.23618; $C_{25}H_{31}O$ requires 347.23694, Δ –2.21 ppm.

(2,3,4,5,6-Pentamethylphenyl)(2-(2-(thiophen-2-yl)ethyl)cyclopent-1-en-1-yl)methanone (S51)



In the preparation of ketone **247** using **General Procedure F** at 125 °C, enone **S51** (21.3 mg, 60.4 μmol, 10%) was also isolated as a pale yellow solid.

m.p. = 88 – 90 °C.

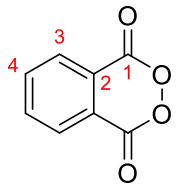
IR (film) ν_{max}/cm^{-1} 2923, 2854, 1659, 1636, 1608, 1440, 1381, 1353, 1309, 1270, 1239, 1190, 1171, 1099, 1071, 1024, 866, 850, 825, 691.

^{1}H NMR ($CDCl_3$, 500 MHz) δ = 7.06 (1H, dd, J = 5.1, 1.2 Hz, C19H), 6.85 (1H, dd, J = 5.1, 3.4 Hz, C18H), 6.53 (1H, d, J = 3.4 Hz, C17H), 2.73 (2H, t, J = 8.3 Hz, $C15H_2$), 2.69 (2H, t, J = 7.5 Hz, $C13H_2$), 2.58 (2H, tt, J = 7.9, 2.3 Hz, $C11H_2$), 2.36 (2H, br. t, J = 8.6 Hz, $C14H_2$), 2.23 (3H, s, $C8H_3$), 2.17 (6H, s, 2 × $C7H_3$), 2.04 (6H, s, 2 × $C6H_3$), 1.83 (2H, quint., J = 7.6 Hz, $C12H_3$).

^{13}C NMR ($CDCl_3$, 126 MHz) δ = 200.5 (C1=O), 158.5 (C10), 144.2 (C16), 140.7 (C2), 138.5 (br. s, C9), 135.4 (C5), 133.2 (2C, 2 × C4), 128.1 (2C, 2 × C3), 126.7 (C18H), 124.2 (C17H), 123.3 (C19H), 39.5 ($C11H_2$), 33.8 ($C13H_2$), 32.4 ($C14H_2$), 28.2 ($C15H_2$), 21.3 ($C12H_2$), 17.3 (2C, 2 × $C6H_3$), 16.8 ($C8H_3$), 16.1 (2C, 2 × $C7H_3$).

HRMS (ESI^+) Found $[M+H]^+$ = 353.19339; $C_{23}H_{29}O_2S$ requires 353.19336, Δ 0.08 ppm.

Benzo[*d*][1,2]dioxine-1,4-dione (S52), or Phthaloyl peroxide (S52)[8]



To a vigorously stirred suspension of $Na_2CO_3 \cdot 1.5H_2O_2$ (2.36 g, 15.0 mmol, 1.5 equiv) and Na_2CO_3 (530 mg, 5.00 mmol, 0.5 equiv) in water-saturated DCM (50 mL, 0.2 M) was added phthaloyl chloride (1.45 mL, 2.03 mmol, 1.0 equiv) at RT and stirred for 3 h. The reaction mixture was filtered under suction through a pad of Celite®, eluting with conventional DCM (100 mL), and the eluent concentrated *in vacuo*, ensuring that the water bath temperature does not exceed 30 °C. The residue was redissolved in a minimum amount of warm benzene without any additional source of direct heat, then poured into ice-cold pentane (100 – 150 mL). The suspension was filtered, eluting with cold pentane (50 mL), and the filtrate similarly concentrated *in vacuo* to afford phthaloyl peroxide **S52** (555 mg, 3.38 mmol, 34 %) as a colourless solid.

m.p. = >79 °C (slow decomposition).

IR (film) ν_{max}/cm^{-1} 1740, 1720, 1596, 1461, 1326, 1283, 1226, 1107, 1094, 1039, 1021.

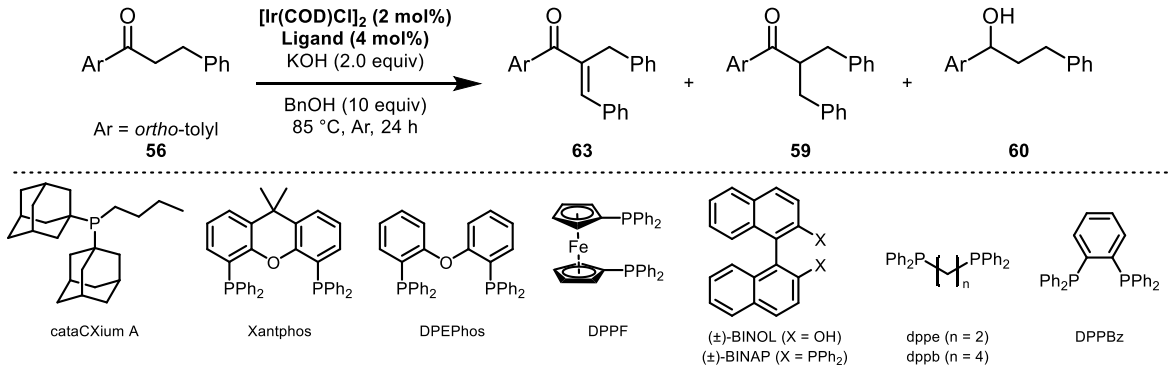
^{1}H NMR ($CDCl_3$, 400 MHz) δ = 8.29 (2H, app. dd, J = 5.8, 3.3 Hz, 2 × C3H), 8.03 (2H, dd, J = 5.8, 3.3 Hz, 2 × C4H).

^{13}C NMR ($CDCl_3$, 101 MHz) δ = 162.1 (2C, 2 × C1=O), 136.6 (2C, 2 × C4H), 130.3 (2C, 2 × C3H), 123.8 (2C, 2 × C2).

Note: The material should be stored in the freezer immediately to extend its longevity.

10. Appendices

Appendix 10.1 Ligand Parameters



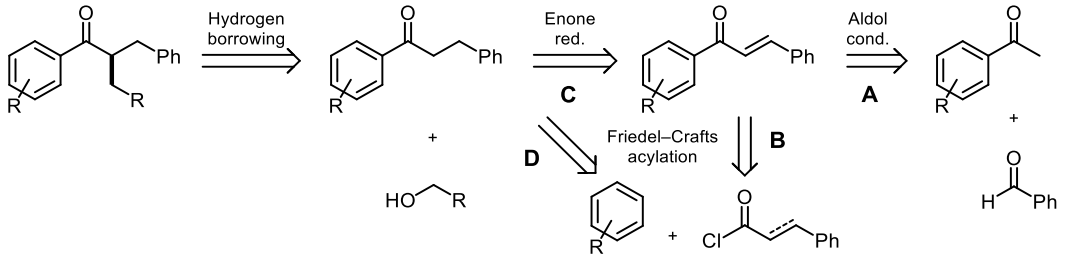
Entry	Ligand	Pt–P bond length (Å)[a]	Bite angle (°)[b]	Cone angle (°)[c,d]	ν(C≡O) (cm^{-1})[c]	% Buried volume[e]	Yield (%)	
							63	**59**
1	P(*o*-tolyl)$_3$	-	-	194	2066.6	39.4	3	42
2	cataCXium® A	-	-	178	2057.1	36.3	5	45
3	P(*n*-Bu)$_3$	-	-	132	2060.3	-	12	45
4	PEt_3	-	-	132	2061.7	27.1	-	-
5	PPh_3	-	-	145	2068.9	29.9	6	48
6	PCy_3	-	-	170	2056.4	33.4	5	52
7	P(OPh)$_3$	-	-	128	2085.3	31.9	7	53
8	P(OEt)$_3$	-	-	109	2079.5	-	3	62
9	P(OMe)$_3$	-	-	107	2079.5	26.4	-	-
10	XantPhos	2.297	102.7	192.2	-	42.5	15	35
11	DPEPhos	-	-	-	-	41.3	15	44
12	DPPF	2.286	99.6	191.9	-	33.5	3	57
13	dppe	2.267	85.5	178.2	-	29.2	Trace	59
14	dppb	2.274	96.7	188.8	-	30.9	1	63
15	(±)-BINAP	2.287	93	189	-	54.6	Trace	64
16	**DPPBz**	**2.235**	**86.8**	**179**	**-**	**39.9**	**-**	**71**

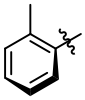
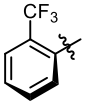
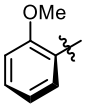
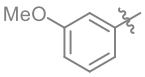
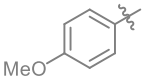
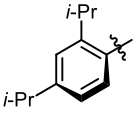
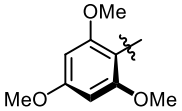
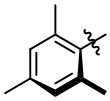
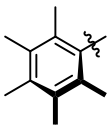
Table 10.1 *List of ligand parameters and their correlation to yields of **63** and **59**. The rest of the mass balance was predominantly alcohol **60** (see Table 3.6). Data for PEt_3 and P(OMe)$_3$ are included for comparison. [a]Values were derived from square planar Pt complexes;[68] [b]P–Pt–P angles;[68,69] [c]Data for monodentate ligands were obtained from the comprehensive review by Tolman,[70] and data for cataCXium® A was from Carrow and Chen;[71] [d]Bidentate cone angles were calculated from Pt complexes;[68,72] [e]Values were derived from [PR_3AuCl] or [(AuCl)R_2P—PR_2(AuCl)] complexes.[73]*

Various ligand parameters were investigated to rationalise the result of the ligand screen (Table 9.1). For the monodentate ligands, there is a weak trend in decreasing Tolman cone angle and buried volume that gives a higher yield of **63**, whereas the Tolman electronic parameter does not seem to give any sensible correlation. However, the deviations from the alkyl phosphines P(*n*-Bu)$_3$ and PCy$_3$ leave much to be desired from such a conclusion.

For the bidentate ligands, the most significant effect came from the decrease in bite and cone angles, leading to a decreased yield of enone **63** and an increased yield of ketone **59**. It is also interesting to note that the best ligand DPPBz has the shortest Pt–P bond amongst all the ligands in the screen as reported by Niksch et al.,[68] while the least suitable ligand XantPhos has the longest bond. However, given the complex interplay between geometric, steric and electronic parameters of the ligands and transition metals, such a form of data should be used with utmost caution.

Appendix 10.2 Substrates for Hydrogen Borrowing Reactions in Scheme 3.11



Ar	Synthesis route	Yields (%)	
		Enone	Ketone
	A, C	58% (**S18**)	75% (**S19**)
	-[a]	-	-
	-[b]	-	-
	A, C	97% (**S1**)	92% (**S2**)
	-[a]	-	-
	-[a]	-	-
	-[b]	-	-
	A, C	96% (**S3**)	36% (**S4**)
	A, C	100% (**S6**)	92% (**S7**)
	-[a]	-	-
	-[a]	-	-
	A, C	97% (**S8**)	100% (**145**)

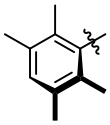
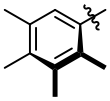
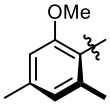
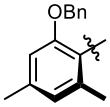
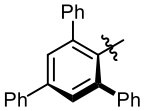
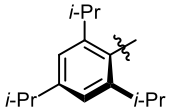
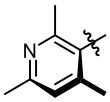
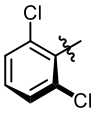
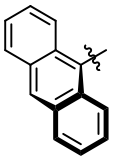
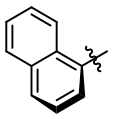
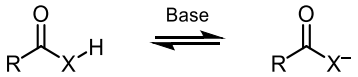
Ar	Synthesis route	Yields (%)	
		Enone	Ketone
	B, C	83% (**345**)	90% (**181**)
	D		63% (**340**)
	-[d]	-	90% (**S9**)
	-[d]	-	96% (**S10**)
	B, C	74% (**S11**)	96% (**S12**)
	B, C	66% (**S13**)	89% (**S14**)
	A, C	89% (**S15**)	94% (**S16**)
	-[a]	-	-
	A[e], D	92% (**9**)	62% (**10**)
	-[f]	-	35% (**S17**)

Table 10.2 *Synthesis of substrates for Scheme 3.11 and Scheme 3.15. [a]Material was provided by Dr. James Frost; [b]Material is commercially available; [c]The methyl ketone was prepared by Friedel–Crafts acylation; [d]Material was prepared by Fries rearrangement followed by alkylation of the corresponding phenol; [e]The reduction of the enone by catalytic hydrogenation results in the formation of many side products; [f]The material was prepared by metal-free alkylation (see Experimental section).*

Appendix 10.3 Extended pK_a Table for Ketones and Benzoic Acids



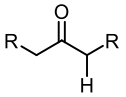
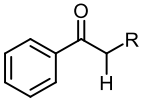
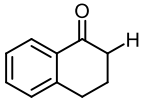
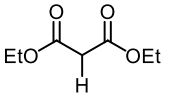
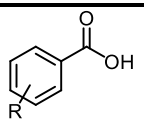
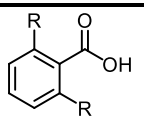
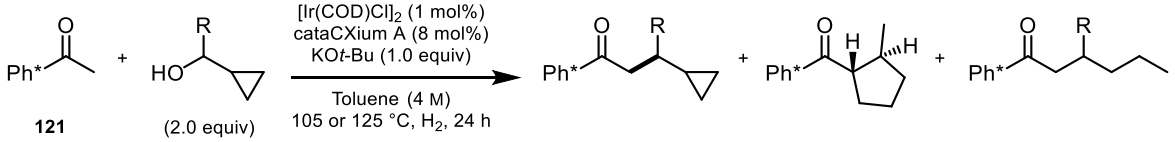
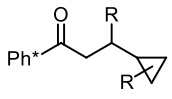
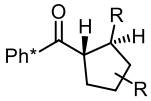
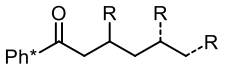
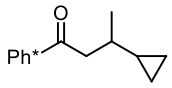
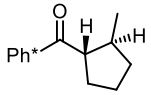
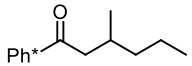
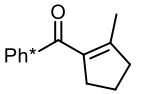
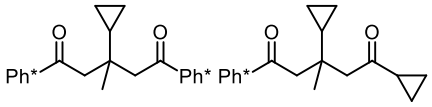
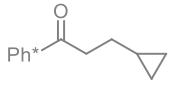
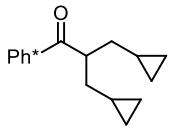
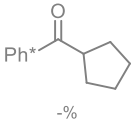
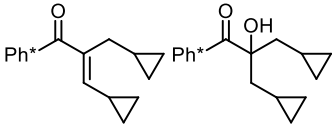
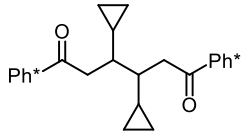
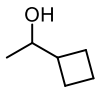
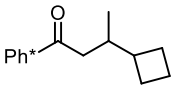
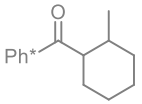
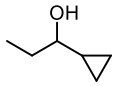
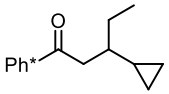
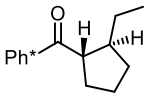
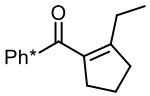
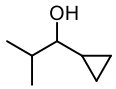
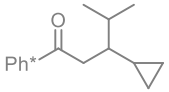
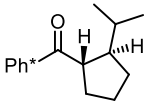
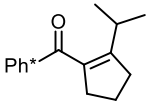
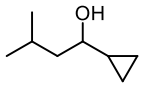
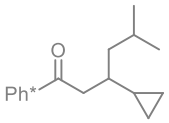
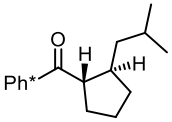
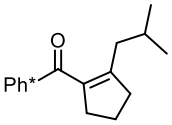
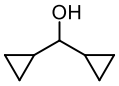
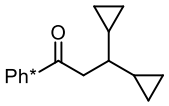
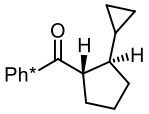
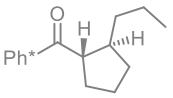
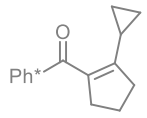
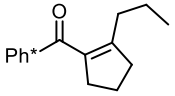
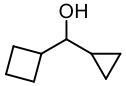
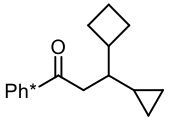
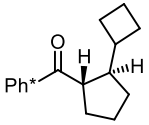
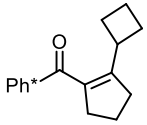
		 			
DMSO	26.4 (R = H) 27.1 (R = Me)	24.7 (R = H) 24.4 (R = Me) 23.5 (R = Bn)	24.7	16.4	11.0 (Ph) 11.1 (*o*-Tolyl) 11.3 (*m*-Tolyl) 11.4 (*p*- Tolyl)	11.3 (R = OMe) 10.9 (R = Me) 11.0 (R = OMe/Me)
H_2O[a]	19.2 (R = H) - (R = Me)	18.4 (R = H) 17.6 (R = Me) - (R = Bn)	-	12.9	4.21 (Ph) 3.91 (*o*-Tolyl) 4.24 (*m*-Tolyl) 4.38 (*p*-Tolyl)	3.44 (R = OMe) 3.45 (R = Me) 3.46 (R = OMe/Me)

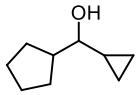
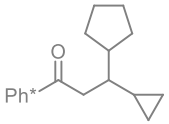
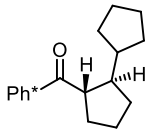
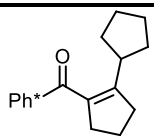
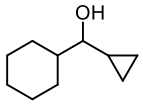
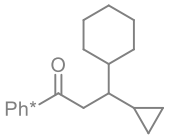
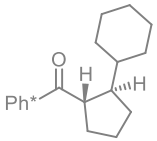
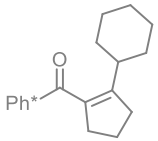
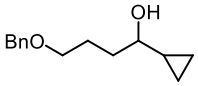
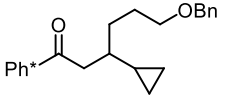
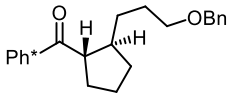
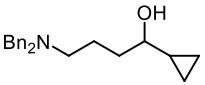
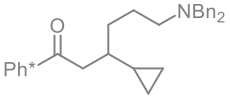
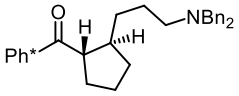
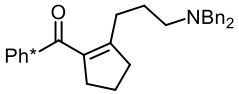
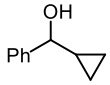
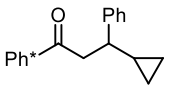
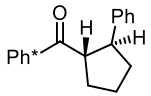
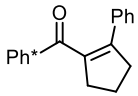
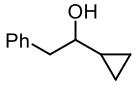
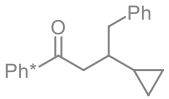
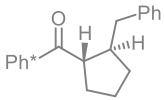
Table 10.3 *pK_a values of several carbon acids. The ketones shown were able to be used for hydrogen borrowing with higher alcohols and/or secondary alcohols. The manifestation of the ortho-effect in the pK_a of benzoic acids is particularly clear. See also Table 1.1. [a]Some data for pK_a in water is unavailable.*[74–76]

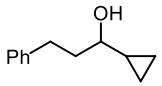
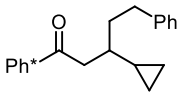
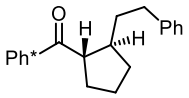
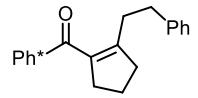
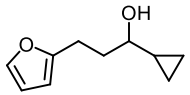
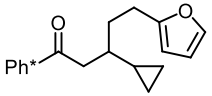
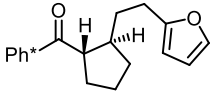
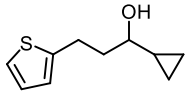
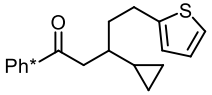
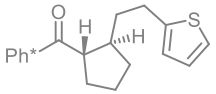
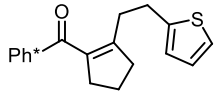
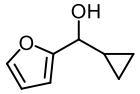
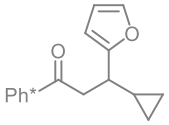
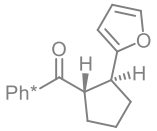
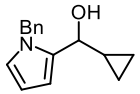
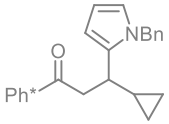
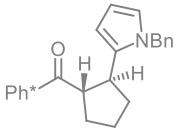
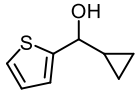
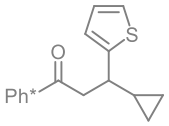
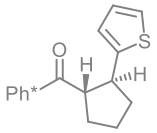
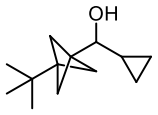
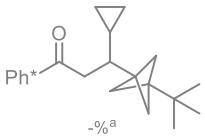
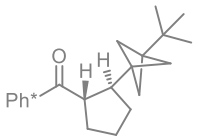
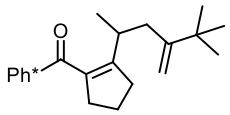
Appendix 10.4 Complete List of Products from the Substrate Scope Study of the VCP Rearrangement/Hydrogen Borrowing Reaction

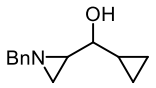
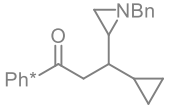
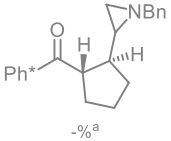
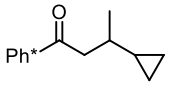
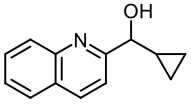
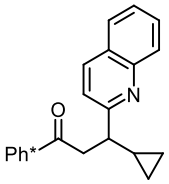
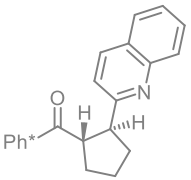
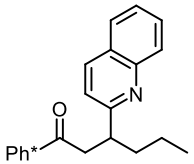
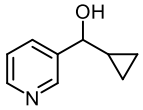
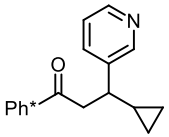
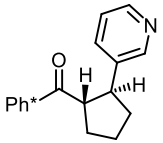
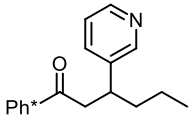
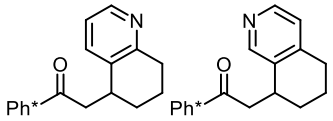
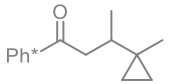
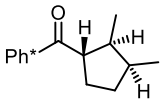
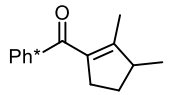
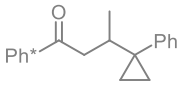
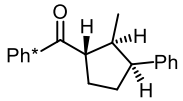
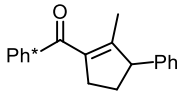
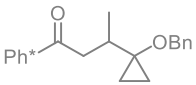
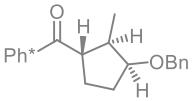


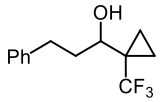
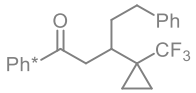
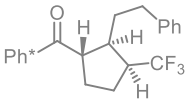
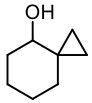
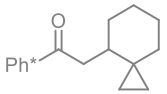
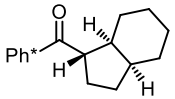
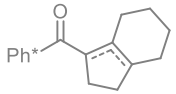
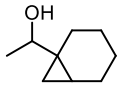
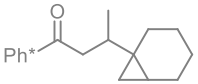
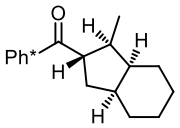
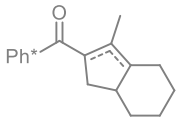
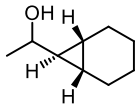
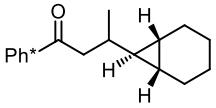
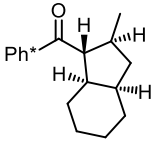
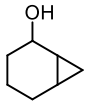
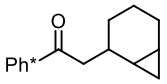
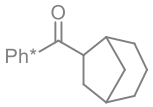
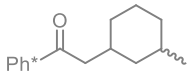
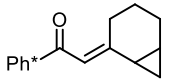
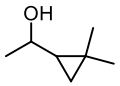
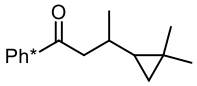
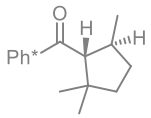
Entry	Alcohol	Yield (%)			
					Enones and other side products
1		 **196** 25% 19%[a]	 **176** 56% 52%[a]	 **197** Traces Traces[a]	 **177** Traces -%[a]  **199** Traces **200** Traces
2		 **303** Traces  **304** 4%	 -%	-	 **305** 61%[b] **306** 2%[b]  **307** 7%[b]

3	 **295**	 **298** 76%[b]	 **299** -%	-	-
4		 **231** 8%[b] 8%[a]	 **232** 50%[b] 67%[a]	-	 **S44** 10%[b] Traces[a]
5		 Traces	 **233** 6%[b]	-	 **S45** 19%[b]
6		 -% -%[a]	 **234** 15%[b] 29%[a,b]	-	 **S46** 6%[b] N.D.[a]
7		 **165** 3% 6%[a]	 **166** 32% 56%[a]	 11% 13%[a] (tentative structure)	 Traces Traces[a]  **302** N.D. N.D.[a]
8		 **235** 5%[b]	 **236** 71%[b]	-	 **S47** 11%[b]

9		 -%	 **237** 5%[b]	-	 **S48** 12%
10		 -%	 Traces	-	 Traces
11		 **242** 2%	 **243** 74%[a]	-	-
12		 -%[a]	 **244** 72%[a,b]	-	 **S49** 7%[a,b]
13		 **238** 6% 8%[a]	 **239** 41% 57%[a]	-	 **295** 6% Traces[a]
14		 -%	 -%	-	-

15		 **240** 9% 20%[a]	 **241** 45% 51%[a]	-	 **S50** 13% Traces[a]
16		 **245** 7%[a]	 **246** 45%[a]	-	-
17		 **247** 7%[a,b]	 -%[a]	-	 **S51** 10%[a,b]
18		 -%[a]	 -%[a]		
19		 -%[a]	 -%[a]	-	-
20		 -%[a]	 -%[a]	-	-
21	 **217**	 -%[a]	 -%[a]	-	 **248** 6%[a,b]

22	 **249**	 -%[a]	 -%[a]	-	 **196** 13%[a]
23	 **250**	 **251** 26%[a]	 **252** -%[a]	 **253** 34%[a]	-
24	 **254**	 **255** 33%[a]	 **256** 16%[a]	 **257** 5%[a,b]	 **258** 9%[a] **259** 4%[a]
25	 **260**	 -% -%[a]	 **261** 26% 35%[a,b]	-	 **262** 22% N.D.[a]
26	 **263**	 -%[a]	 **264** < 3%[a,b]	-	 **265** 8%[a,b]
27	 **206**	 -%	 -%	-	-

28	 **214**	 -%	 -%	-	-
29	 **223**	 -% -%[a]	 **266** 16%[b] 49%[a,b]	-	 N.D. Traces[a]
30	 **221**	 -% -%[a]	 **267** 31%[b] 64%[a]	-	 12% Traces[a]
31	 **268**	 **269** 38%[a] d.r. = 7.9:1	 **270** 47%[a]	-	-
32	 **271**	 **272** 25% *syn*:*anti* = 1.5:1	 **255** -%	 **254** Traces	 **273** 10% *E*:*Z* = 1:1
33	 **276**	 **277** 30%[a,b] d.r. = 2.2:1	 **278** -%[a]	-	-

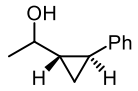
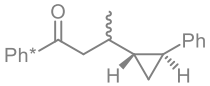
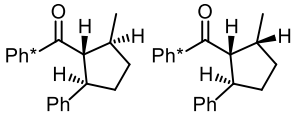
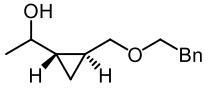
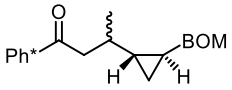
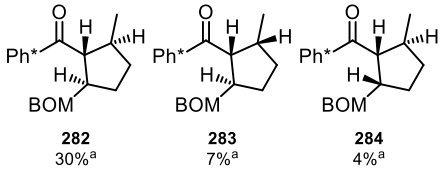
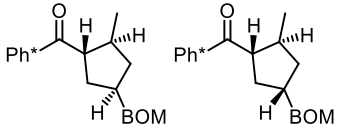
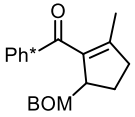
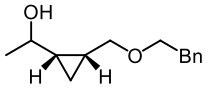
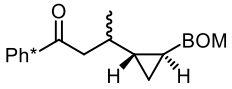
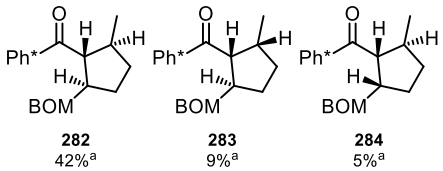
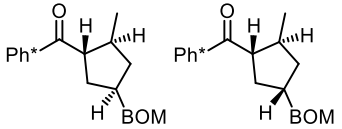
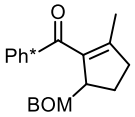
34	 **279**	 Traces[a]	 **280** 40%[a] **281** 13%[a]	-	-
35	 *trans*-**228**	 **286** 19%[a] d.r. = 1:1	 **282** 30%[a] **283** 7%[a] **284** 4%[a]  **287** 7%[a] **288** < 2%[a]	-	 **285** Traces[a]
36	 *cis*-**228**	 **286** 10%[a] d.r. = 1:1	 **282** 42%[a] **283** 9%[a] **284** 5%[a]  **287** 10%[a] **288** < 2%[a]	-	 **285** 3%[a]

Table 10.4 *Complete list of products from the substrate scope study of the VCP rearrangement/hydrogen borrowing reaction. Alcohols in entries 1, 2, 7 and 13 are commercially available. Alcohols in entries 21, 27 – 30, 35 and 36 were prepared by Choon Boon Cheong. All other alcohols were prepared by Dr. James Frost. No data is available for structures in gray. Unless otherwise stated, all the compounds are isolated as mixtures after chromatographic purification, and the reported yields of the individual components are calculated by quantitative ^{1}H NMR analysis. The identity of each compound was confirmed after further careful chromatographic purification to obtain analytically pure samples. N.D. = not determined. [a]Reaction performed at 125 °C; [b]Complete separation by chromatographic purification was achieved in these cases.*

References

[1] Watson, S. C.; Eastham, J. F. *J. Organometal. Chem.* **1967**, *9* (1), 165–168.

[2] Still, W. C.; Kahn, M.; Mitra, A. *J. Org. Chem.* **1978**, *43* (14), 2923–2925.

[3] Harris, R. K.; Becker, E. D.; Cabral de Menezes, S. M.; Granger, P.; Hoffman, R. E. and Zilm, K. W. *Pure Appl. Chem.* **2008**, *80* (1), 59–84.

[4] Betteridge, P. W.; Carruthers, J. R.; Cooper, R. I.; Prout, K.; Watkin, D. J. *J. Appl. Cryst.* **2003**, *36* (6), 1487.

[5] Frost, J. R.; Cheong, C. B.; Akhtar, W. M.; Caputo, D. F. J.; Stevenson, N. G.; Donohoe, T. J. *J. Am. Chem. Soc.* **2015**, *137* (50), 15664–15667.

[6] Akhtar, W. M.; Cheong, C. B.; Frost, J. R.; Christensen, K. E.; Stevenson, N. G.; Donohoe, T. J. *J. Am. Chem. Soc.* **2017**, *139* (7), 2577–2580.

[7] Alvaro, G.; Dambruoso, P.; Tommasi, S.; Decor, A.; Large, C. Hydantoin Derivatives Useful as Kv3 Inhibitors. US Patent 20130267510, October 10, 2013.

[8] Yuan, C.; Eliasen, A. M.; Camelio, A. M.; Siegel, D.; *Nat. Protoc.* **2014**, *9* (11), 2624–2629.

[9] Clemens, A. H.; Ridd, J. H.; Sandall, J. P. B. *J. Chem. Soc., Perkin Trans. II* **1985**, 1227–1231.

[10] Cao, P.; Khorev, O.; Devaux, A.; Sägesser, L.; Kunzmann, A. et al. *Chem. Eur. J.* **2016**, *22* (12), 4046–4060.

[11] Zheng, C.; Dubovyk, I.; Lazarski, K. E.; Thomson, R. J. *J. Am. Chem. Soc.* **2014**, *136* (51), 17750–17756.

[12] Chan, L. K. M.; Poole, D. L.; Shen, D.; Healy, M. P.; Donohoe, T. J. *Angew. Chem. Int. Ed.* **2014**, *53* (3), 761–765.

[13] Vanos, C. M.; Lambert, T. H. *Angew. Chem. Int. Ed.* **2011**, *50* (51), 12222–12226.

[14] Fuson, R. C.; Foster, R. E. *J. Am. Chem. Soc.* **1943**, *65* (5), 913–915.

[15] Fujita, H.; Kakuyama, S.; Fukuyoshi, S.; Hayakawa, N.; Oda, A.; Kunishima, M. *J. Org. Chem.* **2018**, *83* (8), 4568–4580.

[16] Keumi, T.; Matsuura, K.; Nakayama, N.; Tsubota, T.; Morita, T. et al. *Tetrahedron* **1993**, *49* (3), 537–556.

[17] Wei, Y.; Cong, X.; Zeng, X. *J. Am. Chem. Soc.* **2015**, *137* (29), 9250–9253.

[18] Shen, D.; Poole, D. L.; Shotton, C. C.; Kornahrens, A. F.; Healy, M. P.; Donohoe, T. J. *Angew. Chem. Int. Ed.* **2015**, *54* (5), 1642–1645.

[19] Lau, S.; Ward, B.; Zhou, X.; White, A. J. P.; Casely, I. J. et al. *Organometallics* **2017**, *36* (18), 3654–3663.

[20] Sanyal, A.; Snyder, J. K. *Org. Lett.* **2000**, *2* (16), 2527–2530.

[21] Ohta, T.; Komoriya, S.; Yoshino, T.; Uoto, K.; Nakamoto, Y. et al. Diamine Derivatives. EP1405852 (A1), April 7, 2004.

[22] Cogan, D.; Hao, M.-H.; Kamhi, V. M.; Miller, C. A.; Netherton, M. R.; Swinamer, A. D. 3-′4-Heterocyclyl-1,2,3,-Triazol-1-yl!-*N*-Aryl-Benzamides as Inhibitors of the Cytokines Production for the Treatment of Chronic Inflammatory Diseases. WO2005090333 (A1), September 29, 2005.

[23] Bekish, A. V.; Prokhorevich, K. N.; Kulinkovich, O. G. *Eur. J. Org. Chem.* **2006**, 5069–5075.

[24] Johnson, R. J.; O'Mahony, D. J. R.; Edwards, W. T.; Duncton, M. A. J. *Org. Biomol. Chem.* **2013**, *11* (8), 1358–1366.

[25] Goh, Y. L.; Tam, E. K. W.; Bernardo, P. H.; Cheong, C. B.; Johannes, C. W. et al. *Org. Lett.* **2014**, *16* (7), 1884–1887.

[26] Della, E. W.; Taylor, D. K. *J. Org. Chem.* 1994, 59 (11), 2986–2996.

[27] Degnan, A. P.; Maxwell, D.; Hill, M. D.; Fang, H.; Parker, M. F. et al. Oxazolidinone as Modulators of mGluR5. WO2015054103 (A1), April 16, 2015.

[28] Alcaraz, L.; Harnett, J.; Mioskowski, C.; Martel, J. P.; Gall, T. L. et al. *Tetrahedron Lett.* **1994**, *35* (30), 5449–5452.

[29] Alcaraz, L.; Cridl, A.; Kinchin, E. *Org. Lett.* **2001**, *3* (25), 4051–4053.

[30] Furukawa, J.; Kawabata, N.; Nishimura, J. *Tetrahedron* **1968**, *24* (1), 53–58.

[31] Jorand-Lebrun, C.; Lan, R.; Chen, A.; Clark, R. C. Heteroaryl Compounds as IRAK Inhibitors and Uses Thereof. WO2017049068 (A1), March 23, 2017.

[32] Charette, A. B.; Juteau, H.; Lebel, H.; Molinaro, C. *J. Am. Chem. Soc.* **1998**, *120* (46), 11943–11952.

[33] Kazuta, Y.; Abe, H.; Yamamoto, T.; Matsuda, A.; Shuto, S. *J. Org. Chem.* **2003**, *68* (9), 3511–3521.

[34] Kubota, K.; Yamamoto, E.; Ito, H. *J. Am. Chem. Soc.* **2013**, *135* (7), 2635–2640.

[35] Endo, Y.; Bäckvall, J.-E. *Chem. Eur. J.* **2011**, *17* (45), 12596–12601.

[36] Riss, P. J.; Rösch, F. *Org. Biomol. Chem.* **2008**, *6* (24), 4567–4574.

[37] Clausen, C.; Wartchow, R.; Butenschön, H. *Eur. J. Org. Chem.* **2001**, 93–113.

[38] Zhou, Y.-Y.; Uyeda, C. *Angew. Chem. Int. Ed.* **2016**, *55* (9), 3171–3175.

[39] Garayalde, D.; Gómez-Bengoa, E.; Guang, X.; Goeke, A.; Nevado, C. *J. Am. Chem. Soc.* **2010**, *132* (13), 4720–4730.

[40] Ji, Y.; Trenkle, W. C.; Vowles, J. V. *Org. Lett.* **2006**, *8* (6), 1161–1163.

[41] Imamoto, T.; Takiyama, N.; Nakamura, K.; Hatajima, T.; Kamiya, Y. *J. Am. Chem. Soc.* **1989**, *111* (12), 4392–4398.

[42] Kohara, T.; Hashimoto, Y.; Shioya, R.; Saigo, K. *Tetrahedron: Asymmetry* **1999**, *10* (24), 4831–4840.

[43] Skillinghaug, B.; Sköld, C.; Rydfjord, J.; Svensson, F. Behrends, M. et al. *J. Org. Chem.* **2014**, *79* (24), 12018–12032.

[44] Lubish, W.; Raschack, M.; von Philipsborn, G. *p*-Hydroxy Phenone Derivatives and the Use Thereof. US5118682 (A), June 02, 1992.

[45] Ahlin, J. S. E.; Donets, P. A.; Cramer, N. *Angew. Chem. Int. Ed.* **2014**, *53* (48), 13229–13233.

[46] Lu, L.; Liu, H.; Hua, R. *Org. Lett.* **2018**, *20* (11), 3197–3201.

[47] Manglik, A. K.; Moodie, R. B.; Schofield, K.; Dedeoglu, E.; Dutly, A.; Rys, P. *J. Chem. Soc., Perkin Trans. II* **1981**, 1358–1366.

[48] Fuson, R. C.; Bannister, R. G. *J. Am. Chem. Soc.* **1952**, *74* (4), 1629–1631.

[49] Poole, D. L. Studies Towards the Nucleophilic Dearomatisation of Electron-Deficient Heteroaromatics and Hydrogen Borrowing Reactions of Methanol. DPhil. Thesis, University of Oxford, 2014.

[50] Kim, M. Y.; Lim, G. J.; Lim, J. I.; Kim, D. S.; Kim, I. Y.; Yang, J. S. *Heterocycles* **1997**, *45* (10), 2041–2043.

[51] Diemer, V.; Chaumeil, H.; Defoin, A.; Fort, A.; Boeglin, A.; Carre, C. *Eur. J. Org. Chem.* **2006**, 2727–2738.

[52] Tagaki, M.; Tazaki, M.; Matsuda, T. *Bull. Chem. Soc. Jpn.* **1977**, *50* (10), 2704–2713.

[53] Nagai, H.; Morita, Y.; Shhimizu, Y.; Kanai, M. *Org. Lett.* **2016**, *18* (9), 2276–2279.

[54] Uto, Y.; Karasawa, H.; Takaishi, K. Novel Tetrahydroisoquinoline Compounds. EP2471777 (A1), July 04, 2012.

[55] Newman, M. S.; Lord, B. T. *J. Am. Chem. Soc.* **1944**, *66* (5), 733–735.

[56] Chan, T.-L.; Mak, T. C. W.; Poon, C.-D.; Wong, H. N. C.; Jia, J. H.; Wang, L. L. *Tetrahedron* **1986**, *42* (2), 655–661.

[57] Smith, J. G.; Wikman, R. T. *Tetrahedron* **1974**, *30* (16), 2603–3611.

[58] Cai, M.; Zheng, G.; Ding, G. *Green Chem.* **2009**, *11* (10), 1687–1693.

[59] Szmant, H. H.; Basso, A. J. *J. Am. Chem. Soc.* **1951**, *73* (10), 4521–4523.

[60] Kohler, E. P.; Blanchard Jr., L. W. *J. Am. Chem. Soc.* **1935**, *57* (2), 367–371.

[61] Liang, Y.-F.; Zhou, X.-F.; Tang, S.-Y.; Huang, Y.-B.; Feng, Y.-S.; Xu, H.-J. *RSC Adv.* **2013**, *3* (21), 7739–7742.

[62] Kerr, W. J.; Mudd, R. J.; Paterson, L. C.; Brown, J. A. *Chem. Eur. J.* **2014**, *20* (45), 14604–14607.

[63] Liu, P.; Liang, R.; Lu, L.; Yu, Z.; Li, F. *J. Org. Chem.* **2017**, *82* (4), 1943–1950.

[64] Fuson, R. C.; Hammann, W. C. *J. Am. Chem. Soc.* **1952**, *74* (7), 1626–1628.

[65] Woo, J. C. S.; Fenster, E.; Dake, G. R. *J. Org. Chem.* **2004**, *69* (25), 8984–8986.

[66] Pelletier, G.; Bechara, W. S.; Charette, A. B. *J. Am. Chem. Soc.* **2010**, *132* (37), 12817–12819.

[67] Takeuchi, H.; Adachi, T.; Nishiguchi, H; Itou, K.; Koyama, K. *J. Chem. Soc., Perkin Trans I* **1993**, 867–870.

[68] Niksch, T.; Görls, H.; Weigand, W. *Eur. J. Inorg. Chem.* **2010**, 95–105.

[69] Dierkes, P.; van Leeuwen, P. W. N. M. *J. Chem. Soc., Dalton Trans.* **1999**, 1519–1530.

[70] Tolman, C. A. *Chem. Rev.* **1977**, *77* (3), 313–348.

[71] Carrow, B. P.; Chen, L. *Synlett* **2017**, *28* (3), 280–288.

[72] Immirzi, A.; Musco, A. *Inorg. Chim. Acta* **1977**, *25*, L41–L42.

[73] Clavier, H.; Nolan, S. P. *Chem. Commun.* **2010**, *46*, 841–861.

[74] Bordwell, F. G. *Acc. Chem. Res.* **1988**, *21* (12), 456–463.

[75] Matthews, W. S.; Bares, J. E.; Bartmess, J. E.; Bordwell, F. G.; Cornforth, F. J. et al. *J. Am. Chem. Soc*. **1975**, 97 (24), 7006–7014.

[76] Jover, J.; Bosque, R.; Sales, J. *QSAR Comb. Sci.* **2008**, *27* (5), 563–581.